Proceedings Presentation

＜12:35～13:50 at Room A＞

Chairperson：Kiyohisa Natsume（Kyushu Institute of Technology）

A-1. Possibility of regional revitalization by students' IT

Soji Otabe（Kyushu Institute of Technology）

A-2. Effect of Physical Exercise in High-Pressure High-Oxygen Environment on Vascular Endothelial Function and Cognitive Performance

Nakao Takehira（Kyushu Sangyo University）

A-3. Development of Learning Environment by Posing Arithmetic Word Problem as "Learning by Teaching" and Its Preliminary Evaluation

Yuuya Matuno（Kindai University）

A-4. Development of Tracking Method Using Individual Player Identification in Field Sports

Wenyuan Jiang（Osaka Sangyo University）

A-5. Development of a new smart insole designed to prevent stride shortening during exercise walking

Kazushige Oshita（Okayama Prefectural University）

＜13:55～15:25 at Room A＞

Chairperson：Hirohisa Isogai（Kyushu Sangyo University）

A-6. University Enrollment of Japan's Representatives in the Tokyo Olympics: Examination by Gender and Competition

Futa Yahiro（Japan University of Economics）

A-7. Study on Play Type Estimation Using Soccer Game Video Images

Kazuma Sakamoto（Komatsu University）

A-8. Change in perception of corporal punishment among college students who heard about a case of child suicide caused by instruction

Yuya Watanabe（Japan University of Economics）

A-9. Accuracy Improvement in Player Detection Using Deep Learning in Field Sports

Yuhei Yamamoto（Kansai University）

A-10. Analysis of Data Using Information and Communication Technology Related to Education

Hiroyuki Maruyama（Takushoku University）

A-11. The gains and losses of moving an interactive pre-FD program from face-to-face to online

Kayoko Kurita（The University of Tokyo）

＜12:35～13:50 at Room B＞

Chairperson：Yuhei Yamamoto（Kansai University）

B-1. Micro-dynamic Pricing Modeling: Price Personalization in Digital Platform

Kazuhiro Miyatsu（Senshu University）

B-2. Proposal of Method for Efficient Management of Digital Data on Public Structures Using Metaverse Space

Yoshinori Tsukada（Setsunan University）

B-3. Fundamental Research on Determination of Working State of Construction Machinery Using Deep Learning

Yoshimasa Umehara（Setsunan University）

B-4. A study of cognitive function in professional and university soccer players

Yoshiko Saito（Kyushu Institute of Technology）

B-5. Study on Generating Parametric Models of Bridges Using Part-Identification Technology for Point Cloud Data

Masaya Nakahara（Osaka Electro-Communication University）

＜13:55～15:25 at Room B＞

Chairperson：Kazumoto Tanaka（Kindai University）

B-6. Exploring Micromanagement and Multiple Target Tracking Skills in Esports Players: Insights from Perceptual and Cognitive Tasks

Ryousuke Furukado（Nishinippon Institute of Technology）

B-7. The relationship between music preference and time-frequency-based phase difference between BRAIN WAVES and audio of music

Akio Wakata（Kyushu Institute of Technology）

B-8. The Effects of Positive and Negative Ions on esports Performance and Arousal Levels Part 2 -Testing Higher Ion Density-

Goichi Hagiwara（Kyushu Sangyo University）

B-9. Activity of the inferior frontal gyrus during a driving game

Takashi Oyama（Okayama Prefectural University）

B-10. Study of SEO Strategies to Improve a Website Search Result Ranking

Kazuma Sakamoto（Komatsu University）

Digital Life

Journal of Digital Life 2023, A-1

Conference Proceedings

Possibility of regional revitalization by students' IT

Edmund Soji Otabe [1], Yusei Hyodo [2] and Takafumi Miyasato [3]

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Abstract

Recently, the number of students who can develop applications that can actually be used has increased. We thought that this power could be used for regional revitalization, we tried to connect the students and the region. First we start to extract the issues in regional area by a questionnaire. This questionnaire was taken by various age groups, and simply asked how local problems could be solved, or what kind of things they wanted to be solved in Saikai City, Nagasaki by Saikai Creative Company. As a result, we were able to create some interesting applications, some of which have become widely used in practice. For example, there was a request to have an OCR application which is easier than usual one. Fig. 1 shows the Transcription Varygood-kun which you take the photo of document and get text data on LINE. LINE has 95 million active users as of March 2023, and is an application that can send messages that can be used on smartphones, etc., which is used by most Japanese people. Varygood-kun is the LINE bot and a character created by Saikai Creative Company, and the story is added that if the user asks this character for a job, it will be solved. Therefore, all you have to do is become friends with the Transcription Varygood-kun. You will find it is very easy to use compared with usual OCR systems. Fig. 2 is the Painter Varygood-kun. There are more than 2.5 million friends as of August 2023. If you send the text for the picture you want such as “Photo of an astronaut on a horse”, you can get the image via LINE. For students, before going out to society, they can work on practical application development and know what kind of ingenuity is necessary to get them to actually use it. Also, from a local point of view, it is quite risky to suddenly ask a software development company to develop an application that solves a problem. Considering the time required for implementation, cost, and flexible handling, it is clear that realization is difficult. And we do not know whether the created application will actually be used. On the other hand, if you develop with students, there is a risk that it will not be realized, but you can minimize the development time and cost through frequent communication.

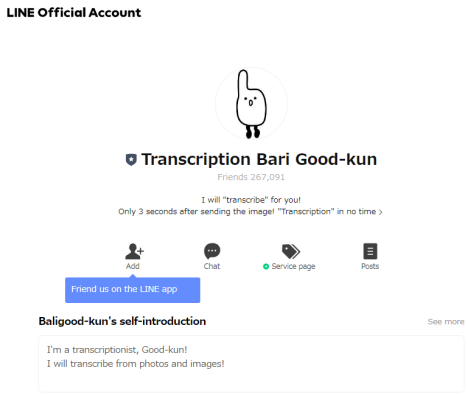

Fig. 1. Transcription Varygood-kun

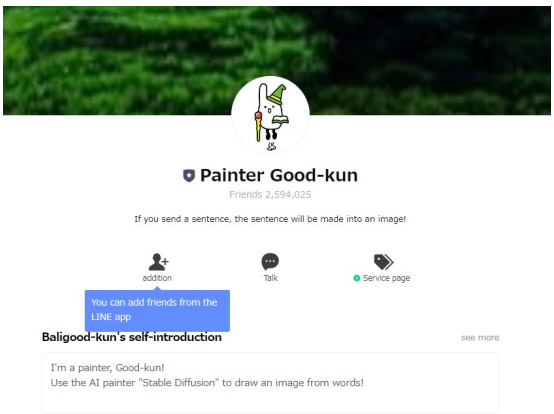

Fig. 2. Painter Varygood-kun

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Digital Life

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Conference Proceedings

Effect of Physical Exercise in High-Pressure High-Oxygen Environment on Vascular Endothelial Function and Cognitive Performance

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Abstract

The effects of microgravity on the body are wide-ranging and include space sickness, balance disorders, muscle and bone loss, visual disturbances, orthostatic hypotension, and exposure to space radiation (Lackner JR, 2006; Peter HU Lee, 2022; Wojcik P, 2020). It has been noted that these effects can be seen as similar phenomena in the elderly on the ground (1gravity). As humans are expected to expand their life sphere in the microgravity environment of space, research on the body's physiological response and prediction of pathological conditions will be of great importance. Currently, astronauts and trainers are undergoing training on the ground to simulate the space environment. Among these, underwater work tasks in high-pressure environments and under buoyancy control are particularly demanding (Andrew PK, 2020). While biomonitoring in these work environments is primarily conducted for accident prevention and health management, there is still a lack of basic data on biological responses. In the future, it is conceivable that these environments could have a positive effect on body function, as in hyperbaric oxygen (HBO) therapy. In the medical field, body functions are improved by placing humans in hyperbaric chambers with absolute pressures exceeding 2.0 atmospheres, thereby increasing partial pressure of oxygen, blood volume, and dissolved oxygen. This technique has been reported to be effective in treating decompression sickness, Alzheimer's disease, and vascular dementia (Ishihara, 2005; Priya B, 2021; Yuan L, 2018). On the other hand, regular aerobic exercise in a normal environment (normobaric normoxic environment) has been reported to contribute to health maintenance and promotion. Specific benefits include delaying the age-related decline in vasodilatory function (DeSouza CA, 2000), enhancement of vascular endothelial nitric oxide synthase (eNOS) phosphorylation by aerobic exercise (Hambrecht R, 2003 2003), and endurance training promotes nitric oxide synthesis (Maeda S, 2001). Furthermore, it has been reported that aerobic exercise is effective not only in improving vascular function, but also in preventing brain dysfunction and improving neurological diseases (Adlard PA, 2005), improving glucose metabolism by increasing neurotrophic factor (BDNF) in the hippocampal region of the brain (Nakagawa T, 2000), improving memory learning ability (Radak Z, 2001). Vascular endothelial dysfunction in a normal environment may contribute to lifestyle-related diseases such as hypertension, cerebrovascular disease, and dyslipidemia, and may also affect motor dysfunction and dementia. However, the general response of vascular endothelial function and cognitive function in the unique environment of high-pressure hyperoxia and its synergistic effects with exercise have not yet been examined. Further research in this area is needed to examine the diversity of exercise prescriptions.
The purpose of this study was to determine the effects of physical exercise in a hyperbaric hyperoxic environment on vascular endothelial function and cognitive function.

Twelve healthy male non-smokers (age 19.5 ± 0.7 years, height 171.5 ± 6.2 cm, weight 68.6 ± 14.9 kg, BMI 23.3 ± 4.5 kg/m^2) were selected as subjects for the study. Subjects were given a detailed explanation of the purpose, objectives, content, methods, and possible risks of the study, both written and verbal. Written consent was then obtained before the study began. The study was approved by the Ethical Review Board for Research on Human Subjects of Kyushu Sangyo University and the approval number is 2019-0013.

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This study was conducted as a randomized crossover study. The study period was set from May 26, 2023 to August 3, 2023. Prior to the start of the experiment, subjects underwent an exercise stress test to estimate body shape, body composition, cognitive function, and peak oxygen uptake (VO_2 peak), as well as to measure ecological responses before and after their stay in the hyperbaric hyperoxic chamber. Body shape measurements were taken using a stadiometer (A&D co. LTD) and height was measured using common methods. Body weight, body composition, and basal metabolic rate were measured using a dedicated bioelectrical impedance instrument (Inbody 770, Inbody Japan). exercise testing for VO_2 peak estimation was performed using a respiratory metabolic monitoring system (AE-310S, Minato Medical Science) and a bicycle ergometer (STB-3400, Nihon Kohden). Flow-mediated dilation response (FMD: flow-mediated dilation) was measured by B-mode ultrasound imaging (UNEX EF 38G, UNEX Corporation) using a 7.5-MHz linear array transducer. Specifically, in the morning, after 5 minutes of rest in the supine position, the right brachial artery was scanned in longitudinal section 1-10 cm above the elbow, marked on the skin surface, and the arm was kept in the same position during the measurement. After baseline measurement of brachial artery diameter, resting heart rate and blood pressure were measured. A pneumatic cuff placed around the forearm inflated the systolic blood pressure to about 160 mmHg and egested the vessel for 5 minutes only. After the ejection was released, blood flow velocity and blood flow-dependent vasodilatory responses were measured over a 2-minute period. The New Stroop Test II (Stroop Test II, Toyo Physical) was used to measure cognitive function. The New Stroop Test II consists of four tasks. Tasks 1 and 3 consisted of letter and color processing for information processing speed, and tasks 2 and 4 consisted of this task plus a task test in which subjects were asked to pay attention to either color or letter, which indicates attentiveness. Subjects were randomly divided into a normobaric normoxic group (n=6) and a hyperbaric hyperoxic group (n=6). Each group trained in a different environment, exercise frequency was twice a week for 8 weeks, duration was 60 minutes per session, bicycle ergometer intensity was 60-70% of VO_2 peak, and rotation speed was 50-60 rpm. Hyperbaric hyperoxic bicycle exercise was performed for 60 minutes after reaching an absolute pressure of 1.4 ATA. Each group was given an interim measurement after 4 weeks of exercise, then switched exercise environments and exercised for another 4 weeks. after 8 weeks of exercise, measurements were taken again under the same conditions as before the start of the experiment. Statistical analysis was performed using SPSS Advanced Statistics (IBM Inc., Chicago, IL). All values are presented as mean ± standard deviation (Means ± SD). Corresponding t-tests were used to compare the measures. The significance level was set at less than 5%. Other results are currently being analyzed. This work was supported by JSPS KAKENHI Grant Number 23K01975.

Digital Life

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Conference Proceedings

Development of Learning Environment by Posing Arithmetic Word Problem as "Learning by Teaching" and Its Preliminary Evaluation

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Abstract

A widely handled learning method to understanding of arithmetic word problem is to solve problems. On the other hand, it has also been noted by several researchers that posing problems, rather than solving them, is more useful for understanding arithmetic word problem. This learning method is also mentioned in the Japanese elementary school arithmetic guidelines and is regarded as a useful activity. However, a challenge in widely disseminating this learning method is that it is difficult to assess problems posed by learners. In response, a learning environment called Monsakun has been developed, which can automatically assess problems posed by learners by implementing an explainable AI that understands arithmetic word problems. This learning environment is used in various elementary schools and has been implemented in digital textbooks.

Monsakun promotes learners to understand structure of arithmetic word problems. However, there was a issue that simply performing exercises with fixed assignments did not necessarily lead to more sophisticated learning by students with high ability. Specifically, Monsakun makes students understand the structure through problem-posing. This method is appropriate because it is difficult to directly ask novice students about the conditions for the structure of arithmetic word problems, but there is also an aspect that does not explicitly have students learn to understand the structure of arithmetic word problems. Therefore, we thought that realization of more advanced learning could be achieved if students with high ability could learn the condition for structure of arithmetic word problems directly.

