

## Proposal of Organizing Learning Material with Multiple Perceptions Depending on Preference of Physical Training

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### ABSTRACT

Our research focuses on making a new e-learning framework which supports learning of physical activity skills. Generally, when we practice sports, we can use a learning material which includes multiple perceptions (e.g. coaching video with onomatopoeia). Additionally, the feedback with three-senses (e.g. sound, visual) which except senses of taste and smell is usually effective for the learner. Moreover, learning materials adopt to differences of individual learning environment (e.g. preference of the material). If the learners use the material under the environment, there is a possibility that they can acquire the skills easily. We propose a learning methodology which the learners can choose the candidates of learning material based on three-senses to realize a personalized and reliable training media through trial and error. The candidates are recommended by the system based on a relationship between players' and coaches' preferences (e.g. visual feedback support). The system obtains players' movements through wearable devices with sensors during each training, and gives feedback as a coaching trigger which adopts to the player's favorite perception in real-time.

### KEYWORDS

e-Learning, Physical Training, Knowledge Communication, Perceptual Feedback, Trial and Error

### 1 INTRODUCTION

Generally, a learning material and method include multiple perceptions which are not based on text only are very important for communicating skill to other man. The candidates of requisite perceptions depend on the material feature of the target skill. In the case of communicating posture, visual content is easy to accept for learners. On the other hand, when the system communicates the timing to the learner, an audio content tends to accept for the learners. If the contents can be adequately related, they have possible to can learn motion skills without face-to-face coaching. It is important to provide the same and suitable type of perception information to teach anyone and be taught by anyone on the skill learning mutually. Therefore, the most important point is that the coaches who have the information and the learners who wish for the information are connected.

A study of Gotoda et.al. (2013) focuses on the shoot-timing of tennis. In the study, they used vision, and transmit some timings. As another study, Tamura et.al. (2014) tackles to learner's motions of baseball pitching. The study uses 2-D motion image as visual feedback. However, according to each study, the goal of the skill learning is defined on either a self-evident strategy or the strong assumption. These studies not focus on organization of learning materials. In other words, the condition of the support is fixed (e.g. self-evident goal of traditional

sports) in these research. On the other hand, there are various sports over the world and sports have been creating and deriving from another sports. These sports become temporary minor, but they have possibility that they become develop in the future. If there is a frame work that develops the material through trial and error when there is not the material for the sports, it has possible to be able to promote development of the sports and contribute to adjust the learning materials about the sports. Therefore, this research proposes a system that connect the players and they become able to make the material through trial and error. Recently, variety wearable devices become available at low-cost. The wearable devices can use to objectively observe the player. Also it can apply the activity data which is retrieved in the sports activity to the material and give feedback to the player.

Thus, this research proposes a learning support system which realizes a methodology to create learning material. The methodology includes methods to organize and recommend the learning material. When they create the learning material, the methodology makes the players conscious of relation of information which each players are focusing when they apply the learning material. The system obtains players' movements through wearable devices with sensors during each training, and gives feedback as coaching trigger adopts to the player's favorite perception in real-time.

## 2 RELATED WORKS

As studies which are related to providing feedback to learners in sports, A study of Gotoda et.al. (2013) provides shoot-timing of tennis using vision feedback. A study of Tamura et.al. (2014) provides 2-D motion image feedback to learn motions of baseball pitching. In these studies, the goal of the skill learning is defined on either a self-evident strategy or the strong assumption. These studies do not focus on organization of learning materials. In other words, the condition of the support is fixed (e.g.

self-evident goal of traditional sports) in these research. The learners train with prepared learning material. On the other hand, In the world, many various sports exist. These sports have been creating and deriving from another sports. The variety of sport is increasing. These sports become temporary minor, but they have possibility that they become develop in the future. If there is a frame work that develops the material through trial and error, it has possible to be able to promote development of the sports and contribute to adjust the learning materials about the sports.

A study of Matsuura et.al. (2009) proposes "a web-based community environment" for the joggers. The research shows a possible that if the system adopting to construct the community of learners, it can provide the motivation to training for the learners.

Recently, variety wearable devices become available at low-cost. The wearable devices can use to objectively observe the learner. The activity data in the sports activity are retrieved by the device with sensors such as gyro sensors, magneto metric sensors to organize the material. In addition, the device can provide feedback to the player using actuators such as speakers.

