Creating a Device for Assisting Disc Golfers During Gameplay: Tamagolfi

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Abstract. This paper presents a wearable device named Tamagolfi, designed to help disc golf players keep track of their game score. Unlike mobile apps, this device aims to give players a quick tactile and non-distracting score tracking experience. We conducted usability tests with four participants, which confirmed the device was intuitive and fast to use. Although the device needed improvements in certain aspects, the results suggested that using a dedicated score tracking device during gameplay can help players stay focused.

Keywords: Human-Computer Interaction (HCI), Tangible Interaction, Device Prototyping, Wearable Devices, Sports Scoring Devices, Disc Golf

1 Introduction

1.1 Background and Motivation

Disc golf is a fairly new sport that in recent years has seen a huge increase in popularity. When playing disc golf the player is required, as in most other sports, to keep track of their score throughout the game. For many players this can become a point of annoyance, and for beginners it can be a hurdle to get over. Noting scores physically, as with a piece of paper, or digitally, as with a mobile application, can quickly become bothersome. Having to repeatedly put away and take out something to update the score takes away attention and time that could otherwise be spent on the game itself. For this reason, we wanted to create a device that would help alleviate this problem.

1.2 Research Question and Scope

To answer the question of how a dedicated score tracking device could help a player keep track of their score in a game of disc golf, we wanted to design it in a way where it could be wearable, durable, and intuitive to use. The functionality of the device will initially be limited to only keeping track of scores. It will take into account the par system used in disc golf and show the score for each tee as well as for the entire round. As of now the device will be individual, as in it only lets a player keep track of their own score. The possibility of expanding upon this, as well as other parts of the device, is discussed in later chapters. Through our research into the topic, we found little

research or development done into a device resembling what we envisioned. Seeing as the scoring system for disc golf is identical to golf, and golf is a more popular sport, most products existing are made for golf. In terms of the scoring system, the device would work for golf, but disc golf is generally played in more varied and rough terrain than golf, making it useful for the device to be made with a more sturdy design in mind.

1.3 Related Work

Previous studies show how digital and physical devices can be useful to aid in different types of sports. This can for example be by making the execution of the specific sport safer, or making it easier to monitor performance and results, leading to an overall better user experience. Academic literature with focus on disc golf score trackers and equipment is limited, and studies on other sports equipment, wearables and devices is therefore relevant to show the range of different sports devices.

One of the earliest electronic scoring devices in sports was designed in 1991 and was made specifically for golf [1]: the "Electronic Golf Score Card". It was a microcontroller-based score card, tracking scores across 18 holes. The device was designed to replace the paper score cards which was the traditional way to track scores in golf. The device included additional functions like world clock, calendar, alarm and stopwatch. This work highlights how electronic devices can support players in golf, or even disc golf gameplay, and illustrates the need for a device to replace the traditional paper score cards. More recent work often relies on mobile applications. One example of this is the "Frisbee Golf Score Keeper"[2]. Using mobile applications as score trackers means that the user needs to interact with a touchscreen during gameplay and durability depends on the phone's hardware. The dominant trend in this field today is software-based solutions rather than dedicated physical devices. Another study [3] presents a set of design guidelines for how disc golf applications should be designed to support the players during gameplay. These guidelines were developed based on user studies and reviews of existing disc golf tools. Their findings point out complex landscape and limited functionality, which results in frustration and poor usability for the players. They also point out how important it is to have a robust, weather-resistant interface to accommodate this sport, because of possible rough terrain and varying weather conditions. Our project explores a dedicated physical device, which can be made more robust than a smartphone, water resistant and perform better during the varying weather conditions. One study [4] presented a wearable device for rock climbing. The device highlights how sport wearables can help beginners in early stages of performing a sport, by offering clear feedback during use. This device is a vibrotactile device, and uses vibration to communicate between climber and belayer, which gives the climber a fast and direct instruction on how to move. Their work also highlights the importance of wearable and practical attachment methods for sports equipment. Using carabiners is common in climbing gear and is also used as the attachment method in this device. This allows the climber to clip on the device directly onto clothes to ensure a secure attachment. This illustrates how attachment solutions from other sports devices can be used in other physical outdoor devices during movement. Although this device is not related

to disc golf, it offers insight into how wearable devices could interact with the user regarding haptic cues and illustrate secure attachment methods in which the device can be worn during movement.