In this study, we tried to extend Monsakun's exercises by using a learning method called "Learning by Teaching," which is a method of learning through teaching it to others, and it is said that through the act of teaching, a deeper understanding of the subject is achieved. By using this learning method, we thought that students would become more explicitly aware of the conditions for the structure of arithmetic word problems in Monsakun than in previous systems. In order to realize this system, it is important to develop a virtual learner with whom to teach and to develop an interface for teaching. Based on this purpose, we designed and developed a virtual learner that behaves according to the understanding of the user-learner based on Monsakun's structure. We also developed an interface for teaching the virtual learner to the user-learner. Preliminary validation of the system suggested that the intended exercises could be performed, but that the interface remained problematic in terms of awareness of the activity of instructing the agent and ease of use.

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Digital Life

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Conference Proceedings

Development of Tracking Method Using Individual Player Identification in Field Sports

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[2] Faculty of Engineering, Osaka Sangyo University
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Abstract

Recently, the rapid development of deep learning has greatly improved the accuracy of the tracking of objects in images. However, in field sports, where occlusion frequently occurs, existing object tracking methods cannot track players for a long time. Furthermore, these methods cannot identify individual players, so it is difficult to obtain the data that is essential for advanced tactical analysis, such as the distance run for each player. In this study, we attempt to improve the tracking accuracy by developing a method that can identify individual players by tracking them from images captured by an inexpensive video camera.

Introduction

In Japan, research on game strategy is being actively carried out to realize the sustainable improvement of international competitiveness. For example, for field sports, there are studies on the estimation of the player condition and the prediction of the success or failure of a play with the application of player tracking. The methods that can be used to track players include methods using GNSS sensors and methods using image processing technology, but as mounting sensors on players may not be possible during a match, the method of using image processing technology is desirable. However, the image processing methods have the problem that the cost of installing the dedicated systems is expensive, or the problem that the player tracking accuracy is low. Furthermore, there is no identification of the individual players, so only the team characteristics can be found from the individual player data such as the running distance of each player. In this study, we attempt to improve the tracking accuracy by developing a method (Fig. 1) that can identify individual players before and after occlusion by tracking them from the images captured by an inexpensive video camera.

Proposed method

Fig. 2. shows the processing flow of the proposed method. The proposed method is composed of a tracklet extraction function, a player ReID model building function and an individual player identification function.

In the tracklet extraction function, first, YOLOX is used to detect the players per frame. Next, the object tracking method ByteTrack is used to track the players, and a tracking number is given to each player. Finally, tracking results are deleted where the framewise mutual IoU of player detections exceeds 0.1 to generate player tracklets.

In the player ReID model building function, first, player images acquired framewisely from tracklets extracted from match footage which is of different time stamps to the match footage for reference and manually corrected player IDs are used to create training data. Next, the player ReID model is built by using the learning data and using the technique CTL, which identifies individual persons.

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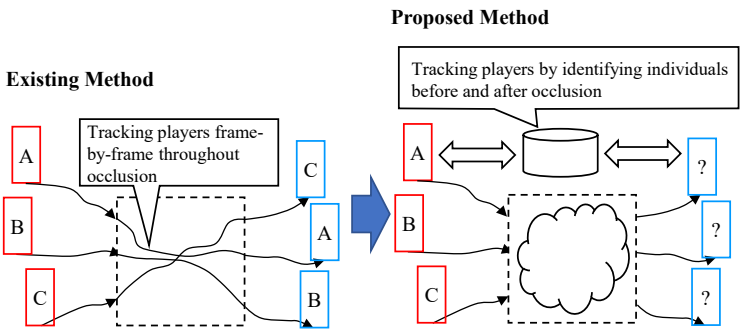

Fig. 1. Identification of individual players before and after occlusions

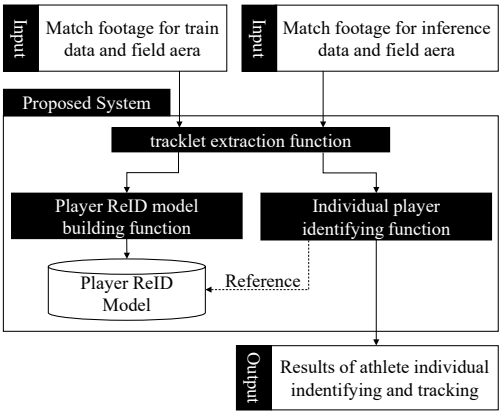

Fig. 2. Processing flow

Table 1. Experimental results

Viewpoint	Methods	GT	TP	FP
1	Existing	41,423	38,401	921
	Proposed	41,423	33,516	1
2	Existing	41,423	38,244	1,231
	Proposed	41,423	34,366	5
Viewpoint	Methods	FN	GIDSW	GMOTA
1	Existing	3,022	15,093	0.54
	Proposed	7,907	3,762	0.72
2	Existing	3,179	24,709	0.30
	Proposed	7,057	8,368	0.63

$$GMOTA = 1 - \frac{\sum_t (FN_t + FP_t + GIDSW_t)}{\sum_t GT} \qquad \text{Equation 1}$$

Fig. 3. An example of tracking results

In the individual player identifying function, first, the correspondence relation between a tracklet and a player ID is sequentially updated based on the upper ranking results of the ReID results for each tracklet. Finally, the trajectory of a player is output by combining the tracklet associated with the same player ID.

Demonstration experiment

In this experiment, the usefulness of the proposed method is verified by applying an existing method (ByteTrack) and the proposed method to a footage of soccer match and confirming the tracking accuracy for each player. The images for the experiment were captured in 4k at 30 fps using cameras installed on the diagonals of the field in positions that could capture the entire field from diagonally above with all four corners of the field included in the angle of view. The train data is the player images and IDs for 23 players and one referee created by the player ReID model building function using footages taken from two viewpoints for seven minutes from the start of a match. Next, the existing method and the proposed method are applied to footages from two viewpoints lasting for one minute from nine minutes after the start of the match and each result is compared with the correct answer data created manually. Evaluation was then performed using the number of ground truth player detections (GT), the number of true positive player detections in the tracking results (TP), the number of false positive detections of players (FP), the number of players undetected (FN), and the number of incorrect answers in the individual player tracking (GIDSW). The tracking accuracy evaluation index GMOTA calculated from these detection quantities by using Equation 1 was used for the evaluation.

Table 1 shows the experiment results, and Figure 3 shows an example of the tracking results. From GMOTA, it was found that from both viewpoints, the proposed method was a great improvement from the existing method. This is because it was possible to reduce FP by deleting the player detection results at occlusion points and to reduce GIDSW through the identification of individual players using the player ReID model. From the results above, the usefulness of the proposed method was confirmed. On the other hand, the deletion of the player detection results at occlusion points meant that a decrease in TP and an increase in FN were observed. In order to respond to this issue, in the future, we will develop a tracking method that uses images taken from multiple viewpoints in a localized part of the field to aim for further improvement of the tracking accuracy.

Conclusion

In this study, we proposed a tracking method using the individual identification of players. Through the demonstration experiment, we confirmed that the player tracking could be performed with high accuracy by using the proposed method. In the future, we will aim for further accuracy improvement through tracking using images taken from multiple viewpoints in a localized area of the field.

Reference

Naik, T., Hashmi, F., Geem, W. and Bokde, D. (2022), DeepPlayer-Track: Player and Referee Tracking with Jersey Color Recognition in Soccer, IEEE Access, 10, 32494-32509.

Digital Life

Journal of Digital Life 2023, A-5

Conference Proceedings

Development of a new smart insole designed to prevent stride shortening during exercise walking

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[1]Department of Human Information Engineering, Okayama Prefectural University

Abstract

Many "smart insoles" have attracted attention, where various sensors are embedded in the insole and the walking and/or running status (speed, distance, number of steps, stride length, etc.) is displayed on a mobile device. Current smart insoles allow the user to check their walking and running status and adjust their movements based on this information. However, some users may only check their condition and not be able to improve their movement. If the smart insole itself analyses the gait and provides some stimulus to the user via the insole, thereby making the user aware of improving the gait, it would be an 'advanced' smart insole.

Although gait consists of cadence and stride, widening stride can be achieved by a variety of strategies, including landing the swinging leg more forward, enhancing push-off at terminal stance, increasing arm swing, and increasing trunk roll. Our previous study investigated how individuals widen their stride during brisk gait [1]. Eighteen healthy males performed two 10-meter gait tasks: 1) they simply walked faster and 2) they walked faster with wider strides. The participants were then asked how they widened their stride. The study was found that 14 of them widened their stride in an attempt to extend their swinging leg forward. Two participants attempted to increase the push-off during the terminal stance phase, while the remaining two participants were aware of both. The study also investigated the effects of extending the stride while emphasizing push-off at the terminal stance phase on strides. Fourteen participants who were not aware of push-off during the terminal stance phase when widening their strides performed a 10-meter fast gait task with widening the strides while emphasizing the push-off during the terminal stance phase. This experiment observed that the emphasis on push-off resulted in a wider stride than the attempting to extend the swinging leg forward. Therefore, these results suggest that although most (approximately 80%) of the participants widened their stride by attempting to extend the swinging leg forward, the enhancement of push-off in the terminal stance phase resulted in more widened strides [1].

The enhancement of the push-off may have a number of other benefits. For example, shorter strides have been associated with lower muscle strength [Ostrosky et al., *Phys Ther*, 1994]. Age-related impairment in ankle power-generating capacity limits gait speed and step length [McGibbon, *Exerc Sport Sci Rev*, 2003]. Furthermore, in relation to fall prevention, the onset of reduced push-off in the terminal stance phase with age may independently contribute to poorer balance control and precipitate slower gait speeds [Browne & Franz, *R Soc Open Sci*, 2017]. These reports suggest that promoting adequate push-off and improving gait with sufficient strides may be beneficial for 1) increasing physical activity through exercise, 2) preventing age-related declines in gait speed, and 3) preventing falls from a balance control perspective.

Because of these benefits, this study attempted to enhance push-off during walking using light tactile stimulation (i.e., tactile guidance) to the plantar surface with an insole [2]. The tip of the insole was heated (the area from the ball of the foot to the toe of the insole) and participants were instructed to widen their stride while pushing off with the warm area. Heat-generating insoles with embedded electrically heated elements have been developed and marketed in recent years. Most are charged by a USB or other power source and generate heat in response to the ambient temperature (e.g. in cold environments) to maintain a comfortable plantar temperature. The heating insole had a simple structure consisting of an embedded heat-generating foil and a small battery. Therefore, with a smart insole, stride shortening is detected and then heating the tip of the insole may allow the user to perceive a push-off area. The stride may then increase when the user tries to push off with the warm part. In order to develop such insoles, it is first necessary to determine whether stimulation of the sole can lead the user to the target gait movement. Therefore, the first

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experiment investigated the effect of heating the tip of the insole to facilitate conscious pushing off with the warm part on lower limb joint angles during gait [2].
Fifteen healthy males performed treadmill walking under three different conditions: CONTROL walked as usual; INST was instructed to extend the stride with an enhancement of push-off with a normal insole, and HEAT was asked to walk while attempting to push-off the warm area, which was attached to the disposable warmer over the area from the ball of the foot to the toe of the insole. A 3D motion capture system with infrared cameras was used to analyse the gait. The hip joint range of motion (ROM) increased significantly with INST and HEAT. Although ankle dorsiflexion at heel strike was not significantly different for these conditions, ankle plantarflexion at toe-off increased significantly for INST and HEAT. In particular, the effect size (*d*) for increased plantarflexion was large for HEAT (=1.50), whereas it was moderate for INST (=0.68). These results suggest that a heated stimulus during gait increased awareness of push-off and increased leg swing and ankle plantarflexion during the terminal stance phase, which may increase stride.
However, the experiment only found an increase in plantarflexion when the tip of the insole was heated. Based on the experimental results, the insoles should be kept warm to prevent stride shortening. However, prolonged heating may cause discomfort to the sole (e.g. sweating). In addition, if the heat applied is 44°C or more for a long time, skin tissue damage will occur, which could lead to low-temperature burns from such a heated insole. Therefore, in the second experiment, the changes in gait movements during and immediately after the enhancement of push-off by heating the tip of the insole were investigated [unpublished data].
Twelve healthy men walked on a treadmill in three different conditions as in the previous experiment. In the INST and HEAT conditions, hip and ankle ROM and step length increased during push-off attention. However, the ankle ROM and step length in the HEAT condition increased significantly even immediately after the use of the heated insoles compared to before use. This increase in ROM may have been caused by increased plantarflexion during the terminal stance phase. One concern in the first experiment with heated insoles was that keeping the insoles warm for a long time would cause discomfort and low temperature burns on the sole [2]. The results of this experiment suggest that by temporarily heating the tip of the insole to encourage the user to push off, the enhancement in push-off is maintained even when the heating is stopped. The results of this study can be applied (Figure 1) to 1) detect a shortening of the stride using currently available smart insole technology (i.e. using sensors for foot pressure distribution, acceleration, gyro, etc.); 2) temporarily heat the insole with a heating foil attached to the tip of the insole when a shortening of the stride is detected; and 3) the user can perceive how to push-off at the heated area and the stride is extended and the extension of the stride can be maintained even after the insole heating is deactivated. It would be possible to develop 'advanced' smart insoles in this process.

