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Implementation of Pseudo Golf Club and Virtual Golf Simulation System

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Abstract

In this study, we propose a pseudo golf club which can sense user's swing motion and virtual golf simulation system using the pseudo golf club. The proposed system is a virtual golf simulation system of a complex play type in which a player can enjoy various types of golf play according to the user's taste by providing a play mode for hitting an actual golf ball and a play mode for swinging the pseudo golf club. This virtual golf play system calculates and displays the trajectory of a golf ball by a simulator just like playing a real golf, and suggests suitable swing motion, so it helps users to learn golf easily.

Keywords: *Golf System, Simulator, Pseudo Golf Club, Virtual Golf Simulation System*

1. Introduction

In recent years, simulation devices using three-dimensional stereoscopic images and computer simulating techniques have been developed and widely spread, so that a sports game can be enjoyed without going to the scene. Particularly, in the case of a screen golf which is performed indoors, because the image of the golf course is displayed through the screen, time and cost are saved compared with playing in the outdoor field, it is very popular among busy modern people who are hard to play outdoor golf because of time and economical reason.

For beginners, it is difficult to swing the golf swing in the following ways: When the swing trajectory of the head swings down too far down the golf swing, it hits the ground behind the golf swing. And that the swing trajectory of the head hits the upper part of the golf ball in the course of climbing past the lowest point. Particularly, when the golf club is strongly hit on the ground, the impact is transmitted to the golfer, causing injury to the golfer. In addition, the difficulty for a beginner is that when there is a deviation in the golf ability between the members of the group to be played, there is a considerable difference also in the play scores, and there is a concern that the interest in the golf itself may be lost. Therefore, it is required to develop a technique that enables beginners to practice golf easily without worrying about injuries.

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It is also required to develop a technique that allows the members to continue enjoying the golf play without causing a large deviation of the play score even if there is a difference between the members.

So far, much research has been published about golf system. This includes: Research on golf simulations such as the movement of golf balls or golfers [4-8], data collection through sensors [1-2], and research on advice system [3].

The golf system we developed in this study includes a pseudo golf club that can detect the user's swing motion and can swing easily without worrying about injury even for a beginner, and a virtual golf simulator of a complex play method. In Chapter 2, the overview of the pseudo golf club and the sensing module are described. In Section 3, we describe the configuration, operation, and trajectory calculation method of the virtual golf simulating system. Chapter 4 concludes the paper.

2. Pseudo Golf Club

2.1 Overview

The proposed pseudo golf club is composed as shown in Figure 1. When you swing with this golf club, it works in conjunction with a smart phone or other screen golf system, so that the golf system is activated by receiving pseudo golf data from the pseudo golf club.

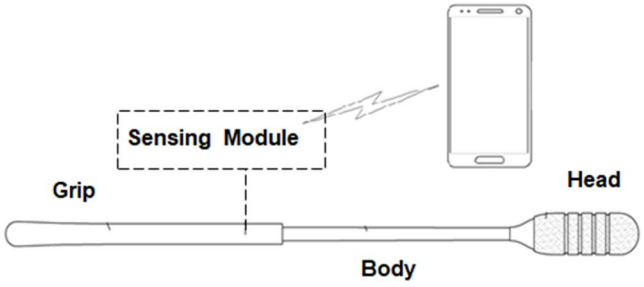


Figure 1. Pseudo Golf Club

The grip part is the portion that the user grips when swinging. The body portion has a shape extending in a predetermined direction, and is a portion constituting the body of a pseudo golf club. The head is a part where the golf ball is assumed to be impacted when the user swings. The pseudo golf club shown in Figure 1 is not used to strike a real golf ball. It is used only for swinging without a golf ball. Therefore, it is assumed that there is a golf ball to be hit at the head portion, and the actual golf ball is not impacted.

2.2 Sensing Module

The pseudo golf club is equipped with a sensing module which can serve as a sensing part for sensing the swing motion of the user. The sensing module is embedded inside the pseudo golf club. The sensing module consists of a sensing unit, a processor, a transmitter / receiver unit, and a vibration unit. The configuration diagram of the sensing module is shown in Figure 2.