1.4 Research Gap and Originality

While previous research examined an early electronic device to track scores in golf, design guidelines for mobile applications specifically made for disc golf, and wearable devices in other sports, no work has explored a dedicated modern device specifically made for tracking scores in disc golf. Existing tools in terms of disc golf mostly rely on mobile applications, which introduce several limitations like being vulnerable to rough weather conditions, they require more visual attention and can be less easy to operate during gameplay. A dedicated physical device allows for the robustness that is needed in rough weather conditions and terrain, while also being easy to use during gameplay because it is designed to be used for this very purpose. It also allows the user to be able to interact quickly without looking to track strokes and is more tactile in use.

Because disc golf is a fairly new and rapidly growing sport, there aren't many devices or much research done in this field yet. The result of that is a lack of equipment that can support disc golf players during gameplay and the requirements of the players. Disc golf equipment needs to be sturdy and robust due to rough weather conditions and terrain, and also comfortable to wear during movement. The right attachment method therefore needs to be comfortable and secure during play.

Our contribution addresses these gaps by introducing a robust and minimalistic wearable device, designed to be easy and quick to use during gameplay. The device will not require a lot of visual attention during gameplay and will rely on physical interactions. By focusing on durability, ease of use, and efficient interaction, this work offers an original hardware-based score tool in an application dominated field.

2 Method

2.1 The Device

The goal of this project was to develop a small, wearable device to aid a user to keep track of their score in a game of disc golf. When players need to use a mobile application during gameplay it requires the player to locate the phone, unlock it and navigate through an app to track their scores. This can be inconvenient, and a mobile phone can also be vulnerable to rough weather conditions. To address these challenges, we aimed to design a compact, tactile device that can attach securely to clothing or a belt. The following is the initial product description we initially set forth with: "We want to create a small electronic handheld device that helps a user with keeping track of their current amount of strokes in a game of disc golf. In disc golf it can be a hassle to keep track of how many strokes you have used, especially when playing a larger tee. Needing to pull up your phone and open an app to note down each stroke is also a hassle. Therefore, we want to design a small device that can easily fit to your belt or clothes, that at the click of a button notes down each stroke. As the device would be electronic it could also

include expanded features, such as: Option to enter the information about a course to use as a preset, automatically calculating your overall score, based on the par of each tee, and option to save game stats remotely to your phone."

Although we made the device with disc golf in mind, seeing as the scoring system is identical to traditional golf it would also work for golf. The main difference in focusing on disc golf is that the device would be more focused towards being sturdy and easy to carry, seeing as disc golf often involves rougher terrain and more movement than golf.

2.2 Creating the Prototype

The prototyping process consisted of several phases, from early sketches to low fidelity prototypes and eventually functional high fidelity (high-fi) prototypes. This approach allowed us to refine the shape, interaction design and attachment method over time. We went through multiple different methods of creating our prototype, but roughly speaking it consisted of two stages, a "low-fi" and a "high-fi" stage.

Sketches and "Low-fi" prototyping. In the early stages of development, we created a lot of sketches and low fidelity ("low-fi") prototypes to help us realize and narrow in our ideas for the design and functionality of the device. We created a series of Figma sketches (see Fig. 1) exploring different sizes, shapes, and button placements. These sketches allowed us to evaluate the possible layout of the device.