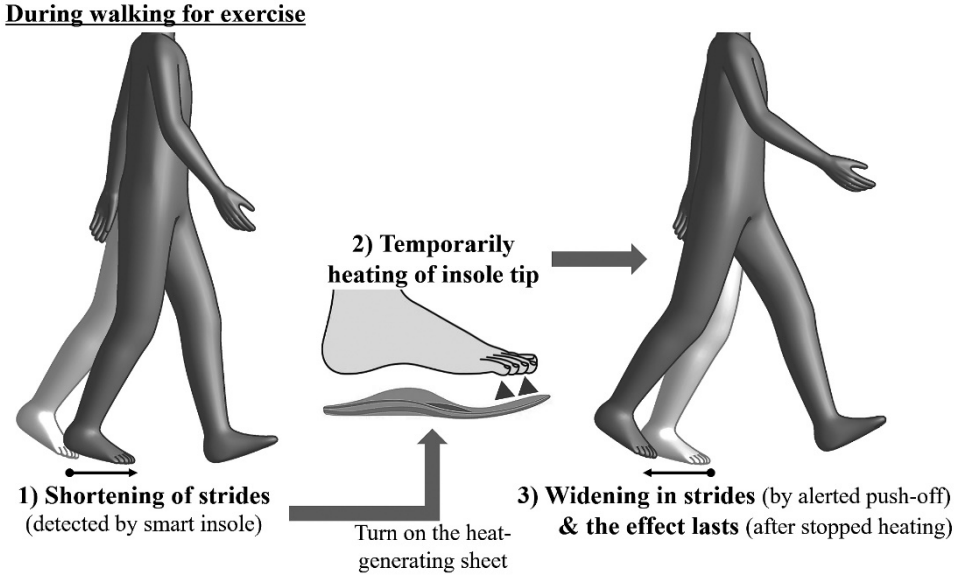

Fig. 1 Concept of “advanced” smart insole.

1. Takebe M., Oshita K. Influence of emphasizing push-off at the terminal stance phase on stride length and gait speed during fast walking. *Walking Research 26*: 111-117, 2022. (In Japanese with English abstract)
2. Oshita K. Gait improvement by alerted push-off via heating of insole tip. *Healthcare 10*: 2461, 2022. doi: 10.3390/healthcare10122461.

Digital Life

Journal of Digital Life 2023, A-6

Conference Proceedings

University Enrollment of Japan's Representatives in the Tokyo Olympics: Examination by Gender and Competition

Futa Yahiro [1], Goichi Hagiwara [2]

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Abstract

Universities have been reported to have the function of supporting the career development of athletes (Aquilina, 2013). University sports have been shown at the conference on the promotion of university sports to become an important entity that supports the development of society through sports (MEXT, 2017). Due to this situation, there is increasing interest in athletes who belong to universities (hereinafter referred to as university student athletes) (Brown et al., 2015). With the increase in the general university entrance rate, the number of top-level athletes who choose the course of university entrance is increasing (Arai et al., 2018).

In addition, from the perspective of a second career, athletes need to be active in sports as well as complete their studies, and form careers for the future, that is, dual careers. A dual career is defined as "combining the beginning and end of a competitive life, which is part of a long life, with the important events and desires that occupy each stage of school, work, and other life (EU expert group, 2012; Waku, 2015)."

However, in Japan, there are reports that female athletes have fewer options for university entrance than male athletes (Inaba et al., 2017), and it can be seen that the university entrance rate is low in sports with established professional leagues. Also, In Japan, the Basic Sports Plan (Japan Sports Agency, 2016) devises measures to raise awareness about dual careers among top-level athletes.

Therefore, in this study, we aimed to clarify the university admission situation by gender and sports, targeting top athletes in Japan, the representative athletes of the Tokyo Olympics (2021). By clarifying the progress of current top athletes, it is possible to present issues for future dual career formation.

Methods

The subjects of the survey were those registered as athletes (Including alternate players) for the Tokyo Olympics. Athletes who are university students but belong to professional and business teams are experienced university student athletes. High school and junior high school athletes are excluded from experienced university student athletes. For the current affiliation, final educational background, and competition results, the official website of the Japanese Olympic Committee was referenced (Japanese Olympic Committee, 2021).

Results & Discussion

1. Consideration by gender

The study found that 250 of 313 male athletes (79.9%) and 171 of 284 female athletes (60.2%) had gone on to college. As noted in previous studies, female athletes may have fewer college options. In Japan, there are many competitions such as the "Hakone Ekiden" in which male collegiate athletes are the focus of attention, but there are few competitions in which female collegiate athletes are the focus. Therefore, we believe it is necessary to run a tournament that is worth competing in or to increase the value of the current tournament. However, as a top athlete, it is conceivable that he may have gone on to a professional or business career

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after high school. In the future, it will be necessary to investigate the reasons why they chose to go to college or join a business career.

2. Sport-specific considerations

The number of students entering college by sport is shown in Table 1. As for male athletes, sports with established professional leagues showed lower rates of university enrollment. As for female athletes, the results showed significant differences by sport. It is highly likely that the university is not reinforcing this as a club activity, suggesting that the instructor is affiliated with a business career. It would be necessary to investigate whether universities are focusing on strengthening female athletes.

Table1 Number of athletes who went on to university

Sport	male	female	total
Athletics	44/44	13/22	57/66
Swimming	18/18	16/17	34/35
Diving	5/6	5/5	10/11
Artistic swimming		8/8	8/8
Water polo	12/12	12/12	24/24
Archery	3/3	3/3	6/6
Badminton	2/6	0/7	2/13
Baseball	12/24		12/24
Softball		1/15	1/15
Basketball	14/16	3/16	17/32
Boxing	4/4	1/2	5/6
Canoe	6/7	3/5	9/12
Cycling	2/8	5/8	7/16
Equestrain	8/9		8/9
Fencing	12/12	10/10	22/22
Football	5/22	7/21	12/43
Golf	1/2	1/2	2/4
Gymnastics	6/7	14/15	22/24
Handball	14/14	11/14	25/28
Hockey	16/16	11/16	27/32
Judo	7/7	4/7	11/14
Karate	4/4	4/4	8/8
Modern Pentathlon	0/1	0/2	0/3
Rowing	1/1	2/2	3/3
Rugby	10/12	11/12	21/24
Sailing	7/8	7/7	14/15
Shooting	4/6	2/6	6/12
SkateBoarding	1/4	0/6	1/10
Sport Climbing	1/2	0/2	1/4
Surfing	0/2	0/2	0/4
Table Tennis	2/3	0/3	2/6
Taekwondo	2/2	2/2	4/4
Tennis	2/5	1/6	3/11
Triathlon	2/2	2/2	4/4
Volleyball	13/14	3/14	16/28
Weightlifting	4/4	3/3	7/7
Wrestling	6/6	6/6	12/12
Total	250/313	171/284	421/597

Digital Life

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Conference Proceedings

Study on Play Type Estimation Using Soccer Game Video Images

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Abstract

In field sports such as soccer and American football, tactical analysis is carried out by classifying the play types from video images of the game in order to look back on the play efficiently. In professional sports, AI and dedicated fixed cameras are used for this classification work. However, in college sports, this is not widely spread because the equipment is expensive and because specialist expertise is required. Therefore, in this study, on the subject of soccer, we propose a system to estimate the play types from video of a game that has been recorded using a commercially available video camera. In the demonstration experiment, it was confirmed that the play type could be estimated with high accuracy by using the proposed method, and the usefulness was proved.

Introduction

In Japan, the Japan Sports Agency was established in 2015 and the utilization of IoT is being promoted as an initiative for regional and economic revitalization through sports. At present, in professional sports, to enable tactical analysis for the purpose of improving competitiveness, the latest technology such as AI technology and the installation of dedicated fixed cameras are used to automatically classify the play types in field sports and to look back on the play efficiently (Imai, T., et al. 2018). However, this classification method has not been adopted widely in the field of college sports because the equipment is expensive and because it is necessary to have an expert in data analysis. As a result, the tactical analysis is performed by classifying the play types manually from game videos that are recorded using commercially available video cameras, but this classification work requires a large amount of effort. Therefore, in this study, we focus on soccer and analyze game video recorded on a commercially available video camera to create an image that clarifies the positional relations between the players of both teams by detecting the players of each team. We then propose a system to estimate the play type from the image created.

Proposed Method

Fig. 1 shows the processing flow of the proposed method. The proposed method consists of a play learning function and a play estimation function. The input data consists of gameplay images taken from a single viewpoint, and the output data identifies the types of plays.

In the play learning function, a learning model is constructed to estimate the types of a throw-in, corner kick and free kick (hereinafter called, each play). First, the training data used for the learning model construction is manually created. Specifically, the images of each play are extracted from the play images taken from a single viewpoint. Then, for each extracted image, colors are manually added to the players for each team. A projection transformation is then performed on these images to generate bird's-eye view images with player position information and team classification information added. Finally, an estimation model of each play using the feature

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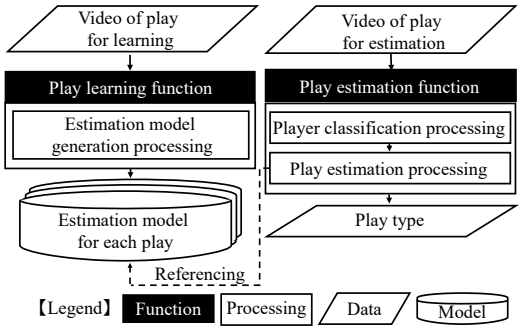
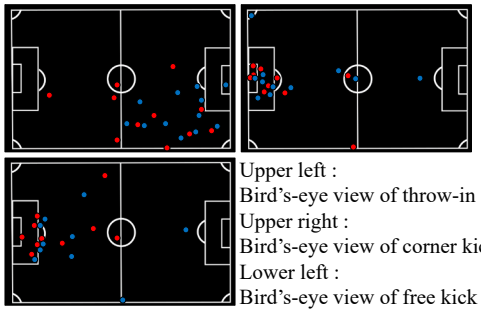


Fig. 1. Flow of proposed method



Upper left :
Bird's-eye view of throw-in
Upper right :
Bird's-eye view of corner kick
Lower left :
Bird's-eye view of free kick

Fig. 2. Bird's-eye view images created by applying proposed method

Table 1. Result of play type estimations

Target play	Number of targets	Number of cases correctly estimated	Number of cases incorrectly estimated			Precision	Recall	F-measure
			Throw-in	Corner kick	Free kick			
Throw-in	50	45	-	1	4	0.92	0.90	0.91
Corner kick	50	47	0	-	3	0.90	0.94	0.92
Free kick	50	42	4	4	-	0.86	0.84	0.85
Average	-					0.89	0.89	0.89

quantity obtained from the bird's-eye view image is constructed through a CNN using the recognition program for handwritten digit images that has been prepared in the tutorial of TensorFlow.

In the play estimation function, processing similar to that for the play learning function is automatically applied using deep learning, and the play type is estimated based on the results. First, a player is detected from an image using YOLOX. Next, the subject of the processing is limited to the upper half of the frame of the detected player, and, by setting the threshold between the two teams, the team classification is performed based on the RGB value of the uniform on the upper body of the player. Finally, a projection transformation is performed to place the position information of the detected players on the plane space, and the bird's-eye view shown in Fig. 2 is created by adding team classification information. The estimation models for each play are then referenced and the play that corresponds to the bird's-eye image created is estimated.

Demonstration experiment

In this experiment, play images from soccer are used to calculate the precision, recall and F-score by comparing the play type estimated by the proposed method with the actual play type, and the usefulness of the method is evaluated. The data used for the YOLOX learning is 100 game images that are different from the video of the play that is used for the estimation. The number of images used for the play type estimation is set to 3,400 images of each play for learning and 50 images of each play for estimation.

Table 1 shows the results of the experiment. When the average F-score is checked for the play overall, the average F-score was 0.89, so it was proven that the play type could be estimated with high accuracy. In addition, the F-score for corner kicks was 0.92, so these can be estimated with the highest accuracy. This may be due to the fact that the position information for the player is more characteristic for a corner kick than for the other play types. However, cases where the play type is wrongly estimated occur for each play type. When the bird's-eye view images for the cases where the play was wrongly estimated were checked, it was found that the team classification had not been accurate, and that this caused failure in the estimation of the play. It is thought that this occurred because the RGB values of the players' uniforms changed greatly from the start of the game due to the shadow of a building encroaching on the whole field as time passed. In the future, we will aim to improve this problem and achieve further accuracy improvement by developing a system which successively updates the threshold values for the RGB value.

Conclusion

In this study, we proposed a system to estimate play types from video of a soccer game that has been recorded using a commercially available video camera. Through the demonstration experiment, we confirmed that the play type could be estimated with high accuracy by using the proposed method. In the future, in addition to solving the issues that became apparent in this experiment, we will aim to develop a system which can capture the movement of the ball in order to also handle types of play in which the player feature quantities are smaller, such as shooting and passing.

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Digital Life

Journal of Digital Life 2023, A-8

Conference Proceedings

Change in perception of corporal punishment among college students who heard about a case of child suicide caused by instruction

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Abstract

It is important that university students studying sports coaching and teacher training courses hear true stories of children who have committed suicide due to corporal punishment, violence, and coercive coaching. This is because students are the future sports coaches and teachers, and they need to be able to provide appropriate guidance. For this reason, learning about the reality of serious incidents and accidents that occurred at schools will motivate them to think about prevention methods and learn about desirable teaching. Universities that train sports leaders and teachers need to conduct effective classes to prevent university students from becoming perpetrators of harassment and corporal punishment of children. To this end, it is important to identify what kind of lecture content would change college students' perceptions of corporal punishment. Particularly in this topic, it is possible that learning about actual cases of serious life-threatening incidents may have an emotional impact and significantly change the perception of corporal punishment. The purpose of this study was to examine changes in perceptions of corporal punishment among university students who listened to the father of a child who committed suicide as a result of actual teaching by a teacher.

In this study, a questionnaire was administered to 68 university students who watched a lecture given by the bereaved father. The date of the lecture was July 7, 2023. The questionnaire was administered twice, once before and once after the lecture was listened to, in the form of a question about perceptions of corporal punishment, and the results at the two points in time were statistically compared. The scale measuring perceptions of corporal punishment was the Koakutsu et al. (2014) Corporal Punishment Perception Scale.