A study of Yamada et.al (2014) propose a system which is possible of providing a real-time feedback to learners. The system using a motion capture to obtain the learner's postural, and the system shows results of own motion from the recently postural of the learner with vision as feedback. If the system adapting with the motion capture, the system can accuracy obtain the motion and postural of learner. However, the motion capture is expensive for the individual learner. Therefore, if the motion capture can be replaced with the wearable device, it is possible that a large number of learner can employ the system as a learning support tool.

Thus, this research proposes a learning support system which realize a methodology to create learning material. The methodology includes methods to organize and recommend the learning material. Also, the system connects the

players. When they create the learning material, the methodology makes the players conscious of relation of information that each player is focusing when they apply the learning material. The system obtains players' movements through wearable devices with sensors during each training, and gives feedback as coaching trigger adopts to the player's favorite perception in real-time.

### **3 ROLE of PERCEPTUAL LEARNING MATERIAL**

#### **3.1 Target Knowledge and Skills**

This research focuses on the physical activity skills which are decided by the players. One of the example of skill is the movement of a player's wrist to hit a ball with a tennis racket. The knowledge related to the skills is constructed mainly from two types. One is explicit knowledge and another one is implicit knowledge. The explicit knowledge is a basic knowledge such as how to swing the tennis racket, and it can be learned by textbooks, videos and so on. The implicit knowledge is obtained by the learners through playing their target sports, and it is based on both the experiences and senses of learner (e.g. release ball timing). If number of textbooks related to explicit knowledge is either less or none, the learners should search or create them. To create the texts is very high cost from the view point of summarization. Moreover, it is difficult for a learner to communicate the implicit knowledge to others with the texts. Therefore, we try to communicate the implicit knowledge such as timing using the perception signal such as visions and hearing as the feedback signal that is provided to the learners.

#### **3.2. Perceptual learning scenario for implicit skills**

The learning in order to gain the skills of sports can divide several steps. The author proposes composed seven steps. The steps of learners are

1. To just try to play the sports
2. To decide goal of skill learning
3. To select the material candidates
4. To train the target skill according to the material
5. To check own skills according to criteria of achievement for the goal
6. To judge that the learners either achieve the goal or not, under the check result
7. To reselect or modify the material and return to step

On this outline, it seems that the learning scenario both the traditional sports and developing sports is similar. However, strictly speaking, the contents of several steps each sport are different. These differences are described in below. Fig. 1 in below shows these difference of the learning steps. The right side of the figure describes contents of the learning step in the traditional sports. The left side of the figure describes that in the developing sports. The middle describes common steps.

In the step 2, if the learners practice the traditional sports, in many cases, the target skill for a novice learner has already decided from traditional success strategy. In contrast, when the learners practice the developing sports, there may be a few probabilities which the learners set the goal of skill in novice players. The chance for the authors to create the goal appears. In the step 3, in the practice of the traditional sports, they can choose the material which they think that the learner is easy to try to learn myself because a large number of materials are prepared traditionally. On the other hand, in the developing sports, the material for specific skills doesn't exist. However, a fundamental-material for the sports is exist. So the learner should extract parts that related the target skill from the fundamental-material. Therefore, in this research, collect the training contents in the step3 to reuse the contents as the material. Evaluating the contents in an after-mentioned method (section 4) by the other learner

owing to retrieving the training contents in the step 3. In the step 4, the learners practice the