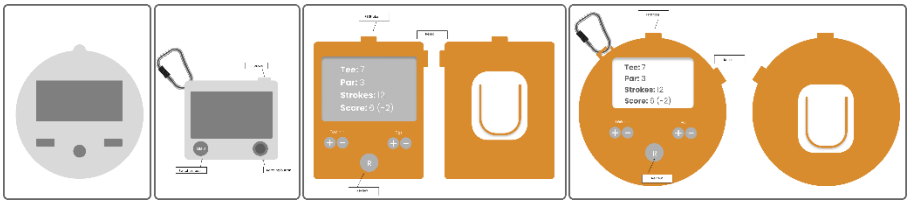

Fig. 1. Illustrations showing different design ideas created in Figma, from left to right starting at the first sketch.

We also created a digital demo of the device to showcase how the software could function (see Fig. 2 left). This prototype simulated screen changes, button presses and basic score tracking. This helped us understand the logic of the interface and interaction flows before starting the process of the physical device. These sketches and demos helped us get a clearer idea of how we wanted our device to look and feel, before we started creating a high-fi prototype. As well as this we created a set of physical mock-ups of the possible product (see Fig. 2 right), using different everyday items, such as pastille- and snus boxes. We tested these models during actual games of disc golf and emulated using them as we would with the actual product. This helped us to decide what shape was the most comfortable and effective to use. This also helped us identify that a round shape was the most comfortable and secure for one-handed use.

Fig. 2. (left) Digital Demo showcasing disc golf stats and (right) physical low-fi models made with household items of square, rectangle and circular shape.

"High-fi" prototyping. Our high-fidelity ("high-fi") prototype consisted of a 3D printed shell, containing the necessary electrical components to implement the software shown in the digital demo, such as a microcontroller, display, wiring and buttons. The first iterations, we produced three different versions of the high-fi prototype, all printed in orange filament (see Fig. 3 left). The use of orange was intentional as the color is commonly used in hunting gear to increase visibility in forest environments [5], which made it suitable for a device that could get lost during a game in the forest. Each iteration varied slightly either in size, button layout, or was missing parts we found the device to need after printing. For example attachment for a hook/carabiner, or engraved text. Our first attempt resulted in functioning hardware, but the length of the wires made it impossible to fit the electronics inside the shell we had previously printed. We had to expand the size of the shell, and although it resulted in a box somewhat larger than what we would want the final product to have, it was necessary to do so to accommodate the electronic components we had available. We also experimented with engraved text on the front of the device to clarify button functions. The software used in the high-fi prototype also had some changes compared to the software shown in the demo. Instead of having the overall score shown persistently on the bottom of the screen, there is now a toggable results screen that includes scores, as well as par and tee played.

Fig. 3. Physical models. (left) Showing print tests for experimentation of button layout and form. (right) Showing final high-fi model with functionality.

The final high-fi prototype was printed in white due to filament availability (see Fig. 3 right). We later realized that offering multiple color options could be beneficial to the users. This version contained all electronics, had a round design for a good grip and a secure carabiner to attach to clothes or belt based on insights from wearable sports devices. We decided to name the device "Tamagolfi".

2.3 Evaluation Plan and Usability Testing

Evaluation Plan. The purpose of the evaluation was to understand how the Tamagolfi device performs in realistic disc golf situations and to identify usability issues, strengths and improvement areas. We wanted to see whether the device was intuitive, comfortable during movement, whether the font size was readable, and if the attachment method was secure and practical during movement. Testing the device in natural conditions let us observe the user's behavior and understand how players would interact with the device naturally. The evaluation focused on usability (how easy it was to interact with during gameplay), wearability (if the device was comfortable and secure during movement) and readability (if the screen and font size was sufficient). The participants were students from the Interaction Design course from Høgskolen i Østfold with limited disc golf experience. The evaluation followed an approach of outdoor field testing, direct observation with tasks (telling the participant to register strokes, change tee, checking score, etc.) and a semi-structured interview with focus on how comfortable the device was to wear, intuitiveness, readability, and suggestions for improvements. The interview was flexible and allowed the participants to ask follow-up questions. Each test lasted around 30 minutes.

