League of Lasers

A superhuman sport using Motion Tracking

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ABSTRACT

League of Lasers is a motion-based game where two teams compete in a mix between football and Pong [2]. Players use 'virtual mirrors' to try to guide a laser pulse towards the opponent team's target. The game aims at stimulating interaction between players by making cooperation a vital part of the gameplay, while having them physically move near each other. The game tracks the physical movement of players as the main control actions. A demonstration trailer can be found here: https://goo.gl/v7mu6k

CCS CONCEPTS

• **Applied computing** → **Computer games**;

KEYWORDS

Competitive gaming, Collaborative gaming, Social Interaction, Mobile gaming, Motion controls

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1 INTRODUCTION

Experience learns that, in many massive events, participants only interact with a small group of, often already known, peers. League of Lasers is a superhuman sport that was initially conceived as a game to stimulate and improve casual interaction between strangers during such events. Firstly, our game works as an "ice breaker", giving a good excuse for people to address and interact with each other. For that, it is playable for short periods of time and its gameplay was designed as very easy to grasp. In addition, the game stimulates players to communicate and collaborate with each other, combining strategic thinking with fast-paced physical movement, in an *Augmented Reality* (AR) setting.

League of Lasers is a game that plays as a crossing of pong and football; the game innovates by using players' positions and orientation as real time input for the game. Players end up running, shouting and quickly turning to play the game, in a similar way as in *Paintrix*, another game where moving around swiftly is key [8]. This leads to a form of engagement that is more akin to a sport than a video game. Moreover, the players' interaction with the game mechanics requires quite some augmentation of the real world, hence giving it the feel of a superhuman sport.

Another game with a similar augmented character is *BloxAR*, recently developed at TU Delft [3]. The goal is for each team to replicate, within a set amount of time, a structure of virtual blocks shown on a public screen. The team that finishes building first, wins. Structure building is done with AR, using players' smartphones. This game is akin to League of Lasers in the sense that it is a competitive team-based game, where reality is mixed with the virtual world. Unlike League of Lasers however, BloxAR cannot be considered a superhuman sport, since players basically stand still during the game.

2 SUPERHUMAN SPORTS

Let us first define what classifies a game as a *superhuman sport*. According to [5]: "The field of superhuman sports combines competition and physical elements from traditional sports with technology to overcome the somatic and spatial limitations of our human bodies". The Superhuman Sports Society [9], defines superhuman sports as activities that:

(1) rely on technology for human augmentation to enhance a human ability,
(2) involve physical fitness and skills and
(3) are played for fun, competition or health reasons.

There are two major ways to implement superhuman sports [5]:

(1) Enhancing players physical abilities (using exoskeletons for example)

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(2) Augment the vision of the player with technology to mix reality with a virtual world.

The game we present in this paper focuses on the latter aspect.

For an example of superhuman sports we can look at the Japanese AR game called *HADO* (figure 1) [1], where two teams of players are pitted up against each other in a small arena, with the goal of eliminating the other entirely team by using an energy ball that players can shoot. Additionally, players can block attacks by creating a barrier in front of them. It is played using a head-mounted display and a gesture tracking armband.

The above definition classifies League of Lasers as a superhuman sport as well, since we combine image processing techniques and mobile phones with human capabilities to enhance and modify classic sports (e.g. soccer) with modern technology. League of Lasers belongs to the second type of superhuman sports described before, since it augments the vision of the players and provides them with a virtual playfield that is fused with reality.

Figure 1: Play capture of HADO [1].

3 GAME CONCEPT

League of Lasers is a motion-based game that stimulates interaction among a group of players. It does so by placing players in a competitive environment where two teams of 3 to 5 players compete for 5 minutes per game to see which team can score the most points.

League of Lasers' core mechanics revolves around reflecting a laser pulse to guide it and hit a target. Each team has its own target, so you want to hit the opponent's target while defending your own (see figure 2 and 3). When your target is hit, the opponent scores a point. The team that scored the most points at the end of the game wins; all in all, the general idea resembles football (soccer) as well as the video game *Rocket League* [7].

The laser behaves as a pulse of energy, only the front of the laser pulse can reflect off surfaces such as the sides of the arena and the players in the game. A Laser pulse cannot be split by catching the pulse half way. Players act as "mirrors", i.e. they reflect laser pulses by intercepting their head. The orientation of the player (shaped as a large rectangular pad, as in Pong) determines the reflection direction of the laser pulse. Players can also opt to use a smaller mirror (shaped as a square) that slows down the laser once it has been hit. After players have hit the laser pulse they are temporarily exhausted, meaning that they can move but not interact with the laser. Targets (like football goals) are static objects that do not move: once they are hit by a laser pulse, a point is scored, and a new laser pulse is spawned to start a new round.

The game is innovative in its control scheme, as players need to physically move and rotate to move their in-game avatar (figure 4). Players' skill to accurately reflect the pulse in the intended direction is crucial to win. Moreover having quick reflexes and a good physical condition strongly helps, as each player's physical speed is used as a direct input for displaying the players' in-game position. League of Lasers purely augments reality adding objects and rules that could never exist in traditional sports, for example the existence of the laser pulse and the intuitive manipulation of its properties.