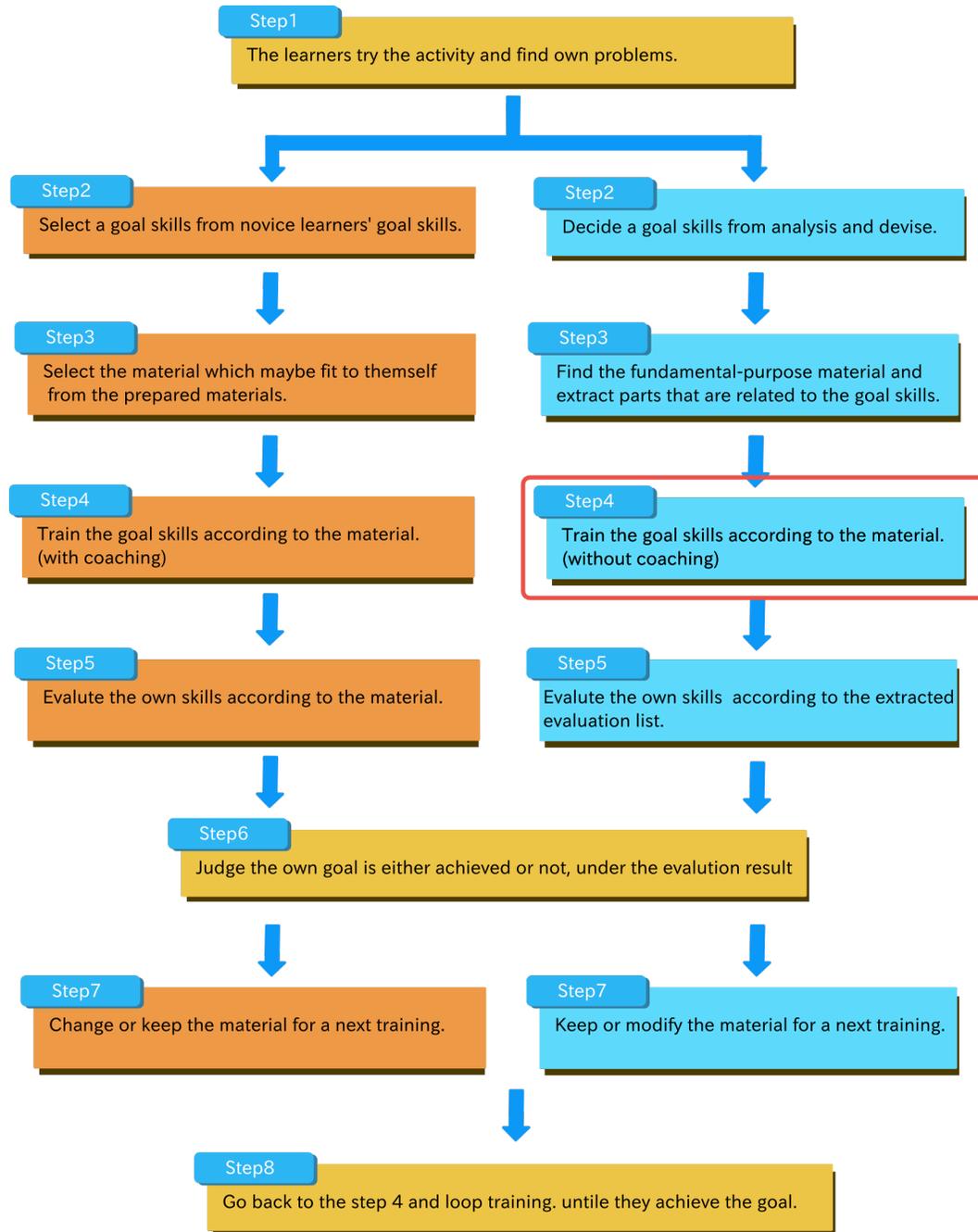


Fig. 1 Difference of learning process between each situation

goal of skill according to the material that is learner that trains skill of the traditional sports can have a chance of enough coaching time. So they can get the skill in short term. However, the learners who train skill of the developing sports, they should train the target skill themselves because they cannot have a chance of coaching enough time. So, the system in this

gathered and chosen in step 3. In this time, the research judges the learner's practice contents according to the material, and provides perceptual feedback to the learner based on the learner's preference of instruction style. In step 5, the player evaluates level of the own skill. In the traditional sports, the player can evaluate own skill level according to the material that

used in step 4. Though, the learner should extract an evaluation list from each fundamental material which is the summary of fundamental skills in a certain developing sports. Therefore, in this research, first, the system makes prototype of the check list which has criteria of the skill level for the evaluation, from the extracted parts in the step 3. The check list is improved by the learners through the system. In step 7, when the player trains the skill of traditional sports, they can either select the material again or create the new material which slightly modify the exist material. Then they use the new material at next train. However, if the players train the skill of the developing sports, they can only modify the fundamental materials to the them target of skill with trial and error.

This research's learning scenario adopts feedback system with perception information, and supports the player. Because the feedback system has possible to improve training effect such that training terms become more shortly.

#### **4 A METHODOLOGY of RETRIEVING and ORGANIZING LEARNING MATERIAL**

This paper describes the learning steps both the traditional sports and the developing sports, and the contents of each sport have difference of a detail in the several steps.

