DRIVR

A Golf Shot-Tracing Program for Home Practice

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ABSTRACT

In this project I will create a system for allowing a user to practice their golf swing at home. By measuring attributes such as swing speed and the club-to-ball angle using 6-axis gyroscopes placed around a golf club, I will create a system in which a user can accurately tell how a shot would be without the need to actually hit a golf ball. I believe there is a gap on the market for a product such as this, as similar systems either require the user to hit a golf ball or do not focus on realism, meaning an experienced golfer looking to improve their game will not be able to benefit much from these. By allowing the user to practice at home, the system will mean that golfers can practice with real time feedback without having to spend more money, such as on driving range costs.

Figure 1: Trackman 4 Display

1 INTRODUCTION

During the lockdown of 2020 due to Covid-19 a problem in the golf industry emerged. Without spending thousands on a home shot tracing system, there is no viable way to accurately practice hitting golf shots. This project will attempt to rectify that, by creating an at-home golf swing analyser that doesn't require the user to actually hit a golf ball. Using a gyroscope attached to the head of the club, and a micro-controller to record the data provided, this system will be able to provide the user with real time feedback of their shot. It will be able to provide the user with information such as swing speed, shot distance and type of spin on the ball, be that hook or slice.

This report will outlay the research taken into consideration during this project, like what similar products are available currently and what other research has been done into this type of project. It will then provide a list of requirements for the system and explain how the implementation of the project will be carried out.

2 EXISTING PRODUCTS

When it comes to analysing golf swings there are a wide variety of products on the market. They vary greatly in technique, accessibility, and price. Whilst researching into these products, 3 categories to define them were decided; On-Board Swing Analysis, Shot Tracers, and Motion Control Games.

2.1 On-Board Swing Analysis

On-board swing analysis provides the user with data on their golf swing by placing a sensor directly on the golf club. The user will purchase a set of 14 GPS trackers which screw into the top end of the golf club, which will then track the position of every shot the user then hits. It does this by taking note of which club the user selects, then records the GPS location of where the shot takes place. When the user has hit their shot and reached the location of the ball, the system then records the location and calculates the distance. The system also keeps track of the ball location (fairway/greens hit etc.).

Over time, with enough data collection, the system can inform the user of their shot trends, providing information such as how far the user can hit the selected club, or how often they hit the green with it. All of this information is transmitted to the user's smartphone or tablet using the Garmin Connect app, making it easily accessible to view. If the user also owns a Garmin GPS watch with golf capabilities, they can view the data on their wrist whilst playing a round of golf. These products, such as the Garmin Approach CT10, are becoming very popular due to their low price and the small size of the product.

2.2 Shot Tracers

Shot tracing provides the user with data about their golf swing by using cameras or radar technology to log details about the flight of the golf ball, which is then calculated into a projection of the full shot. Shot tracing can take advantage of the Doppler Effect in order to determine the ball flight of a shot. These systems, like the Trackman 4 (pictured in Figure 1), are placed behind the user and emit microwave signal in the direction the user will swing. The ball in flight interferes with the signal with some of the it being reflected back towards the monitor. Attributes like the speed and direction of the ball are then calculated and then shown to the user via an attached screen.

Another form of launch monitor uses cameras to calculate the ball flight rather than radar technology. These systems, like the Foresight GC2, take photos of and monitor the club head and ball at impact. From here the system projects the ball flight and speed and displays it to the user via a connected screen.

Figure 2: Gameplay of Wii Sports Golf

Both of these types of launch monitors can be very expensive, costing thousands of pounds for the leading technologies. This means that owning one is generally limited to professionals and business settings. The general public are able to access these systems, as they are owned by many driving ranges and practice facilities who allow customers to use them for a nominal fee. These systems also can't be used on a golf course, meaning they can only be used as training tools.

2.3 Motion Control Games

Perhaps the most accessible form of golf swing analysis is through the use of motion control games. Popularised in the late 2000s by the Nintendo Wii, motion control games involve the user simulating real life scenarios with a small controller. The most popular of these is the golf minigame included in Wii Sports. This game involves the user swinging the Wii remote as if it were a real-life golf club in order to manoeuvre themselves around the fantasy golf course. The user is able to manipulate the outcome in several ways, for instance they can select the club they wish to use, and they can affect the distance the ball goes by how hard they swing the remote.

The game was expanded upon in the sequel Wii Sports Resort (pictured in Figure 2), which added features to allow the user to add spin to their ball, which allowed the user to fade or draw the ball by tilting the remote on impact, and allowed them to add backspin when aiming for the greens. Both these games were hugely popular largely due to their accessibility, as people of all ages and completely inexperienced golfers were to pick it up rather quickly and play. This simple approach to golf meant the game isn't viable as practice to experienced golfers looking to improve their game, largely due to its unrealistic gameplay.

The original Wii remote featured a 3-axis accelerometer in order to register the user's movement.This coupled with the infrared sensor placed in front of the user provided a relatively accurate simulation of the user's actions. It may have struggled with fine motor control, but worked well for larger movements, such as those found in the Wii Sports minigames. With the launch of the sequel Wii Sports Resort came the release of the Wii MotionPlus, an improvement on the original controller. This added a 3-axis 'tuning fork' gyroscope [1] in addition to the original accelerometer in order to register more accurate readings from the user. The MotionPlus could either be bought in a standalone controller or clipped into the bottom of the original remote.

Similar games have also been developed, such as those in the Tiger Woods PGA Tour line. These games attempted to focus on more realistic gameplay, mainly down to licensing professional golfers and PGA Tour courses. These more down-to-earth games give the user a more realistic simulation of the sport but are still limited by the controller used. Other games have been developed using more modern technology, such as Virtual Reality, in order to improve the simulation for the user.