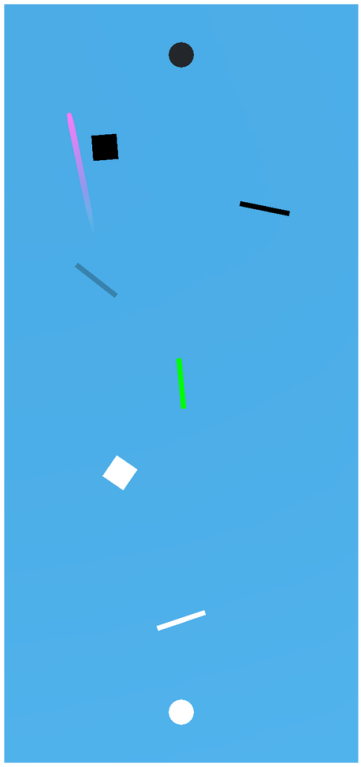

Figure 2: An overview of the in app playfield.

Players have to cooperate strategically to prevent the opponents from scoring a point and to try to reflect the laser to the opponent's target to score a point. Players have to move around and communicate with each other where to position themselves. During playtests, it was found that this communication was almost all positive in nature, often in combination with laughter. While being rather unique, League of Lasers aims to have a low-threshold for entry, requiring little knowledge of the user. This is stimulated in multiple ways. Firstly, the close relation to the world's most popular sport [6] helps people quickly familiarizing themselves with the gameplay. Secondly, menus are kept to a minimum to achieve a quick and natural playing process. Lastly, more functionality like joining

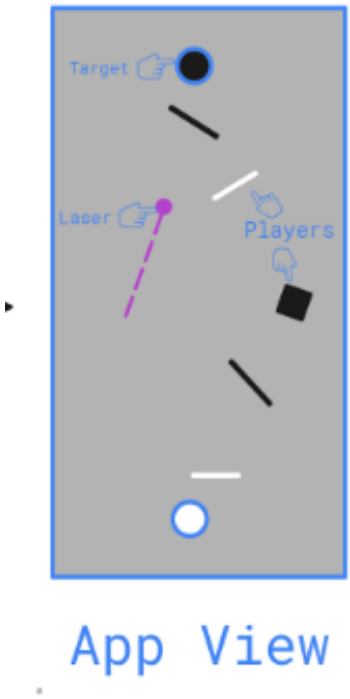

Figure 3: An abstraction of the app view.

a game instance are streamlined by means of scanning QR-codes pre-game.

Figure 4: Playing League of Lasers.

4 CONTROLS

The unique control scheme of League of Lasers is implemented using two major external mechanisms. Firstly, the location of players is determined using a single camera above the playing field. This camera tracks the players by means of specially designed headgear (figure 5). Secondly, player orientation is tracked using the internal gyroscope found in all modern smartphones. These elements provide for cost effective, yet very engaging gameplay.

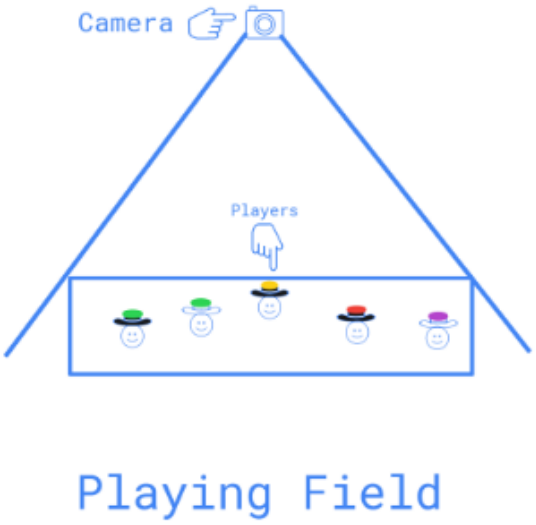

Figure 5: An abstraction of the physical playing field and the setup of the game.

The player tracking system has been developed to be highly configurable and comes with several preset settings. Due to the method of motion tracking, the game is not invariant to differing light circumstances; preferably, the game should be played in locations with constant and even illumination (e.g. indoor locations). It is recommended to have a floor beneath the players that is not white or black and preferably has an even color.

The camera system is robust enough to work at multiple altitudes although it is recommended to have a camera centered 14 meters above a playfield if the playfield is 20 x 10 meters in size. The playfield can be scaled and other heights may apply (depending of the used camera and its field of vision), though it is not recommended to play with the full 10 players on a smaller field. It must be noted that during our play-tests, the camera was at a much lower altitude and the fields were much smaller. However, the game was still enjoyable, even with teams of 2 or 3 players.

The camera system tracks players by a colored dot on their hats; in addition, depending on the hat color itself (either black or white), the system can determine the team of each player and thus is able to uniquely identify all players.