For details of the study, please refer to the presentation day.

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Digital Life

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Conference Proceedings

Accuracy Improvement in Player Detection Using Deep Learning in Field Sports

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Abstract

Recently, there is active use of ICT for the processing of sports information. For field sports in particular, acquiring the position information for the players is becoming important for tactical analysis. To achieve this, the method of using deep learning on moving images to detect players and identify position information is conceivable, but there is an issue that the detection accuracy decreases in cases where the features of the players have not been learned, or if the moving images have different features to those during the learning. In response to this, in this study, we propose a technique to robustly detect players by performing division processing on the moving images. In addition, in the demonstration experiment, the accuracy verification was carried out for the similar images to those during the learning and for different images to those during the learning to confirm the usefulness.

Introduction

In Japan, there are demands for research support related to sports information science for the purpose of improving competitiveness. In particular, for field sports, activities are being implemented to tactical analysis by acquiring the position information for the players. The possible methods for the acquisition of the position information for the players include measures to apply object detection methods using deep learning to the images However, with the object detection method, the detection accuracy decreases if the target object has not been learned, or if it has features that are very different from those at the time of learning. It is also conceivable that depending on the images, the detection accuracy may also be affected by factors such as the weather, the condition of the field, the photographing position and differences in the angle of view. Therefore, in this study, we propose a method to robustly detect the players by taking the moving images that have captured the entire field and dividing them to make it easier to learn the features.

Proposed method

The processing flow of the proposed method is shown in Fig. 1. The proposed method consists of a learning function and an estimation function. In the learning function, the learning model necessary for detecting the players is constructed. First, in the image division processing, as shown in the upper part of Fig. 2, the coordinates in which the whole area of the field is contained are selected from the image, and rectangles with a size ratio of 4:3 are cut out from within those coordinates. At this time, adjacent rectangles are cut out overlapping so that the whole area of a player is cut out. Next, in the detection model construction processing, the players are annotated and learned using YOLOX (Zheng, G., et al. 2021) to construct a model to detect the players from the moving images (hereinafter called the detection model).

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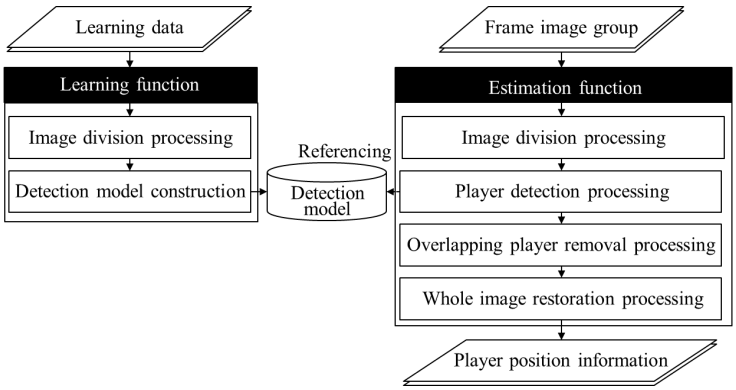

Fig. 1. Flow of proposed method

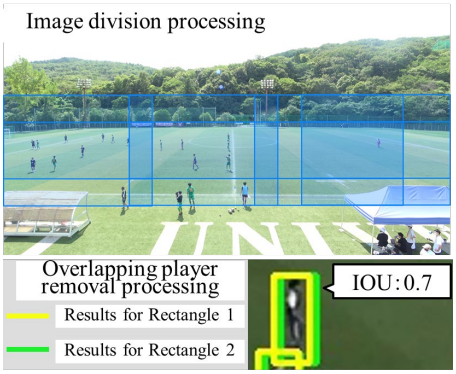

Fig. 2. Image division processing and overlapping player removal processing

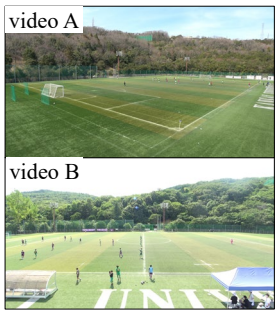

Fig. 3. Game videos A and B

Table 1. Experiment results (average of 100 images)

Image／Model	Number of players	Number of successes	Number of failures	Precision	Recall	F-measure
A／ whole	22.51	20.41	0.16	0.992	0.907	0.948
A／division	22.51	21.14	0.25	0.988	0.939	0.963
B／ whole	21.36	17.28	0.68	0.962	0.809	0.879
B／division	21.36	20.55	1.39	0.937	0.962	0.949

In the estimation function, a player is detected and the position of the player in the image is identified. First, in the image division processing, the same processing as for the learning function is performed. Next, in the player detection processing, the player is detected by referring to the detection model. Then, in the overlapping player removal processing, as the regions were cut out so that they overlap, removal is carried out for cases where a player is detected in two of the regions. In specific terms, when the IoU indicating the degree of overlap of the objects is 0.5 or more (the lower part of Fig. 2), it is judged that it is the same player and removal is performed. Finally, in the whole image restoration processing, the whole image is restored based on the coordinates and sizes of the rectangles specified in the image division processing.

Demonstration experiment

In this experiment, soccer game videos A and B (Fig. 3) are used to compare a detection model applying the proposed method (hereinafter called the division model) with a detection model that does not have the proposed method applied (hereinafter called the whole area model) to confirm the model usefulness. First, on video A, a frame image group is cut out as learning data and a frame image group is cut out for verification. Next, the division model and the whole area model are each constructed and the estimations are carried out. Then, the detection accuracy of the models is confirmed visually and an evaluation is performed using the precision, recall and F-score values. In addition, the accuracy is confirmed by performing the same estimations for video B, which was captured at a different time to video A and on a different field to video A.

Table 1 shows the results of the experiment. First, when the F-scores for video A were checked, the value was 0.948 for the whole area model and 0.963 for the division model, so it was found that the detection accuracy was improved by using the proposed method. Next, when the F-scores were checked for video B, the value was 0.879 for the whole area model and 0.949 for the division model, so it was found that there was robust detection even if there had been no learning on the video. However, the precision in the division model on video B was 0.025 lower than that in the whole area model. This is caused by the occurrence of multiple false detection frames for the players. Therefore, in the future, we will aim to improve the accuracy by estimating the approximate size of the players from the sizes of the frames and using that information to remove their false detection frames.

Conclusion

In this study, we proposed a method for the highly accurate detection of players from moving images of field sports. Through the demonstration experiment, we confirmed that the player detection could be performed with high accuracy by using the proposed method. In the future, we will aim for further accuracy improvement by solving the issues that became apparent in this experiment.

Reference

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Digital Life

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Conference Proceedings

Analysis of Data Using Information and Communication Technology Related to Education

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Abstract

Many changes have taken place in the field of education in recent years. In particular, developments in the field of information and communication technology have had a great impact on these changes.

For example, the Ministry of Education, Culture, Sports, Science and Technology is promoting digital transformation in education and promoting individualized and collaborative learning that utilizes information and communication technology.

However, hardware alone, such as the distribution of tablet terminals, is not enough. It is essential to enhance the software side using tablet terminals.

Therefore, in this research, we analyze the acquisition of data using information and communication technology in education, and the utilization of information and communication technology in education through the analysis of those data.

In this study, we used questionnaire data of students in a certain university. The data for this questionnaire is obtained through a learning management system. In addition, in answering the questionnaire, we asked for a single answer on the scale of 5 levels regarding the impression of the class.

In addition, these methods can be applied to a wide range of fields such as future measurement of educational effects, introduction to individualized education, and marketing in universities.

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The gains and losses of moving an interactive pre-FD program from face-to-face to online

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Background

Many Ph.D.-granting universities offer programs for graduate students who intend to become university professors, known as Preparing Future Faculty programs (Austin, 2002). These programs have also been forced to move online as well as face-to-face classes in order to cope with the 2020 pandemic. These programs are essentially teacher training programs, so that they typically include micro-teaching sessions and other practical exercises. The successful transition to online is a critical issue for the post-COVID era as professors are increasingly being asked to improve their teaching skills. In this study, we compare a face-to-face and an online format of a Preparing Future Faculty program in Japan and examine the difference in terms of changes in participants' attitudes and behaviors.

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UTokyo Future Faculty Program (UTokyo FFP)

UTokyo Future Faculty Program (UTokyo FFP) is a Preparing Future Faculty program. In this program, participants from various disciplines will learn motivation theory, instructional design, syllabus writing, assessment methods and so on by experiencing of a variety of group work and active learning methods. The program will be offered in a face-to-face format through 2019, with a maximum of 25 participants per courses, two courses in the spring and autumn semester respectively.

Moving to online format

Since 2020, UTokyo FFP has been converted from a face-to-face into a real-time online format. The learning content remains basically the same, and learning formats such as group work have been converted into a form that can be implemented in an online environment. For example, group work such as poster tours, where participants view posters created by their own groups, have also been implemented online. Table 1 shows the ideas that were applied during the conversion to the online format.

Table 1 Ideas applied during the conversion to the online format

(Technical aspects)
-Group work can be done in Zoom breakout sessions to the same extent as in face-to-face sessions.
-Share results within and between groups by switching from paper worksheets to Google docs, slides, etc.
-Share information about questions asked and results obtained using Google Form, Slido, etc.
(Facilitation aspects)
-Create a safe environment by starting with warm atmosphere and closed questions right at the beginning of the class.
-Give detailed instructions before group work starts.
-Check the progress of group work by monitoring worksheets on Google Drive if necessary.

Methodology

UTokyo FFP conducts a student survey at the end of the program since 2013. We use the results of this survey to examine what differences emerge between the face-to-face and online formats. The graduates to be studied are 96 participants in the face-to-face format in FY2019, and 96 participants in the online format in FY2020.The survey consist of basic information, satisfaction, course effectiveness, and changes in awareness and behavior. In order to focus on the contrast between the online and face-to-face formats, the following questions were used in the study "Were you satisfied with the program (5-likert scale)", "Was the content of

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the program interesting (5-likert scale)" and "Did your awareness or behavior change (yes/no and open response)?

Results and Discussion

The response rate was 98.9% (95/96) for the face-to-face format and 84.3% (81/96) for the online format. In terms of program satisfaction and interest, there was little difference between the face-to-face and online format; in fact, more respondents were "very satisfied" with the program online than in person (Figure 1). Thus, the results suggest that when an interactive face-to-face program is delivered online, the level of satisfaction and interest can be as high as that of the face-to-face format, if carefully designed.

Regarding changes in attitudes and behaviors, the number and percentage of "yes" responses were 90 (95%) for the face-to-face format and 79 (97.5%) for the online format. Responses to this change were also not significantly different between the two formats. Next, we conducted content analysis to the open-ended responses of those who answered "yes" to the question. When the open-ended responses were broken down by content, there were 117 responses for the face-to-face format and 96 responses for the online format. These were categorized independently by the three researchers and then by consensus for the parts of the judgments that differed, yielding the results shown in Table 2. The numbers in the table are their respective ratios to the total. Cells for items where there is a difference of more than 3 percentage points in the ratio between the face-to-face and online formats are colored, with blue indicating a bigger ratio and yellow indicating a small ratio. The results show that in the online format, more participants pointed that they changed in “improving classes and teaching methods” and “understanding and considering classes and pedagogy” while less participants did “Improvement and awareness of communication in general” “Understanding and discussion of higher education in general” with the contrast of face-to-face format. In other words, online format achieves clearly set goals, but is less likely to produce peripheral learning relative to face-to-face format

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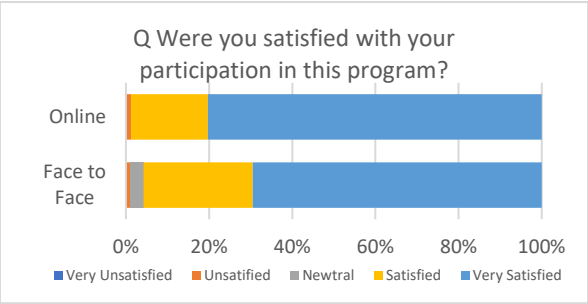

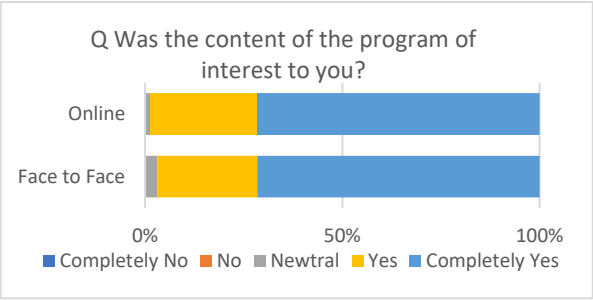

Figure1 Result of Saticfaction and Interest

Table 2 Category of changes after completion of UTokyo FFP

	Category	2019(Face to Face)	2020(Online)
Education	Improving Classes and Teaching Methods	20.5	28.1
	Understanding and considering classes and pedagogy	16.2	29.2
	Obtaining a concrete image of class implementation	2.6	2.1
	Motivation to give classes	5.1	3.1
	Understanding and discussion of higher education in general	6.0	2.1
	Gathering and studying information on education	1.7	4.2
	Acquiring a teacher's point of view	3.4	0.0
General	Improvement and awareness of communication in general	17.1	11.5
Research	Improvement of research presentation	6.0	6.3
	Improvement of in-lab instruction	1.7	2.1
	Acquisition of new perspectives on research and specialized fields	5.1	2.1
	research/specialty	0.9	1.0
Both	Consideration of the relationship between education and research	2.6	2.1
Career	Improvement of motivation to become a university professor member	3.4	1.0
	Consideration and clarification of career path	3.4	4.2
	Consideration and clarification of the image of a university professor	1.7	1.0
Others	Others	2.6	0.0

Digital Life

Journal of Digital Life 2023, B-1

Conference Proceedings

Micro-dynamic Pricing Modeling: Price Personalization in Digital Platform

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Abstract

In an advanced digital society, retailers are personalizing their product proposals and advertisements in order not to miss dynamically changing consumer needs. However, it has not yet been implemented personalization of product prices, which is an important factor at making a purchase decision. The purpose of the research is to design a personalization framework of optimal prices for commodity products and services. We develop a simultaneous model of store visits and product purchases for each consumer in the nested logit framework, and individual parameters are estimated using the Markov Chain Monte Carlo method. With the response rate of the product selling price obtained, the individual optimum price is dynamically back calculated based on situations at the time of store visit on daily basis. Utilizing ID-POS data of retail stores, the optimal price of a family ice cream product was computed for each consumer. The optimal price differs by consumers depending on the purchase situations, and it was found that the optimum price was less correlated with the actual sales price. The scheme is also applicable for individual sale price optimization in online shopping, and can be expected as a framework for sales price personalization on digital platforms.