This paper proposes a system which mainly supports the learners to obtain the skill of developing sports. Fig. 2 shows construction of a learning scenario. The scenario is constructed by two parts. One of part is learners' side. It is placed at left side on Fig. 2, and this part mainly operates on a parallel with the moving body in the skill training. In this part, the learners equip with a wearable device that integrated with both several sensors and actuators, the device retrieves the training contents and provide feedback to the learner when the learners training. The other part is server side parts that operate asynchronously with the learners' training. This part is

constructed by a couple of servers. The one of servers both judge and retrieve that the collected body movement of learner, and the other recommend the learning material to the learner. The system uses the server of former to retrieve the contents and judge that the learner's body movements satisfy the condition of task solution according to the material contents. This learning scenario can use to practice the developing sports. When the system applies the scenario for the sports, it has possible to make developing sports improve. In this system, the other learners evaluate the learner's physical movement. Then, the learners become a consequent creator of the learning material. In this scenario, firstly, the learner submits own preference which contains both the instruction style (e.g. voice, video) and a kind of the target skill (e.g. timing, space) to the system via the learner's PC. Secondly, the learner downloads the learning material which is chosen and recommended by the server according to the learner's preference, from the recommending material server. Here, the server picks up both the feedback signals from the candidate type of signals and the physical movement data of the highest evaluation value. In this time, the learner as the creator of the material in training of the learner become the consequent creator. Next, the learner installs the material in the wearable device. Then, the learner equips own self with the device to train the target skill. When the learner starts on the target skill, the wearable device begins to collect the learner's physical movements with the sensors on the device, and the device compared with both the collected movements by the device and the key points of movement in the material. The device generates the feedback signal in real-time according to both the result of the comparison and the signal in the material. The learner receives the signal and promote the proficiency level of skill through improvement of the physical movement according to the signal. The process from the device collects the physical movement to the system provides the signal for

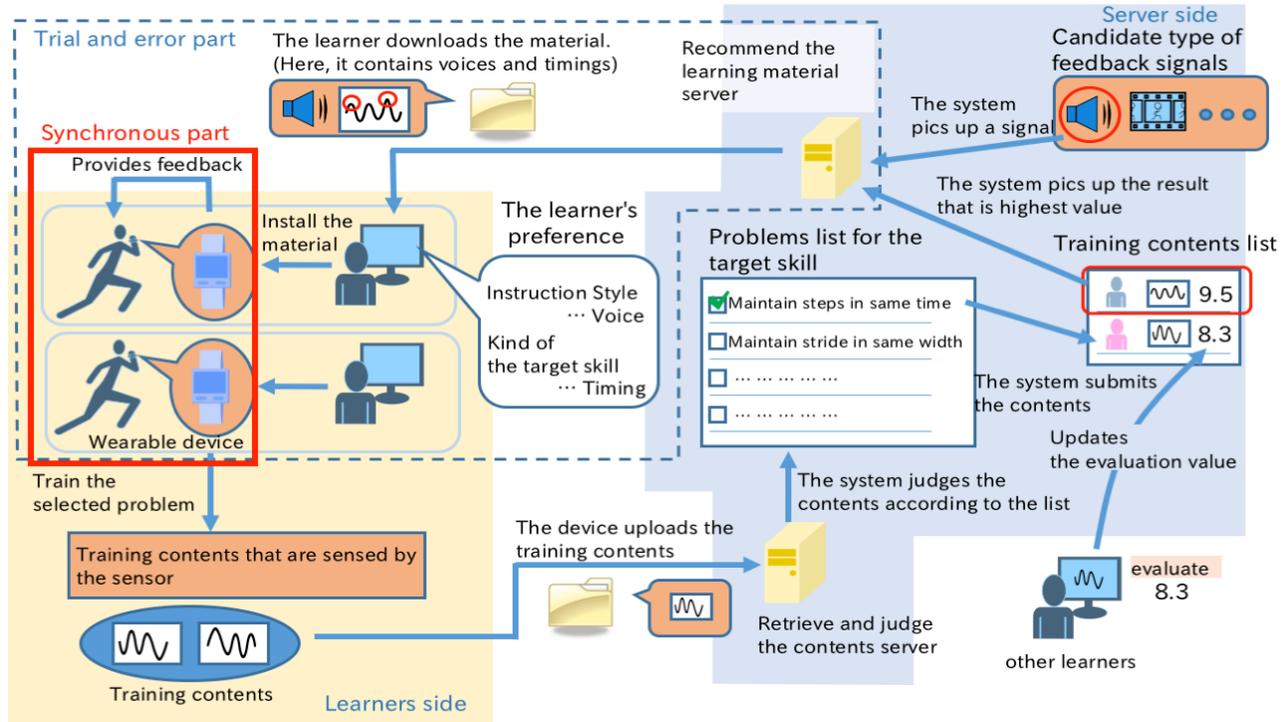


Fig. 2 A learning scenario in the purpose system

the learner is synchronously with the training of learner.