Usability Testing. We conducted four user tests. This number is supported by Jakob Nielsen's theory [6] that most usability issues can be identified with 3-6 participants. The participants first got an introduction to basic disc golf rules and terminology as they were not familiar with the rules and scoring of the game. Each participant tested the latest high-fi prototype (see Fig. 3 left) while simulating a game of disc golf, using it during different throwing techniques and with different discs. The participants were also presented with a disc golf app called "UDisc" for comparison. The evaluation consisted of observation during the gameplay and semi-structured interviews immediately after the session.

Data Analysis. Our data consists of observation notes from the usability test and the semi-structured interviews. The goal was to identify patterns related to usability, wearability and readability. All comments and observations were noted and organized to fit into our main focus areas of the study, to see what issues were repeated across the participants. Observations of behavior were compared with what participants said in the interviews. If the participant said the device was easy to use but struggled to read the screen during the test, this would be noted as a usability problem. We looked at our

prototype stages during the analysis to understand which design choices worked well during real use and which did not.

3 Results

Overall, the prototype was described as easy to use, and all participants were able to record strokes and change tee without major instructions. The physical buttons were reported as intuitive, and several of the participants said that they preferred them over touchscreen, especially when wearing gloves. One of the participants said that the device was “Practical, easy to use, would be easy to use without looking at it”. There were also a few problems reported. Some of the participants were unsure whether the button press had been registered and pressed multiple times, indicating that the device does not provide clear enough feedback. There were some participants that found the results screen confusing due to disc golf terminology, “I think it is intuitive, but the results screen can be confusing”. Some participants also mentioned that the switching between tee was not immediately clear. The shape of the device worked well. None of the participants felt that the shape got in the way while throwing. However, there were some complaints on the attachment method, as some participants were worried that the carabiner could fall off during movement. Participants also said that the size of the screen was a bit too small, making it hard to see the scores. When we asked the participants if there was anything they would change about the design for the device one of the participants said "Basically no, except for a larger screen”. The participants commented that the text was too small to read for quick glances while walking outdoors.

Participants were generally positive towards the disc golf device. They described it as easier and faster to use than a mobile phone, and one participant noted that it helped them stay focused on the game.

4 Discussion

We found that a device dedicated to tracking scores in disc golf helped the players with keeping track of their score with quick interactions that required little visual attention. This aligns with earlier research done on outdoors sports tools [2] and wearable devices [4], which emphasize robustness, simplicity and physical feedback. Compared to phone apps, participants found the device faster and less distracting, supporting our original motivation of reducing distractions during a course of disc golf. At the same time, issues such as unclear button feedback, small text and confusing score labels show that even minimal interfaces need to be carefully designed to make them intuitive and user friendly in outdoor use. Our results from testing the prototypes answer the research question by showing that a dedicated device does help players keep track of stroke more efficiently than app-based solutions, though improvements are needed for clarity and reliability. The shape, size and the physical buttons work well, but the attachment mechanism and screen design limits usability.

There were a few limitations to the study. The prototype development was constrained by the materials and components that were available to us at Makerspace at

Østfold University College. Limited time also restricted how refined the final prototype could become. Also, most of the participants had little or no prior disc golf experience. As a result, we were not able to test the device with participants who match the target audience or who realistically might be interested in such a product.

5 Conclusion and Future Work

This paper presents the development of a dedicated score tracking device for disc golf, addressing limitations of mobile applications due to weather resistance and ease of use. Through the prototyping stages and testing we found that a dedicated disc golf device supports disc golf players better during movement and in varying weather conditions and terrain than mobile applications. Our research found that a dedicated device for disc golf can support players by giving them a quick and easy way to track their game score in disc golf.

Future work should include testing more experienced players and testing in a wider range of weather and terrain. Improvements to the device could also be made, such as stronger attachment, clearer button feedback (vibrations or sound to ensure the player has pressed the right button), and improved readability. There could also be added more functionalities, like being able to store the players' course data and keep track of multiple players' scores. In the future we would also like to have a mobile application that communicates with the device to help players keep persistent scores over time, and to evaluate the game after playing.

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