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Digital Life

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Conference Proceedings

Proposal of Method for Efficient Management of Digital Data on Public Structures Using Metaverse Space

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Abstract

Operations related to public structures such as expressways include investigation, design, execution, and maintenance. Conventionally, design drawings, inspection forms, on-site photographs, and others generated in each of these processes are managed in two-dimensional folders. However, two-dimensional folder management makes it difficult to intuitively grasp where each piece of data points to in the entire structure. In this study, we propose a method that enables intuitive access to necessary information by reproducing a three-dimensional (3D) model of the target structure in the metaverse space and associating inspection records and others with the 3D model.

Introduction

In recent years, the decline in the working-age population has become a problem due to the falling birthrate and aging population, and the education of inexperienced engineers is insufficient. Against this backdrop, the development of AI technology has led to the development of technologies that enable automatic extraction of knowledge that would otherwise be difficult to be determined except by skilled personnel. For these technologies, image or text data in a fixed format is to be input, which is easy for computers to handle. On the other hand, each of inspection results of urban expressways so far have been stored as a single form data, including site photographs, drawing data, and opinions about the inspection results. However, although these inspection results at each location can be visually referred to, they are difficult to retrieve automatically and are not in a format that is easy for computers to handle. In this study, we develop a technology to manage, retrieve, and browse other data, such as photographs of the site, in the metaverse by associating them with the 3D model. The proposed method can be expected to facilitate information sharing among parties involved in execution and maintenance.

Proposed Method

The flow of the proposed method is shown in Fig. 1. The input data of the proposed method consists of point cloud data measuring the structure to be inspected, on-the-site photographs and drawing information, and inspection results. The output data is to be the metaverse space in which the on-the-site photographs and drawing information, inspection results and so on are associated on the 3D model of the structure. First, a 3D model is generated from the point cloud data measuring the current state of the structure to be inspected using the existing method (Tsukada, Y., et al. 2023). Next, the generated 3D model is placed on the metaverse space using F8VPS (Forum8, 2023). Then, texture mapping and annotation are used to associate the 3D model with the on-the-site photographs, drawing information, and inspection records. Finally, respective kinds of data are stored and managed on a common platform such as on-premises online storage.

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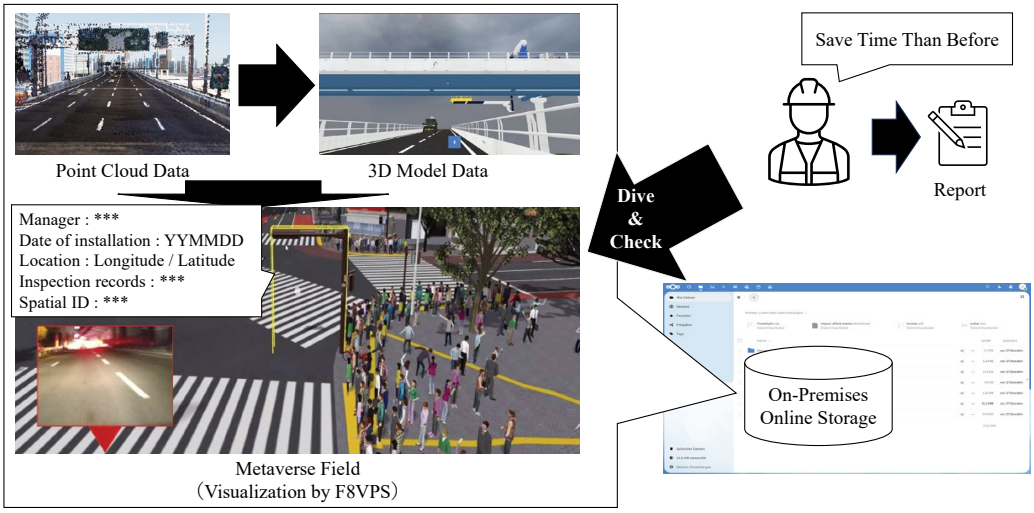

Fig. 1. Flow of proposed method

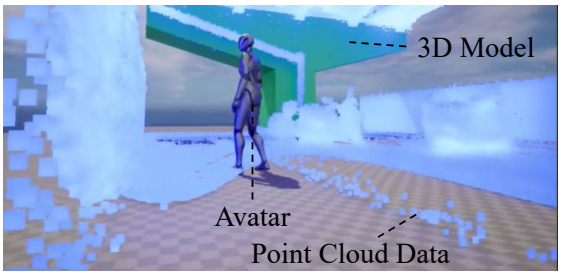

Fig. 2. Results of visualizing point cloud data, 3D model and avatar

Fig. 3. Results of displaying on-the-site photographs using 3D model in metaverse space

Experimental Study

In this experiment, it is confirmed whether the metaverse space generated by the proposed method can be used to intuitively refer to other data such as on-the-site photographs. First, using the point cloud data obtained by measuring a bridge with a laser scanner and on-the-site photographs of damaged spots as input data, the on-the-site photographs are associated with the 3D model in the metaverse space by applying the proposed method. Then, confirming the visualization results in the metaverse space, verification is made as to whether it is possible to intuitively grasp where each of the on-the-site photographs points to on the structure compared with the conventional two-dimensional folder management.

The point cloud data measuring the structure, the 3D model, and the avatar for operation are shown in Fig. 2. A user can operate the avatar in the metaverse space to move to the vicinity of the structure to be inspected, and if necessary, refer to other data associated with the 3D model. The display results of the on-the-site photographs associated with the 3D model are shown in Fig. 3. In this experiment, red voxels are displayed where there is data associated with the 3D model. The user can click on a red voxel to display the on-the-site photograph. This makes it possible to intuitively grasp where each of the on-the-site photographs points to on the structure better than the conventional two-dimensional folder management. This allowed confirmation of the usefulness of the proposed method.

Conclusion

In this study, we proposed a method to reproduce on-the-site photographs, drawing information, and inspection results in the metaverse space using a 3D model generated from the point cloud data of the structure to be inspected. Through demonstration experiments, we confirmed that it is possible to intuitively grasp where the on-the-site photographs point to on the structure more intuitively than the conventional method. In the future, we aim to automate each process of the proposed method.

Acknowledgments

We are grateful to Subaru Enterprise Co., Ltd., Nippon Insiek Co., Ltd. and Forum8 Co., Ltd., who are member of Kansai University Infrastructure Management Study Group, for providing comments on this study. We also appreciate that part of this study is funded by the Hanshin Expressway grant program for young researchers in fiscal 2023.

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Digital Life

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Conference Proceedings

Fundamental Research on Determination of Working State of Construction Machinery Using Deep Learning

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Abstract

Accidents involving contact between construction machinery and workers occur frequently at construction sites in recent years, and introduction of safety management technology utilizing ICT has been considered. An existing study proposes a technology for detecting contact between workers and construction machinery by using video images to grasp their positions. However, since this method does not take the state of construction machinery into account, it is determined as risky even when a worker is approaching the stopped machine that is not inherently dangerous. This paper proposes a technique to determine the working state of a construction machine by capturing the motion of its parts using deep learning. Demonstration experiment is performed to confirm its usefulness by applying the proposed method to the video images of working dump trucks.

Introduction

More accidents tend to occur in the construction industry than other industries. Especially, accidents of contact between construction machinery (hereinafter referred to as "construction machinery") and workers occur frequently. This makes it necessary to introduce ICT-based technology to support worker safety management. Existing services include a technology to use cameras installed on construction machinery to detect their closeness with workers (Komatsu Ltd. 2019), and that to attach edge devices to workers and construction machinery that detect their approaching (Shimuzu Corporation 2020). These technologies enable determining the location of workers and construction machinery to detect risks when they are approaching to each other. Their problem, however, is that since they consider the state of workers and construction machinery, even when a worker approaches to a stopped construction machine, which is not inherently dangerous, it is determined as dangerous. Considering that certain parts of a construction machine move during work, we propose a method of determining three states of a construction machine: moving, stopped, and working, by detecting changes in the motion of the parts of the construction machine using deep learning, The subjects of this study are dump trucks ("dump"), which are involved in the highest number of fatal accidents among construction machinery.

Proposed Method

The process flow of the proposed method is shown in Fig. 1. It consists of a learning function and an estimation function. The input data for the learning function is the learning data, and the output data is the learning model. The input data for the estimation function are video images of construction machinery, and the output data are the results of determining the working states of the machinery.

The learning function is used to build up a learning model needed to detect the whole and parts of a construction machine. In specific, as Fig. 2 shows, it builds a model for detecting the whole construction machine from the video images ("construction-machine-detecting model") and a model for extracting parts from the area of the whole construction machine ("part-detecting model") by annotating the movable parts and the body of the construction machine and learning them using YOLOv4 (Bochkovskiy, A., et al. 2020).

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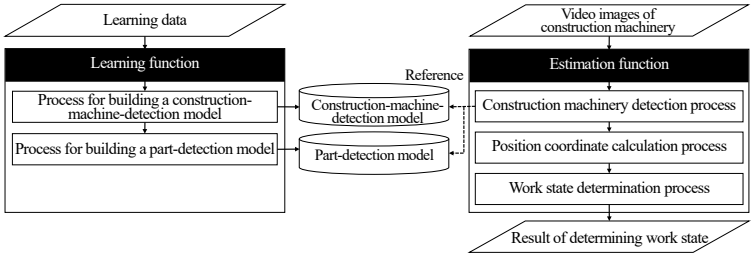
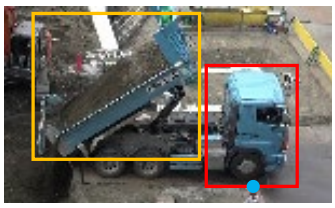


Fig. 1. Process flow



[Legend] : movable part, : vehicle body, : position coordinates of construction machinery

Fig. 2. Method of annotation

The estimation function is used to determine the state of the construction machine by detecting construction machines and their parts and obtaining changes in the movable part using the learning model built up by the learning function. The construction-machine-detection process is for detecting construction machinery and their parts from video images using the construction-machine-detection model and the part-detection model. The position-coordinate-calculation process is for obtaining the midpoint of the lower side of the body area as the position coordinates of the construction machine for projective transformation based on the coordinates of the four corresponding points established on the ground. The work-state-determination process is for determining the state of the construction machine from the area of the movable part and the position coordinates after the projective transformation. First, for 10 seconds during which even a construction machine with slow speed can move for a certain distance, the position coordinates of the current time and those of 10 seconds before are compared. If the distance between two points is longer than a certain distance, it is determined as "moving". Next, if the distance between two points is less than a certain distance, the difference in the movable-part area is detected using the interframe difference calculus. The machine is determined as "working" if the pixel ratio of the difference is above the threshold value, or as "stopped" if it is below it.

Demonstration Experiment

In this experiment, we confirm the usefulness of the proposed method by applying it to the video images of a dump at a real site in Osaka University of Economics. A video camera (SONY/ FDR-AX45) is set up on the fourth floor of the building to capture images of a dump working (Fig. 3). Next, video images of 40 seconds while moving, 63 seconds while stopped, and 32 seconds while working are cut out at 30 fps. Then, the determined results of the states by applying the proposed method to the video images are compared with the manually generated correct-answer data, and evaluation is made based on precision, recall, and F-measure. The learning model was built up using different images from the data used for evaluation. 8,789 images were used for the construction-machine-detection model, and 1,265 images for the construction-machine-part detection model.

The experimental results are shown in Table 1. The overall F-measure is 0.827, which indicates the proposed method is capable of determining the state of construction machinery with high accuracy. However, the F-measure while moving is 0.597, indicating the accuracy tends to be lower than when the dump is stopped or working. This is because of misjudgment as stopped though the dump is moving when it backs up at a lower speed. Thus, in the future, we aim to improve the accuracy by adjusting the threshold value for determining whether it is moving or stopped.

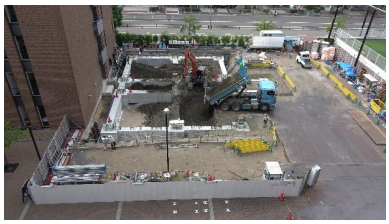


Fig. 3. Scene of capturing video images

Table 1. Experimental results

State	Moving	Stopped	Working	Total
Number of evaluated frames	1,200	1,900	950	4,050
Number of correct answers	519	1,900	660	3,079
Precision	0.963	0.876	0.957	0.906
Recall	0.433	1.000	0.695	0.760
F-measure	0.597	0.934	0.805	0.827

Conclusion

We proposed a method for determining three states of a dump by detecting changes in the movement of its body and the motion of its movable parts from video images. In the future, we aim at improving the accuracy by solving the problems revealed in the experiments. This paper was translated and written based on a part of the article published by Information Processing Society of Japan (Inoue, H., et al. 2023).