3 ACADEMIC PAPER STUDY

The amount of thorough scientific research that has been carried out into the golf industry is surprisingly limited, having only really increased recently. This is mainly due to the necessary technologies only becoming increasingly available in recent years. However, there has been some research into a system similar to the one to be created in this project.

A study carried out in 2016 [2] attempted to attach an inertial-sensor-based portable instrument to a golf club in order to track its movement. The main aim of the study was to develop a system that could identify the main stages of a golf swing. The study carried this out with very small error margins, proving it is possible to track the head of a golf club using only an inertial sensor.

Another study carried out in 2012 [3] attempted to find the differences between good features and bad features of a golf swing using gyro-sensors and 3D acceleration. This was done by using sensors on the swings of novices and comparing them to the swings of experienced golfers. The research paper concluded that the main difference in the swings was with the angular velocity around the axis facing towards the target. The experienced golfer returned a negative value, indicating that he kept his shoulders level whilst on the back swing, whilst the novice golfers, with their more unstable swing, tended to dip their shoulders more.

4 REQUIREMENTS SPECIFICATION

- As a user, I would like to view my swing speed so that I know how fast I can swing the club
- As a user, I would like to view my shot distance so that I know how far I can hit the ball
- As a user, I would like to view my shot on a virtual driving range so that I get a better representation of how the shot was
- As a user, I would like to play on a virtual golf course so that I can practice hitting shots of specific distances
- As a user, I would like to re-calibrate the device, so that I know it is recording accurately
- As a user, I would like to save data on my shots so that I can look back on them

5 USER JOURNEY

The user will turn on the system and will then run the program. Once the golf club has connected, they will find themselves at the main menu. Here they will be met with three options: Driving Range, Play Course and Settings.

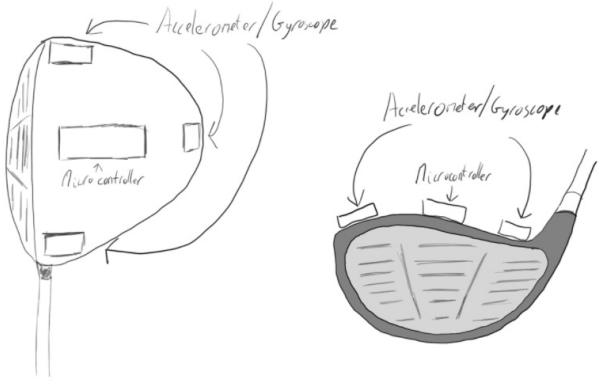

Figure 3: Initial design of the system

If the user selects Settings, they will be shown a screen where they are able to change a variety of options, such re-calibrating the sensors or changing the units of measurement used.

If the user selects the Driving Range, then they will be taken to the 'virtual driving range' screen. Here they will be able to select the club they wish to use, then when the user is ready, they will swing their club. After the shot, the user will be shown on the screen a simulation of their shot. The screen will provide information on a wide variety of attributes such as swing speed, ball carry/total distance, and whether the shot was straight, hooked, or sliced. The user will also be shown a graphic of the shot, similar to a bird's eye view on a real driving range.

If the user selects the Play Course option, they will be met with a similar screen to the Driving Range, with the main difference being that the small avatar will be placed on a golf hole. The user will select their club and swing as before and the ball will be shown to advance along the hole. For the user's second shot they will then have to select the appropriate club for the distance left. Once the user has reached the green, they will then have to use the club to putt the ball into the hole by only swinging it a small amount.

6 REFLECTION AND SUMMARY

So far, I believe the project is going very well. I have a clear and concise idea of what I wish to have completed by the end of the module. I have created a large bank of user stories which will serve as my requirements specification that will help me along the way. These user stories have been created from the background research I have completed as the first stage of my project, I have pooled together ideas and features from a wide variety of golf swing analysis project in order to create something I feel I would personally use. I have taken elements from various products I have researched, such as taking the on board swing functionality of products like the Garmin Approach CT10, the output from launch monitors such as the Trackman 4 in order to give the feel of professional training for the Driving Range function, and I have taken the idea of traversing a virtual golf course from products like Wii Sports in order to add interactivity and fun to the device.

Going forward, I am now entering the final design stages and implementation of the project. I have decided on using an ESP32 Microcontroller board to power my product. I chose this board due to its lightweight and small body and its Wi-Fi capabilities. This means I won't have cables dangling from the product and wrapping around the user when they try to use it. I also have experience working with the Arduino IDE and the Unity game engine which will both come in handy when implementing this project. Due to the ongoing COVID-19 pandemic my testing strategy will be limited. I originally had a test plan of having a group of experienced golfers use the product, followed by hitting similar shots at a driving range to test the accuracy of the device. I would then have the contestants fill out a questionnaire about the device, rating their experience using it. Now my testing plan will be using Auto-Ethnographic testing, focussing mainly of self-reflection and improvement.

REFERENCES

[1] F. Caron. 2008. Of gyroscopes and gaming: the tech behind the Wii MotionPlus. (2008), 1–2.
[2] Y. Hsu, Y. Chen, P. Chou, Y. Kou, Y. Chen, and H. Su. 2016. Golf swing motion detection using an inertial-sensor-based portable instrument. (2016), 1–2.
[3] K. Shirota, K. Watanabe, and Y. Kurihara. 2012. Measurement and analysis of golf swing using 3-D acceleration and gyro sensor. (2012), 356–360.

A USER STORIES

This is a link to the planning board for this project, featuring a more in-depth list of the user stories: Project Board Link