When the learner finishes the training, the wearable device uploads the collected physical movement log with the sensors on the device during the training of learner, to the server. the server both retrieves the sensor log which is collected in the learner's training and decides that the learner achieves the selected target skill in the problem list (e.g. Maintain steps in same time) by the learner according to the list to obtain the target skill. After the decision, both the sensor log and the evaluation value are submitted to the training contents list by the system. The training contents list is a collection of the collected physical movement of the learner in the training of each learner, and there are evaluated by the others learner based on both the knowledges and experiments. The other learners refer to the physical movement data in the training contents list, they evaluate that and updates the evaluation value. The evaluated

data are referred to next training of both the other learner and own self.

The learning material has been built by this scenario. The problem list is improved by the learner either add or delete a contents of the check list. In this research, the authors are purpose the system that realize the scenario in afore-mention.

### 5 SYSTEM CONFIGURATION for REALIZE THE SCENARIO

Fig. 3 shows the system configuration to realize the scenario in section 4. This system is composed of both the wearable device and server on Internet. Then, the users of this system are the learners of both the training learner and others learner. The wearable device consists in a MPU, sensors, and actuators. On the other hand, the server is composed of four databases and two modules. The server and the wearable are connected through the Internet. The training learners and the others learner also access to the learner through the Internet.