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Digital Life

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Conference Proceedings

A study of cognitive function in professional and university soccer players

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Abstract

Cognitive training is used to achieve the best performance for a soccer player as well as the physical training. One method training the cognitive ability is NeuroTracker X (hereafter NTX), a 3D multiple object tracking (3D-MOT) task. You can perform it on a PC wearing 3D glasses. Using the NTX, we previously conducted a preliminary study measuring the change in J-League players' working memory abilities and also measured the change in brain waves. Cognitive tasks included the Trail Making Tests A and B (TMT-A and TMT-B). The results showed that NTX training significantly improved the scores of NTX, TMT-A and -B. The higher score of TMT-A, and -B indicates the higher working memory abilities. The brain wave experiment showed that Fmθ was more facilitated after the training of NTX. Fmθ is involved in working memory. These findings suggest that the cognitive abilities of professional soccer players, such as working memory and attention, will be improved by NTX training (Saito et al., 2023).

In this study, we investigated whether Japanese players in the J-League have better cognitive function than amateur players. We have studied the differences between J-League players and university student soccer players of the cognitive functions.

Participants included 13 J-Leaguers (26.4 + 3.9 (mean + SD) years) and 30 university soccer players (19.9 + 1.1 years). The study protocol was approved by the ethics committees of Kyushu Institute of Technology (approval # 23-01).

The cognitive tasks included NTX, 2-back task, TMT, and creative task. In NTX task, the participants had to track four targets of eight balls moving in 3D space on a personal computer display in a trial. When they have the correct answer without mistakes, their scores increase, otherwise the scores decrease. In the higher-score trial, eight balls are moving faster, while in the lower-score trial, the balls are moving slower. Two-back task was used to measure working memory ability. The pair of the signs were shown on the PC display one by one serially. They had to compare the image with those shown in the two previous ones. TMT includes A and B tests. In TMT-A test, the participants were asked to connect numbers in order from 1 to 25 without releasing the pencil from the paper. In TMT-B, participants were asked to connect numbers and hiragana characters alternately in the same manner as in TMT-A. In TMT's, the complete time was measured for the evaluation. In creativity task, the participants had to connect five dots with a single stroke line in different ways as much as possible. We evaluated creativity as the number of different diagrams produced in one minute.

A summary of the results was as follows. 1. The mean NTX score for J-Leaguers was 1.5 + 0.3 (mean + SD), while the mean score for university players was 1.6 + 0.5. No significant difference was found (unpaired t-test; $t = 0.75$, $p > 0.05$). 2. The mean correct response rate for J-Leaguers in the 2-back task was 79.2 +8.6 %, while that for university students was 81.3 + 11.9 %. There is no significant difference (unpaired t-test; $t = 0.57$, $p > 0.05$). 3. The mean complete time for J-Leaguers in TMT-A was 38.6 + 11.5 seconds, while the one for university players was 29.2 +9.6 seconds. The time of the university players was significantly shorter (unpaired t-test; $t= -2.8$, $p < 0.01$). TMT-B was 44.9 + 11.0. seconds for J-Leaguers, while the mean time for university players was 41.9 + 12.27 seconds. There is no significant difference (unpaired t-test; $t= -0.74$, $p >$

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0.05). 4. The number in the creativity task for J-Leaguers was 14.3 +3.6, while the mean number for university players was 16.6 + 3.8. There is no significant difference (unpaired t-test; $t= 1.83$, $p > 0.05$).

Previous study shows that elite athletes show better cognitive abilities than sub-elite and novice athletes (Vestberg et al., 2012). The results of the cognitive function between J-League players and university soccer players in the present study were almost the same except TMT-A scores. TMT-A of the university soccer players was significantly higher than that of the J-Leaguers. Many of the university soccer players participating in this study were high level players who belongs to the J-League youth teams and who have experienced high school championships. The result suggests that there is a possibility that the university soccer players may have the superior attention to that of J-Leaguers.
The other possibility is that the small number of the participants of J-League players. We should increase the number of participants of J-Leaguers.

Since our study showed that NTX training improved the cognitive function of J-Leaguers, it will be necessary to examine whether NTX training improves the cognitive function of university soccer players in the same way. It will also be important to examine the transfer effect of NTX training to the actual soccer game and how it affects brain mechanisms.

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Digital Life

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Conference Proceedings

Study on Generating Parametric Models of Bridges Using Part-Identification Technology for Point Cloud Data

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Abstract

In Japan, social infrastructure facilities constructed during the period of rapid economic growth is seriously aging, and inspection and repair to extend their service lives are urgently needed. The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) is promoting CIM and i-Construction, aiming to improve the efficiency of maintenance operations by utilizing point cloud data as well as 3D models. In the previous study, the authors proposed a method to generate a 3D model from point cloud data for each part of a bridge, such as piers and leaning structures, using a bridge model template. However, for structures with many components, the work required to separate the point cloud data into each component is labor intensive. In this study, we propose a method for generating 3D models for each part of a bridge by using deep learning to identify individual parts of the bridge.

Introduction

In Japan, infrastructure facilities built during the period of rapid economic growth are aging seriously, and inspection and repair to extend their service lives are urgently needed. However, there are many bridges whose geometry cannot be accurately determined due to the loss of design drawings or related documents. Therefore, technology development for generating drawings and 3D models from point cloud data obtained by measuring the target structures with laser measurement equipment is expected to use for maintenance.

Against this background, an existing study (Kubota, Y., et al. 2021) proposed a method to generate parametric models from point cloud data of bridge parts and model templates (Fig. 1) using a genetic algorithm. However, for structures such as bridges with a large number of components, the task of separating the point cloud data into individual components is labor-intensive. In this study, we propose a method to identify the parts of a bridge using deep learning and generate a parametric model for each part. As to deep learning, we compare ConvPoint (Boulch, A., et al., 2020), which is extended so that CNN can be applied to 3D data, and RandLA-Net (Hu, Q., et al., 2020), which can efficiently learn large-scale point cloud data using random sampling and local feature aggregation, to study the usefulness of each one.

Proposed Method

The process flow of this study is shown in Fig. 2. The method consists of a training function, a part-identification function, and a model generation function.

The training function is used to build up a part-identification model required for identifying parts of a bridge. As Fig. 3 shows, building up a model needs training data for which annotation of part information about the bridge is manually made to each point of the point cloud data. Only one piece of information can be annotated to each point. By providing this training data to ConvPoint or RandLA-Net, a part-identification model can be built up.

The part-identification function is used to annotate part information to the point cloud data of the measured bridge using the part-identification model. Then, using Connected Components of CloudCompare, the point cloud data of the same part is divided into point cloud data for each single part. The model generation function is used to search for

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the optimal parameter from the point cloud data for each single part and the model template using a genetic algorithm, and to generate a parametric model that matches the concerned point cloud data.

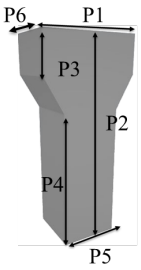


Fig. 1. Model template

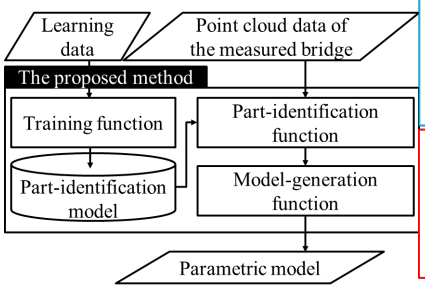


Fig. 2. Process flow

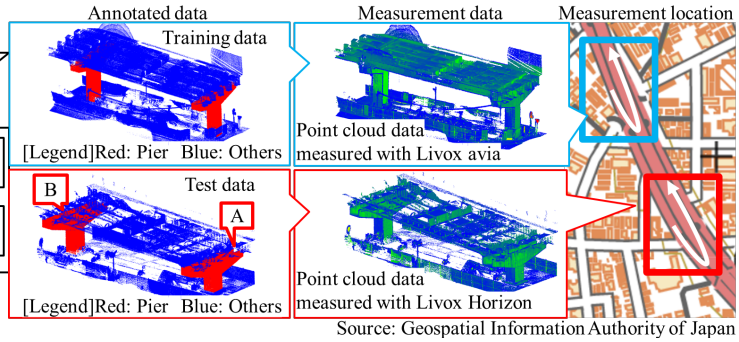
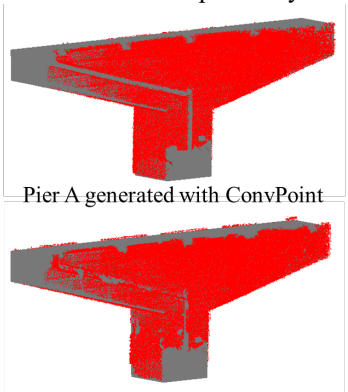


Fig. 3. Location of measurement, measurement data, and annotated data

Experimental Study

This experiment uses point cloud data of the Shinkangetsu Bridge in Fushimi Ward, Kyoto City. First, the area indicated by the red frame in Fig. 3 is measured using Livox Avia. Second, training data is created from the obtained point cloud data to build up a part-identification model. In this experiment, two types of models are built up for comparing their accuracies to see which is better at generating parametric models between ConvPoint or RandLA-Net (Fig. 4). Then, the areas in the blue frame are measured with Livox Horizon to use as the test data. Finally, the proposed method is applied to the test data to generate a parametric model of the pier. The accuracy is evaluated in terms of precision, recall, and F-measure, which are the percentage of agreement between the manually identified part information and the estimated result of part information. In addition, evaluation is also made by the difference between the dimension values and the most probable values of the parametric model of Pier A (Table 1).

As Table 2 shows, the experimental results indicate that the recall of the pier with ConvPoint is 0.13 higher than that with RandLa-Net. It is considered because the training data was too small in a scale to take advantage of the superiority of RandLa-Net, which can efficiently learn large-scale point cloud data. Moreover, the visualization results of the parametric model of Pier A and its numerical results (Table 3) show that all parameters except P1 have the equivalent accuracy. From these points, we believe that utilization of RandLA-Net should be examined for large-scale point cloud data such as of expressways in the future, which can efficiently learn such data.



Pier A generated with ConvPoint

Pier A generated with RandLA-Net

Fig. 4. Visualization results

Table 1. Most probable values for Pier A (unit: m)

Parameter	P1	P2	P3	P4	P5	P6
Most-probable value	11.17	4.50	1.05	2.28	1.75	1.71

Table 2. Part-identification accuracy of point cloud data

Bridge part	Pier			Others		
	Precision	Recall	F-measure	Precision	Recall	F-measure
ConvPoint	0.99	0.96	0.97	0.97	0.99	0.98
RandLA-Net	0.98	0.83	0.90	0.89	0.99	0.94

Table 3. Accuracy of parametric model for Pier A (unit: m)

Parameter	P1	P2	P3	P4	P5	P6
ConvPoint	11.50	4.50	1.00	2.25	1.75	1.75
RandLA-Net	11.25	4.50	1.00	2.25	1.75	1.75

Conclusion

In this study, we proposed a method for identifying parts of a bridge using deep learning and generating parametric models for respective parts. The experimental study clarified the usefulness of ConvPoint and RandLA-Net for small-scale point cloud data. In the future, we will examine a method that can contribute to generation of parametric model more by applying them to large-scale point cloud data.

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Digital Life

Journal of Digital Life 2023, B-6

Conference Proceedings

Exploring Micromanagement and Multiple Target Tracking Skills in Esports Players: Insights from Perceptual and Cognitive Tasks

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Abstract

1. Introduction

Compared to classical sports, the cognitive aspect is more important than the physical aspect in esports. Additionally, micromanagement (micro) and macromanagement (macro) are important for athletes to compete at high levels. Micro, also known as mechanics, refers to a user's control over small aspects of the game. Although micro differs slightly from genre to genre, in First-Person-Shooter (FPS) and Multiplayer-Online-Battle-Arena (MOBA), it consists of the precise and rapid use of input elements, such as a mouse and keyboard, and the synergy between the player's abilities, movement, and positioning, and the combination of allies (Fanfarelli, 2018). Macro refers to a higher level of control over the game, such as game sense and the ability to judge a situation, which are skills related to getting around.

Many performance metrics used in the team-based FPS and MOBA genres are considered unreliable indicators of individual skills (Pedraza-Ramirez et al., 2020). A clear link exists between MOT and esports performance (Wechsler et al., 2021). A study on MOTs that track multiple objects in a field of view was conducted by Pylyshyn and Storm (1988), who investigated the mechanism of object tracking. Additionally, MOT and esports research often involves gamers and non-gamers (Boot et al., 2008).

Unlike MOT tasks, perceptual-cognitive tasks have been developed with a narrow focus on target genres. For example, in an FPS, the ability to aim (hit the target quickly and accurately) is one of the most important microskills, and an application called Aimlabs (Statespace, U.S.) has been released. Pluss et al. (2023) also developed the Mobalytics Proving Ground (MPG) task, a perceptual-cognitive task for the League of Legends (LoL) within the MOBA genre. They studied gamers and non-gamers and showed that group identification can be used to discriminate between groups. Although designed for the MOBA genre in LoL, exploring the MPG task's applicability as an indicator for assessing micro-skills in various esports genres can advance micro-research in the esports field.

With a focus on micro (mechanics) and using perceptual-cognitive tasks, we aimed to identify differences in MOT skills and genre-specific MPG task scores required across esports genres by skill level and game genre.

2. Methods

Twenty-one FPS and MOBA players were grouped according to skill levels. MOT skill was measured using the Neuro Tracker (NT, CogniSens, Canada); a threshold of speed at which an object can be tracked with a 50% probability was calculated and used as the score. The details are described by Furukado et al. (2019). The MPG task had three elements that were executed as simultaneously as possible in one minute, and their scores were evaluated. The details of each element have been described by Pluss et al. (2023). The distance between the participant and monitor was 60.96 cm. only in the NT task, and the participants wore 3D glasses for a total of three sessions (60 trials). In the MPG task, a total of three trials were performed after each practice session. For each task score, groups were divided by game genre and an unpaired t-test was performed by skill level.