The sensing unit includes at least one or more sensors capable of sensing the swing motion of the user. For example, it may include a velocity sensor for measuring velocity and acceleration in three axial directions orthogonal to each other, and an angular velocity sensor for measuring an angular velocity in three axial directions orthogonal to each other. A signal detected by each sensor of the sensing unit is transmitted to the processor, and the detected sensing signal may be converted into various digital signals by the processor and transmitted to the outside through the transmitter / receiver unit at predetermined time intervals.

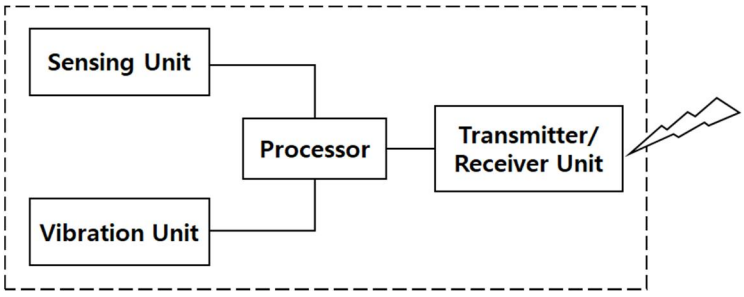


Figure 2. Sensing Module

3. Virtual Golf Simulation

3.1 System Operation

When the user takes a swing motion using the pseudo golf club, the information sensed by the sensing module in the golf club is transmitted to the outside at a predetermined swing position during a swing operation at regular time intervals. The sensing module performs other tasks besides its role as a sensor. The vibration unit in the sensing module generates a vibration to inform the user that a specific situation related to the swing has occurred.

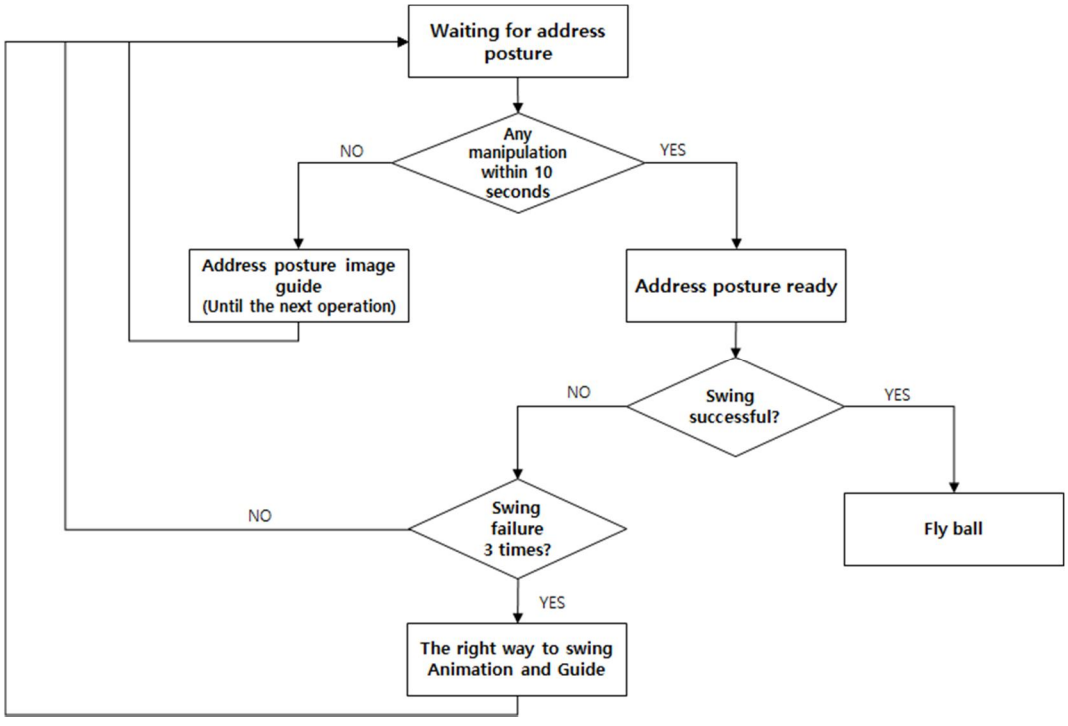


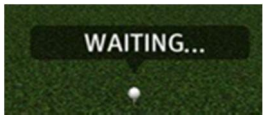
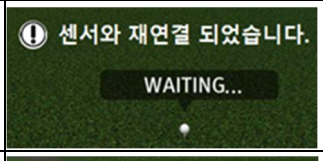
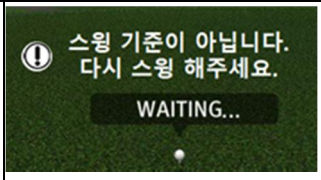
Figure 3. Example of System Operation Flow