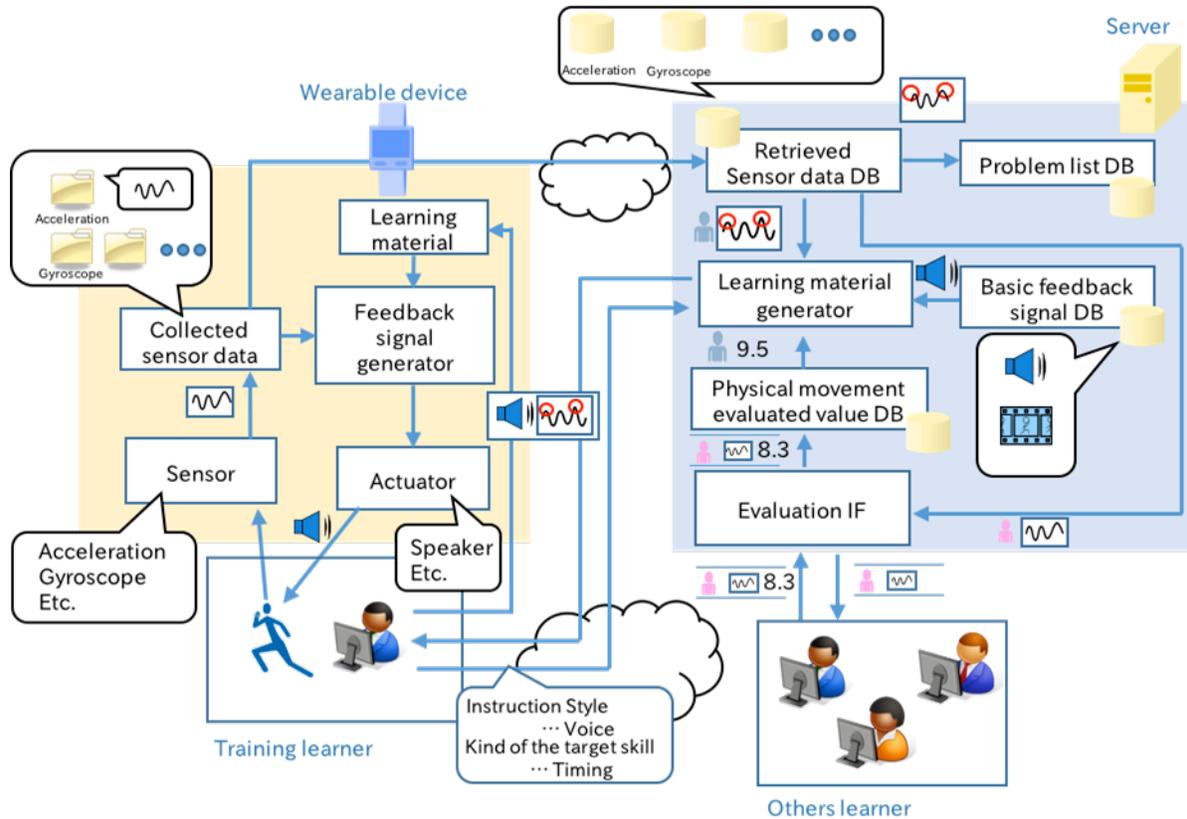


Fig. 3 System configuration

The wearable device mainly provides three functions; measuring the learner’s physical movement, generating the feedback signal, transmitting the measured data. The learners should submit the learning material from the function of server which is described below. If the learners begin training the problem of target skill, the device also begin measurement the learner’s movement with the sensors such as acceleration sensors, gyroscope sensors, magneto metric sensors. For instance, in the Fig. 3, the device both measures the movement of learner with the acceleration sensor, and addition to the sensor data materials in the module of collected sensor data. That module is temporary storage of the sensor measured data, and it memories the data each sensor. Next, when the device processes the feedback signal generator, the module refers to both the learning material and the sensor data in the collected sensor data. The learning material includes the teacher signals and a basic

feedback signal. For example, the learner adopts to an interval of positive peek which is measured by the acceleration sensor, as teacher signals. The generated signal is transformed from electric signals into a physical signal (e.g. sound) by the actuator. In the example of Fig. 3, the electric signal of the feedback is transformed into a sound signal by the speaker. When the learner finishes the training, the device transmits the learner’s physical movement data to the server.

The server mainly has three functions; retrieving the measured physical movement data, generating the learning materials, and retrieving the evaluation of the others learner’s physical movement. A function of the retrieving measured physical movement data receives the sensor data at “Retrieved sensor data DB” in the figure. The stored sensor data are transformed into amount of characteristic data when the DB reserves transmission request from both “Problem list DB” and “Learning

material generator”. For instance, in the Fig.3, peaks of the signal are extracted from the sensor data as the amount of characteristic, after that they are sent to each modules. The problem list DB has the conditions to fix the problem of target skill, and it decides that the received data implement the condition to judge the learner’s skill. On the other hand, when the DB sends to “Evaluation IF” which both provides the data of evaluation target to others learners and receive the evaluation value, the raw data are transmitted. In “Evaluation IF”, the received data are provided to others learners, and then the learners evaluate the data. After that, the module collects the evaluated values from the others learners. Then the values are stored to “Physical movement evaluated value DB”.

When the module of “Learning material generator” receives a request of the data from the learners and the preference, it generates the material which the learner refers to practice of the problem, from both the sensor data and the evaluation value. The module chooses the sensor data which are converted to the data of amount of characteristic, based on the evaluation of data. In this time, “Retrieved sensor data DB” outputs the amount of characteristic data which is adapted to the preference of kind of target skill. In Fig. 3, the learner selects a Timing skill training as that. So, the amount of characteristic data constructed from the peek time of sensor data. In addition, the generator module chooses the feedback signal based on the learner’s preference of instruction style. In Fig.3, for example, the learner selects “Voice” as the instruction style. So the generator recommends sounds as the feedback signal. Finally, the amount of characteristic data and the signal combined by the generator module, and transmitted to the training learner.

The important futures of the system are things that the training learner can choose the feedback signal and the training material, and the learning material is updated consequently by the learner’s training and the others learner’s evaluation. This methodology is the multiple perception material. Our research tackle to

support the learners using the system, and makes the learners easy to obtain the skill of sports.

## 6 CONCLUSION and FUTURE WORK

This paper proposes the sports learning system which uses perceptual material. In this paper, the authors propose a new learning methodology. The learning methodology is based on organizing learning material which includes the information of perceptual type. The perceptual type is constituted by three-senses that are the sense of sight, hearing, and touch.

In the section 3, the authors mentioned the differences of between the training scenario of traditional to developing sports, and if our learning methodology can support the learners’ training without the face-to-face direction, this research has possible that it can improve the developing sports.

In the section 4, the training scenario in this research is mentioned, and the learning material is generated from the physical movement data of the learner and the candidate type of feedback signals. When the system generates the material to improve the learner’s skill, the system refers to the direction preference of learners. Finally, in the section 5, the system configuration is explained. The wearable device equips with the both sensors to collect the physical movement of learner and actuators to provide the feedback signal with physical signals such as sounds and visions. Then, the authors expect that the system to support the learner who train the developing sports with the multiple perception

In the future, the authors develop the system that proposed in this paper, after that experiment the system to confirm the effect.

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