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3. Results

In the FPS group, there was no significant difference in NT scores (Skilled: 1.41±0.56, Semi-Skilled: 1.32±0.75) by skill level, but there was a significant difference in MPG scores (Skilled: 861.94±175.97, Semi-Skilled: 608.23±152.46) and a large effect size (NT: $t(9)= -0.23$, $p = 0.823$, $d = -0.14$, MPG: $t(9)= -2.53$, $p = 0.032$, $d = -1.53$). In the MOBA group, there were no significant differences in both NT (Skilled: 1.63±0.43, Semi-Skilled: 1.19±0.51) and MPG (Skilled: 977.35±110.92, Semi-Skilled : 797.87±194.17) tasks, but the effect sizes could be interpreted as large (NT: $t(8)= -1.45$, $p = 0.185$, $d = -0.92$, MPG: $t(8)= -1.80$, $p = 0.110$, $d = -1.14$).

4. Discussions

One possible reason for the lack of differences in MOT skills between the FPS groups could be the target population. In this study, the group in the top 1% of all players was defined as the high skill level group, but because the highest-ranked resident rank or pro players were not included in the population, it is not possible to draw conclusions without increasing the sample size. Another possible reason is that in FPS, the task characteristics are different from those in the MOT task, in which multiple targets are tracked using peripheral vision because of the longer time spent aiming at the reticle in the center of the screen (Furukado et al., 2020). In the MOBA genre of LoL, in addition to the minimap in the lower-right corner of the screen, many areas must be checked on the screen. In NT, multiple objects must be tracked, and MPG also requires parallel processing of three pieces of information. Therefore, these characteristics may have resulted in differences in scores owing to differences in skill levels among players of the MOBA genre.

5. Conclusions

We examined micro (mechanics) related to individual skills by unifying the game genres of subjects. The results indicate that an MPG task developed for MOBA genre players could discriminate between superior and inferior FPS players. The results also suggest that MOT skills, which are required regardless of the genre, are important for MOBA players to demonstrate performance. Future performance studies could be further developed by increasing the sample size to obtain an analytical perspective on genre factors, regardless of skill level.

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Digital Life

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Conference Proceedings

The relationship between music preference and time-frequency-based phase difference between BRAIN WAVES and audio of music.

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Abstract

The relationship between music preference and the phase difference between electrical brain waves and simultaneously recorded music audio signal was studied on a time-frequency basis. brain waves are related to music preference processing in the brain. Left frontal gamma power of brain wave can be related to the music preference (Tsuji et al., 2019). The instantaneous phase difference between two regions on the brain is also related to the preferences. Phase locking value (PLV) of inter-brain-areas found a higher discrimination accuracy of music preference than with the powers of brain waves (Hayata and Natsume, 2019). PLV corresponds to the consistency of phase difference. The phase relationship between internal brain waves and external speech signal has been found to reflect understandability in listeners (Harding et al., 2019).

Introduction

Frontal gamma powers of brain waves can be related to music preference (Tsuji et al., 2019). Phase locking value (PLV) of inter-channels found a higher discrimination accuracy of music preference than with powers of brain waves (Hayata and Natsume, 2019). The instantaneous phase difference between two regions on the brain is also related to the preferences. PLV corresponds to the consistency of phase difference. Furthermore, the phase relationship between internal brain waves and external Speech rhythm has been found to reflect understandability in listeners (Harding et al., 2019). However, there is yet to be a study on internal brain waves and external audio studies concerning music preference.

In the current study, the novel relationship between an individual's music preference and the phase difference (PD) between EEG and simultaneously recorded audio signal of presented music stimuli was examined.

Methods

Experiment was conducted on 4 participants (age: 22.67 + 0.58 (mean ± SD) years). In a trial, they listened to unique 40-second non-vocal music excerpts, and then had the preference rating based on a 6-point Likert scales with 1-3 being assigned to disliked (D) and 4-6 being to liked (L) excerpts. Brain waves at six positions and music audio were recorded with Intercross415 and dosimeter. The signal data was band-pass filtered with 1Hz-band from 1 to 100 Hz, and Hilbert-transformed to get instantaneous phase. Phase difference (PD) was defined as the value subtracting audio signal phase from brain wave phase.. PD's were then averaged over delta (1-4 Hz), theta (4-8 Hz), alpha (8-12 Hz), beta (12-30 Hz) and gamma (30-100 Hz) representative frequency bands. In time-window analysis, mean PD was calculated every 10 sec for listening period. In statistical analysis, the permutation method of the Mann-Whitney U test was used to calculate the probability.,

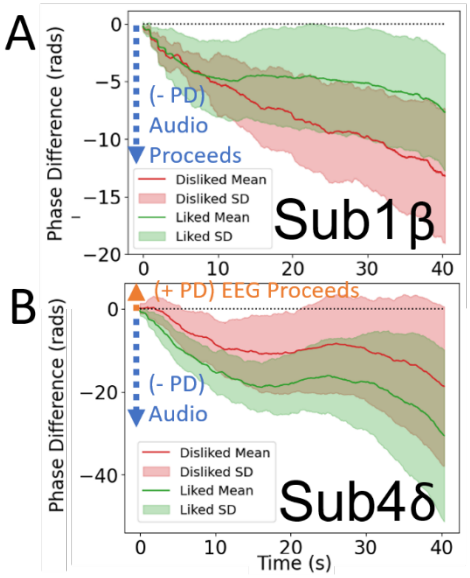

Fig. 1. The time-course of PD between β rhythm at F3 and audio in Sub1 (A), and PD of δ rhythm at F3 and audio in Sub4 (B). Solid lines indicate the mean PD and shadings indicate standard deviations. Dotted lines indicate zero of PD. Green lines indicate PD for L and pink lines indicate that for D music preference.

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The significant probability was set below 0.05. The statistical analysis was performed for the average PD every 10 sec time window (TW) with no overlap.

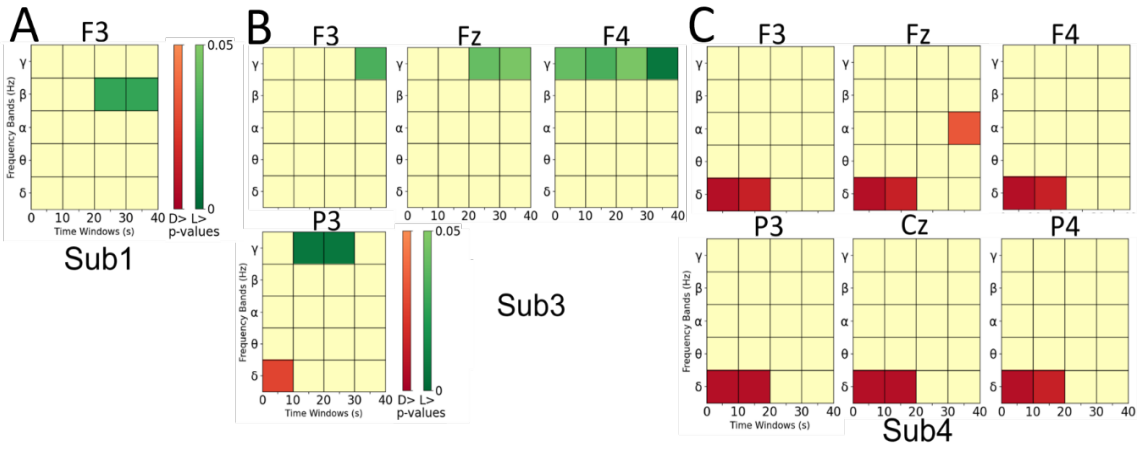
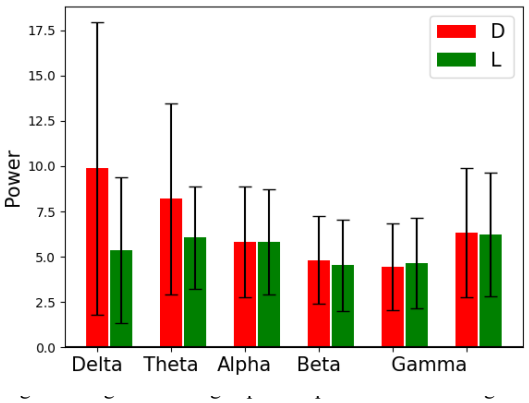


Fig. 2. Individual TW analysis of PD between brain wave and audio in Sub1 (A), in Sub3 (B), and in Sub4 (C). One grid show the significant probability of PD between L and D music. When there is a significant difference between L and D, the gird is colored with green/red. A green grid indicates phase for L is significantly advanced and a red grid indicates phase for D is significantly advanced. The strength of color is determined by p value. When the value approaches 0, then the grids show yellow. That means no significant difference of PD was observed.

Results and Discussions The representative results of PD for L/D music are shown in Fig. 1. It shows that PD of higher frequency brain waves β and γ was larger for L music than D music, while PD of lower frequency waves δ was larger for D music than L music (Fig. 1). Significant differences of PD between L/D music preference were found in left-frontal β of Sub1, left frontal and parietal γ, and left-parietal δ of Sub3, and δ of Sub4 at all positions (Fig. 2; Mann-Whitney test; *p < 0.05). Significant PD often occurred at the latter period of the whole listening period. β and γ rhythms relates to the physical feature processing of music. On the other hand, θ and δ rhythm may be related to emotional process. The results suggest that when the participants listen to the disliked music, the brain may be responding emotionally to the music, while when they listen to liked music, the brain may predict the features of the music. Processing interval of disliked music may proceed to that of liked music. The results also showed the individuality of the brain waves which indicate music-preference-related PD.



all trials of all participants. D (red) and L (green) music audio signal for 40-seconds listening period was Fast-Fourier -Transformed, and the powers of δ, θ, α, β, low-γ, high-γ were calculated. Then the averaged power for 40-seconds was obtained. Bars indicate the averaged powers and error bars indicate standard deviation.

There is no significant difference of the powers between D and L music (Fig. 3). PD of brain waves which had the significant difference between D and L music did not correspond to the different powers of brain waves between D and L music. PD which brain waves had in each participant can't be determined by the power of music audio.

Based on the obtained findings, we will develop music recommendation systems using novel feature, PD between brain waves and audio in the future.

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Digital Life

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Conference Proceedings

Study of SEO Strategies for Improving Website Search Result Ranking

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Abstract

A website operator needs to use search engine optimization (SEO) to have their website listed at a higher place in search results. However, a method of analyzing which of the huge number of SEO strategies are effective and should be applied to the website first has not been established. This makes it difficult to develop ideas for the strategic policy for a website. This study therefore examines the existing methods of identifying priority strategies and formulates a strategy improvement policy for SEO implementation.

Introduction

With the emergence of content management systems (CMS) and free services that enable users to easily build a website, an environment enabling users to launch a website without web-related expertise is beginning to take shape. When a user searches for information hidden somewhere among a huge number of websites, they generally use a search engine and access the websites that contain what they are looking for. For a website to be accessed by many users, the website operator needs to implement SEO to optimize their website and take steps to improve their website's rank in the search results. Existing SEO methods include referring to publicly accessible blogs, referring to specialized books on SEO, use of an analytics service, and paying attention to changes over time and the site's rank. In actual SEO implementation, however, issues faced include "the inability to ascertain the priority strategic areas due to the passage of time" and "the inability to prioritize the huge number of strategic areas." This study, therefore, examines the existing methods to identify priority strategic areas to solve these issues and come up with a suitable method of SEO implementation.

Examination of the existing methods

In this section, the existing methods for solving the issues described in Section 1 were examined, and the result indicated that "attention to changes over time (Krrabaj, S., et al. 2017) (Sonya, Z., et al. 2017) " (Fig. 1a) and

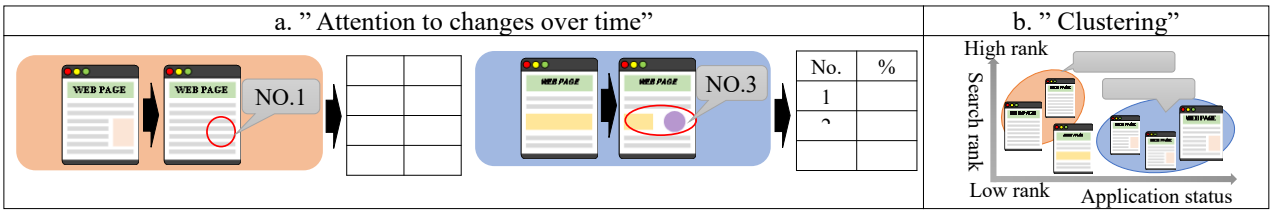

Fig. 1. Existing methods

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Table 1. Number of webpages on search result ranking

Strategic areas	[Usage Guide] A : Increased , B : Decreased , C : No change																	
	Went down									Improved								
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
	6/1 ~ 6/15			6/15 ~ 7/1			7/1 ~ 7/15			6/1 ~ 6/15			6/15 ~ 7/1			7/1 ~ 7/15		
Number of text letters	190	160	341	220	205	306	277	252	433	263	256	461	284	250	379	196	185	367
Number of images used	72	48	571	98	60	573	115	78	769	113	91	776	113	96	704	74	58	616
Viewport setting	1	1	689	3	2	726	0	3	959	0	2	978	3	2	908	2	3	743

Table 2. Classification results by clustering

Clusters		1	2	3	4	5
Webpage search result ranking in each cluster	Mean	52.3	48.7	54.7	49.4	41.9
	Median	54.0	48.0	55.0	56.0	36.5
	Variance	27.4	28.5	27.6	28.8	29.1

"clustering" (Fig. 1b) were commonly used. In the former method, strategic areas that influence rank were analyzed by checking changes in search result rankings for multiple webpages at two different points in time; and whether or not the strategic areas were being addressed at these two times. In the latter method, k-means clustering was carried out to examine if webpages could be grouped by upper or lower search result ranking based on addressing/not addressing the strategic areas. In the next section, a verification experiment of these methods was carried out to see if the existing issues could be solved.