Figure 3 shows an example of system operation flow according to the sensor states. For example, if you take an address posture and then take a swing action for hitting, the system will generate a vibration when the address posture is completed. This vibration can inform the user when the '*swing motion for batting*'

following the addressing operation is started. Or if it is assumed that the golf ball is hit (but not hit by the actual golf ball), the system generates vibration when the pseudo golf club and the golf ball are recognized as being impacted. This can inform the user when the golf ball is impacted. As a method of indicating the address completion point or the impact point of the golf ball, other means such as sound device may be used in place of the vibration unit, or other means may be used together with the vibration unit.

Table 1 shows several states of the sensors and their corresponding actions. Depending on the status of the sensor, the simulating system outputs images and messages to the screen and takes appropriate action.

Table 1. Sensor Status and System Action

Sensor state	Screen message	System action
Before READY		Address posture induction to user before READY state
No operation for 10 seconds		Output to the screen immediately if there is no operation from the user for 10 seconds Fade-out processing for 1 second immediately upon detection of screen touch, user address posture,
Sensor connection loss		Script output and error sound playback when sensor is disconnected Maintain script until connection is completed, change to reconnect script immediately upon completion
Reconnect sensor		Keep script for 1 second after successful connection, play sensor connection sound Fade-out within 0.5 seconds after connection
Swing failure		Output of the failure message when the average club speed per club is 40% or less Error sound playback Fade-out processing in 1 second
Swing failure 3 times		Immediately on the screen when 3 swings failed Fade-out for 1 second after 3 seconds
READY		READY voice playback Error sound playback when ABORT Immediate processing when ABORT in READY When it is READY after ABORT, 1 second delay
After SHOT, then READY	-	Delay 2 seconds by shot

3.2 Trajectory Calculation

With the information from the sensing module, the system can determine which swing trajectory and driving distance the user has swung as a whole. Figure 4 illustrates the trajectory, assuming that the golf ball was hit by a pseudo golf club.

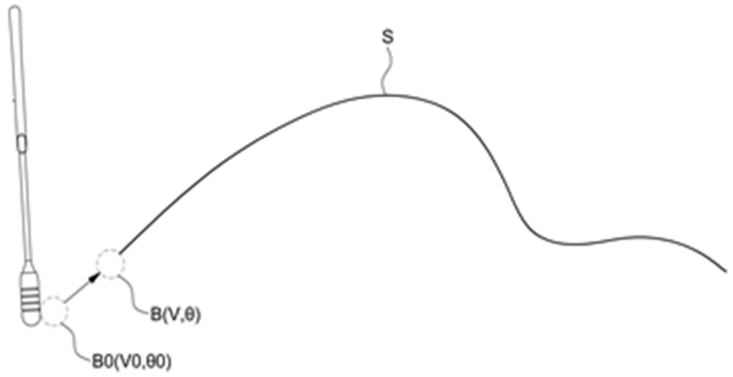


Figure 4. Trajectory of Golf Ball

Assume that the user hits the golf ball B0 in the stop state (V0, θ0) as shown in Figure 4 with the pseudo golf club, and the state changes to the golf ball B having the certain movement state (V, θ). The parameters are indicating the physical state of the golf ball. V0, θ0, V, and θ denote initial velocity, initial angle, post-impact velocity, and post-impact angle, respectively. The angle may indicate an azimuth angle indicating a direction on the horizontal plane of the golf ball or a vertical angle indicating an angle of inclination of the golf ball with respect to the horizontal plane. The parameters such as the speed or angle mentioned herein are exemplarily shown, and other parameters such as spins and the like may be further considered. When calculating the post-impact velocity and the post-impact angle, the data sensed by the pseudo golf club is used in the swing motion of the user. For example, the angle of swing and swing speed is determined when the club is considered to be impacted with the golf ball. When hitting the golf ball at this angle and speed, the post-impact speed and post-impact angle can be calculated in consideration of the amount of impact transmitted to the golf ball or the impact direction.