Verification experiment

In this experiment, the existing methods were applied to a webpage and the result was examined in order to check their viability. The website used was about a roadside station. Since the tested SEO strategic areas needed to be highly effective, they were chosen based on the official blog by the search engine provider and specialized books on SEO. Note that the search engine by Google LLC was used in this study.Table 1 shows the number of webpages whose search result rank went down after the attention to changes over time method was applied, and the number of webpages whose search result rank improved after the same method was applied. These tables indicated that addressing individual strategic areas improved or worsened the search result rankings. Note, however, the website, which maintained its search result ranking, contained webpages whose search result rank improved or worsened. This makes it difficult to appropriately decide which strategic areas contributed to the higher search result rank. This change could be attributed to the fact that Google LLC frequently updates its search result ranking algorithm and that the content of many other websites was also updated during the same period of time. Accurate evaluation of the strategic areas is therefore difficult if only one webpage is used for the analysis. The clustering method suggested that it was difficult to sort webpages by search result ranking level (Table 2). This result was also true when the number of clusters was changed. This could be attributed to the fact that each strategic area is high-dimensional data and that there was no weighting setting for each strategic area. Google LLC has not disclosed specific strategic areas and weighting, and therefore it seems difficult to cluster webpages based on strategic areas. The result of testing each existing method suggested that these existing methods were unable to solve the issues described in Section 1, and drafting an improvement policy for the existing methods and development of new methods are necessary. By analyzing webpages by the search result ranking level and developing a method of comparing the application rate among the strategic areas as an improvement policy, estimation of the priorities of strategic areas should be possible.

Conclusion

In this study, the existing methods were examined in order to solve existing issues and the viability of these methods was tested. The experiment confirmed that these existing methods were unable to solve the issues, indicating the need for improvement. The future task is to carry out the same experiment using improved methods to confirm the usability of the proposed improvement policy and solve the issues described above.

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Digital Life

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Conference Proceedings

Activity of the inferior frontal gyrus during a driving game

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Abstract

The activity of the inferior frontal gyrus during a video game was measured by using near-infrared spectoroscopy (NIRS) to investigate the role of linguistic information in the learning and achievement of cognitive tasks. Six healthy participants cooperated this research. The participants were asked to play a driving game, and they played the game three times on each of the two difficulty levels. The density of oxygenated hemoglobin on the cerebral area regarded as Broca's area was measured by NIRS to evaluate the activation and deactivation of Broca's area. As a result, significant activation/deactivation of Broca's area was confirmed in some participants and conditions. However, a consistent trend across participants was not confirmed, which requires further study.

Background

A number of previous studies have reported that Broca's area located in the left inferior frontal gyrus serves the role of linguistic functions. The roles of Broca's area in speech are considered as speech production (Trupe et al., 2013), syntactic processing (Sakai, 2002), and formulation of articulatory code (Flinker et al., 2015). Aphasia due to the impairment of Broca's area causes a decline of performance of cognitive tasks (Bonini & Radanovic, 2015). Hermer-Vazquez et al (Hermer et al., 1999). reported a cognitive task in which participants failed to achieve the task when they were imposed to respond to auditory stimuli that were irrelevant to the current task. There is no doubt that Broca's area is involved in cognitive tasks, although it has not been clear how the cerebral area achieves the goal of tasks in which participants were not explicitly imposed linguistic factor. In this study, the activity of the inferior frontal gyrus during a video game was reported to investigate the behavior of Broca's area.

Methods

Six healthy people participated in this experiment. They were asked to play a video game (Mario Kart 8), and their density of oxygenated hemoglobin of the left inferior frontal gyrus was measured by using near-infrared spectoroscopy (NIRS) (OEG-17 APD, Spectratech). In the current paper, results were reported for only one channel located on Broca's area. Participants were classified into two groups (Skilled and Novice) according to participants' experience of the game. Four participants were classified in the Skilled group, and 2 participants were classified in the Novice group. Participants were asked to play the easy course and the hard course three times, respectively. A one-minute rest period was set between each game.

The data of measured NIRS signals were applied a low-pass digital filter with a cut-off frequency of 0.1 Hz. It was hypothesized that the amplitude of a NIRS signal would increase/decrease if game play affected the activity of Broca's area, and the change in the amplitude could be detected as the change in slope of a regression line approximating a NIRS signal over the game play and rest periods. The measured NIRS signals in each period were fitted to two regression lines, and the slopes of regression lines at the transition from a rest and game play periods were compared to detect the effect of game play on the cerebral area. The increase and decrease in the slope of regression lines, tested by a parallelism test, were considered as the activation and deactivation of Broca's area. Statistical power was calculated using the binomial theorem to conjunct all data in the group. When there is a 95% probability that the activation/deactivation occurs and is detected, the probability P of observing a significant difference in the slopes of the regression lines at least k times out of n trials is expressed as $P = \sum_{i=k}^{n} C(n,k) 0.95^i 0.05^{n-i}$. Where P is regarded as the power.

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Results

Table 1 shows the number of activation/deactivation in the 3 trials for each participant and the combined numbers in the Skilled and the Novice groups. There was no significant activation/deactivation for the Skilled group and the Novice group. For some individual participants and conditions, 3 times activation/deactivation were confirmed in the 3 trials, where *P* was calculated as 0.86 ($=0.95^3$), however, a consistent trend across participants was not confirmed in the analysis of this paper.

Table 1. The number of activation/deactivation detected by the parallelism test of the slopes of the regression lines. To set power *P* to approximately 0.8-0.9, the number of activation/deactivation in the Skilled group is calculated as 11 or more times, and that in the Novice group is calculated as 6 times. Note that in the Novice group, *P* is calculated as 0.96 when 5 times is applied to the number of activation/deactivation, and *P* is calculated as 0.76 when 6 times is applied to that.

	Skilled 1	Skilled 2	Skilled 3	Skilled 4	Novice 1	Novice 2	Skilled group	Novice group
Easy	3/0	0/3	2/1	2/1	0/3	3/0	7/5	3/3
Hard	2/1	1/2	3/0	3/0	2/1	3/0	9/3	5/1

Conclusions

Prior to the experiment, the difference in the activation of Broca's area between skilled and novice participants was expected. Because it was assumed that novice players would talk to themselves, "What do I do to achieve the goal of this game?," to control much information about the game in their minds, meanwhile skilled players can perform the game without explicit attention. It has been reported that some cerebral areas (e.g., prefrontal cortex and cingulate cortex) activate more when an individual learns a new task than when performs a prelearned task without paying attention to one's movement (Jueptner et al., 1997). Contrary to the expectations mentioned above, neither consistent trend of activation of Broca's area for the Novice group nor that of deactivation for the Skilled group were not revealed.

There are some possible reasons why the failure to reveal the difference in Broca's area by the difficulty of a task and participant's skill. The relevance of Broca's area to attention and motor learning and the type of tasks demanding the use of linguistic information have not been clarified. Moreover, production of automatic movements might be hard to occur during playing the game adopted by this study. Fast and difficult sequential movements are desirable to detect the difference in activity of the cerebral cortex area by individual's task performance.

Acknowledgement

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Digital Life

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Conference Proceedings

The Effects of Positive and Negative Ions on esports Performance and Arousal Levels Part 2 -Testing Higher Ion Density-

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Abstract

An air ion is a naturally existing tiny particle, a positively or negatively charged molecule or atom in the air (Jiang & Ma, 2018). Positively charged ions are positive ions, and negatively charged ions are defined as negative ions (Yamamoto et al., 2015). Air ions, including positive and negative ions, also have certain functions such as purifying the atmosphere and deodorizing the air (Nishikawa, 2013). Some research has also been conducted on the relationship between air ions and emotions (Flory et al., 2010; Perez et al.) For example, a high-density negative ion environment was found to reduce depression. In addition, several studies have examined the relationship between negative ions and depression (Goel & Etwaroo, 2006; Terman & Terman, 2006; Terman et al., 1998), lower stress (Malik et al., 2010), and increased happiness (Lips et al., 1987). There are also several studies suggested that a relationship exists between positive ions environments and human emotions (Perez et al., 2013). For example, Gianinni et al. (1986) investigated the correlation between positive air ions and emotions. The results indicated that anxiety and excitement were significantly increased under these conditions. They also examined the relationship between positive ions and discomfort, irritation, and anxiety (Giannini et al., 1986; Charry & Hawkinshire, 1981). Thus, although the results of the studies are variable, there is a relationship between the environment and emotions that trigger ions.

Hagiwara et al (2021) examined the relationship between gameplay and air ions by examining the relationship between game performance and subjective and objective arousal levels in positive and negative ion environments and in controlled environments in 10 university students, The results indicated that game performance levels were higher in the positive and negative environments, as were levels of subjective and objective arousal, compared to the control environment. However, it is difficult to suggest an association with air ions based on their study alone, and as mentioned earlier, air ion research is highly skeptical and difficult to prove. Therefore, the purpose of this study was to examine arousal levels and performance in gameplay in an environment with increased concentrations of positive and negative ions, replicating the protocol employed by Hagiwara et al. (2021).

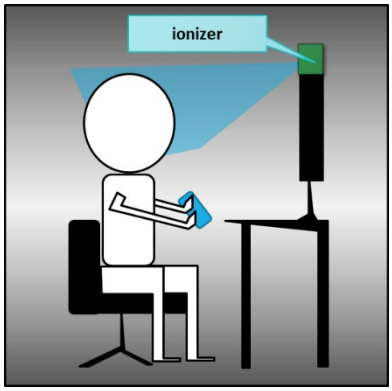

Fig. 1 Position of ion exposure

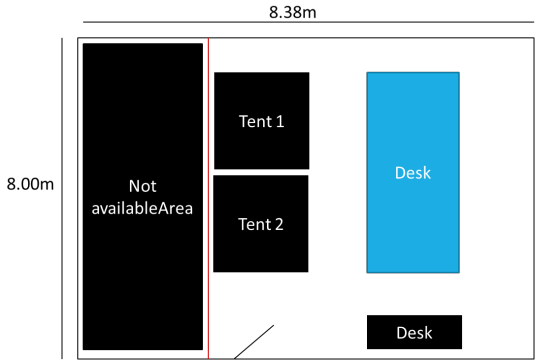

Fig. 2 Laboratory Layout

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Participants were ten male members of a collegiate esports team. Participants were informed of the purpose of the study and completed an informed consent form prior to participation. Approval was obtained from the Institutional Review Board of the research institution. The effects of the ions environment were evaluated in a randomized, crossover, placebo-controlled, double-blind study. Each participant participated in two experiments, four weeks apart; two experimental conditions were provided: a positive and a negative ionic environment (PNI) and a positive and a negative ionic environment (PNI). In the PNI condition, a Plasmacluster^{TM} ionizer (Sharp Corporation) was used, and positive and negative ions (approximately 320,000 ions/cm^3) were irradiated; under the CON condition, wind from the ionizer without ions was adapted at the same wind speed (wind speed: 0.29 m/sec) (Fig. 1, 2). In addition, positive and negative ions were generated by applying positive and negative high voltages to each discharge brush electrode of the ionizer to break up molecules in the air (Nishikawa & Nojima, 2001). The details of the experimental procedure are as follows. First, participants were required to wear an electroencephalograph (EEG) for two minutes to conduct a baseline assessment of their arousal level. Then, participants completed a questionnaire to assess their arousal level before playing a racing game. Participants completed three trials as practice trials prior to the experiment in the tent. In addition, three trials were conducted as the final trial. For the performance task, participants played MARIOKART Deluxe 8. In the race mode, the setting was time attack, with three laps of the same course. The vehicle class was set to 150 cc, and participants selected a driver character. EEG was measured upon completing the task, and arousal level was measured. After the task, participants completed the questionnaire again.

Arousal level was assessed by questionnaire and EEG. The two-dimensional mood scale (TDMS) (Sakairi et al., 2013) was used to assess arousal; the TDMS consists of eight items and four factors: activity, stability, comfort, and arousal. For EEG, we employed a simple band electroencephalograph (Neurosky Corporation, Tokyo) that measures only the frontal pole 1 lobe (Fp1) as defined by the International 10-20 System, and EEG obtained from Fp1 has been found to be suitable for obtaining psychological state data (Mitsukura, 2016), Fp1 was used to estimate arousal level. The estimation method is the same as in previous studies (Hagiwara et al., 2021). The TDMS scores before and after completing the task and EEG during the task were averaged. A t-test was used to examine the difference between the PNI and CON conditions on the TDMS and EEG. For the task performance, the 3 trials prior between the PNI and CON conditions were averaged. A t-test was also performed to examine the difference between the two conditions. The IBM SPSS Statistics 25.0 software was used for the analysis, and p value was set at 0.05.

For TDMS, there was a significant tendency ($p > 0.1$) between the PNI condition ($M = 8.1$, $SD = 4.3$) and the CON condition ($M = 6.6$, $SD = 3.2$). The PNI condition ($M=31.0$, $SD=7.3$) had a significantly higher ($p<0.05$) change in beta band power ratio indicating arousal than the CON condition ($M=10.5$, $SD=8.2$). Race performance indicated that the PNI condition ($M = -4.9$, $SD = 3.1$) tended to have significantly faster time changes than the CON condition ($M = -3.1$, $SD = 2.3$) ($p < 0.1$).

In summary, the purpose of this study was to reexamine the effects of positive and negative ion environments on game performance and arousal levels, which had been indicated in previous studies, and the results of the present study also demonstrated that the PNI condition resulted in higher race game performance and arousal levels. It is interesting to note that the results also demonstrated a greater amount of change in subjective arousal of changing ion density. However, to further scientifically prove the results of this study, it is also necessary to examine that what has changed in brain function. For example, additional studies of changes in cerebral blood flow in ionic environments would probably come closer to resolving the question of why game performance is better in ionic environments. Ion research is skeptical, and further experiments are needed.