Since the pseudo golf club is not actually hitting the golf ball, it is necessary to decide what state of the swinging motion with this pseudo golf club will be considered to be impacted with the golf ball. Various methods can be applied. First, the position of the pseudo golf club when the address operation is completed immediately before the user swings is memorized, and it can be an impact point when the pseudo golf club passes the memorized position in the swing motion of the user. As another method, considering that the maximum swing speed is obtained when an impact occurs, it can be considered that a golf ball and an impact have occurred at a point where the maximum swing speed is reached. Or you can combine the above two. That is, a predetermined range is set from the point where the address operation is completed, and it can be considered that a golf ball and an impact have occurred at a point where the swing speed becomes the maximum of the swing operation of the user within the set range. For example, it can be considered that a golf ball and an impact have occurred at a point at which the maximum swing speed is within the above range, assuming a range of 5 degrees from the point where the address operation is completed.

Assuming the state change (V0, θ0 → V, θ) of the golf ball as described above, the system calculate

the values of parameters such as post-impact velocity V and post-impact angle θ of the golf ball. Then, with these values, the final trajectory S of the golf ball is calculated.

In calculating the final trajectory S of the golf ball, it is possible to consider what type of golf club the user has swung to. There are various kinds of golf clubs such as wood, iron, and putter, and the trajectory of the golf ball may vary depending on which golf club is used. As for a pseudo golf club, it is possible to construct a plurality of pseudo golf clubs corresponding to various kinds of golf clubs as in real, but it is not efficient. Therefore, it is preferable to configure one pseudo golf club to correspond to various kinds of golf clubs in practice.

In this case, considering that the actual golf clubs vary in driving distance and accuracy depending on their types, the system checks which of the actual golf clubs the pseudo golf club represents, and reflects this in the calculation of the trajectory of the golf ball. For example, an intermediate driving distance value D is calculated from the parameter V and θ, and then D is multiplied by the constant K to obtain the final driving distance value. The value of the constant K is changed according to the kind of the golf club. Here, information on what kind of golf club the pseudo golf club represents during the current swing can be input by the user himself or herself before the swing operation. That is, the user inputs a swing operation after inputting in advance what kind of actual golf club he is going to swing, and the controller calculates the driving distance according to the input information.

3.3 Simulator

The simulator uses the data from the sensing module of the pseudo golf club to show the trajectory and driving distance as if it were a real swing. The sensed values used in calculation are Ball speed, Club speed, Launch angle, Backspin, Sidespin, Left and Right angle, and Face angle. Types of clubs include Putter, SW, AW, PW, Iron9 to Iron 3, Wood5, Wood3, and Driver. The swing is simulated by giving a correction value for each club type. Figure 5 shows the final result of the simulation by adjusting the seven sensing values for each club type.

Figure 5. Simulation Results

4. Conclusion

In this paper, we proposed the implementation of pseudo golf club and virtual golf simulation system using it. Inside the pseudo golf club is a sensing module, which consists of a sensor, a vibrator, a processor, and a transmitter / receiver unit. When a user swings using a pseudo golf club, a swing motion is detected by the sensor unit and transmitted to the outside such as a mobile device or screen golf system.

The virtual golf simulation system receives the sensed data, analyzes the swing motion, calculates the trajectory and driving distance of the golf ball, and displays it to the user. Initial velocity, initial angle, post-impact velocity, post-impact angle, and type of golf club are the parameters of the trajectory and driving distance calculation, assuming that the pseudo golf club swung the golf ball. The system not only shows the trajectory and driving distance of the golf ball, but also displays a message about the action according to the state of the sensor and suggests a desirable swing motion. The mobile golf simulation device can improve the swing motion of the user.

With the proposed virtual golf simulation system of a complex play system using a pseudo golf club, the user can check his / her swing motion while viewing a message presented by the simulating system, and can learn and enjoy golf play in a variety of ways.

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