The image processing techniques involved in tracking the players works as follows: We begin by performing a multiplication of the saturation and value channels of the frame, since the colored dots have an high value and saturation. Then this image is inverted and fed to the blob detector. Any detected blob could possibly be a player, so each one will be evaluated on its values, to see whether it falls within the range of what is considered a player. If it does, it will first determine the player's team by detecting the hat color (looking at the area around the dot) and then the player number by detecting the dot color (looking at its hue). That player is then added to a dictionary, mapping its number to a tuple of normalized coordinates and other information that is necessary for duplicate

handling. Duplicates may appear in rare cases, but the system has proven to be robust enough to handle them.

The tracking system developed is robust and runs at around 10 frames per second, which is more than enough as the human body cannot respond much faster than a physical response time of around 250ms [4].

5 USER EXPERIENCE

As previously stated, the game aims to be as simple as possible. Players simply need to install the app, scan a QR code and join the game. The game also draws a lot of attention, this is due to the large scope and somewhat funny nature of the game. Passersby see players walking around, shouting and looking at their phones, wearing large head gear, while the game is visible on either a monitor or a projector on the wall.

At first, players seem to be a bit lost, but they quite rapidly figure the game out; after their first match, the level of the players has increased dramatically and in larger teams, their teamwork is increased. The fun experience of the game stimulates players to play multiple matches and leaves players surprised at how quickly a match ends. After a few matches players start to communicate more and outperform other teams once they start to communicate, thus the game rewards interaction within a team, but also among teams, as eavesdropping is a good strategy as well. All in all, players enjoy playing the prototype and usually end up recapping their game afterwards and sometimes end up talking for a while.

For Science Day 2017 in Delft we were asked to deploy League of Lasers and let visitors play it. This gave us a good opportunity to examine user responses and see how they handled the game. During this opportunity we were also displaying what was happening in the game for the audience via a projector.

Pre-game, the QR-code and hat-selection parts were fairly intuitive, aside from some minor connection and QR-code issues. Downloading the app and getting it to work was a bit problematic for many people though, so we let them use our phones instead. This was because our app currently only supports Android phones and is not yet in the Play Store.

The during the Science Day was a bit different than before: the visitors who played were mainly young children, sometimes playing with or against their parents. During these gameplay sessions, we saw all kinds of interesting behavior. We observed the game critically and detected a couple of potential UX issues:

(1) younger players did not immediately understand how to translate a physical movement into a virtual one within the game;
(2) the fact that one of the two teams is "upside-down" in the game also made movement non-intuitive, and especially younger players had to be told that they should rotate the phone to make moving around easier;
(3) sometimes it was not entirely clear to players that they should look on their phone's screen instead of at the projected version of the game for viewers.

Fortunately, all these issues are either relatively minor or easy to fix. The movement confusion for instance, only lasted for a minute and after having played one game the players even became quite proficient at moving and rotating their mirror around. The second problem is a matter of flipping the playing field in-game for the team that ends up being upside down. For the third issue, we can always clearly separate the projector screen from the players to make them focus on their phone's display instead. Sometimes this even was a feature, when the phone's WiFi disconnected, they players could still continue by watching the projector view, only their rotation would not be updated anymore.

We also saw a lot of positive UX signs. In particular, children were having a massive amount of fun and many of them played not one, but many rounds, against different opponents. It was also interesting to observe players becoming competitive at the game after a couple of rounds, playing in a more engaged manner with a lot of movement and running around, cheering and screaming. Additionally, the players were highly enthusiastic and there was no sign of frustration among them, even with the issues mentioned above, aside from some rare technical difficulties causing trouble.

One game feature that seemed to be under-used was the role feature, with which players could change their mirror into a delayer. Only the players that had played a couple of rounds seemed to discover the feature, and quickly changed back to the mirror in due to its wider shape. It could be the case that there should be a more intuitive way of providing this feature (instead of having to open a menu) or that this feature was perhaps redundant.

6 FUTURE OUTLOOK

The AR nature of the game makes it interesting to look at other promising AR developments and interfaces that could possibly empower the game; one such development is the Microsoft HoloLens. It would be interesting to explore whether players' positions can be determined without using image processing. Keeping in mind that the HoloLens has some advanced AR capabilities that could possibly be exploited for this, we believe this might take the game to the next level, removing the requirement for players to either wear hats or look on their phone's screen, and instead having the game visualized right in front of their eyes.

Other options would be to add power ups to players; for example, one power up could make the laser go faster after being reflected. Other possibilities could revolve around placing traps for players: stepping on these would temporarily disable a player's ability to use the mirror, or vary their reflection precision. Other modes could be added as well, involving e.g. moving targets, or trying to hit players on a weak spot (for example their back) to score (extra) points instead of (or in addition to) using the traditional targets. If the HoloLens would be used, power-downs that would specifically target the view of a single player could also be possible, e.g. adding a power-down that deteriorates their view making it harder to see the in-game laser pulse. Moreover, additional tools could be added, e.g. voice commands (possibly using the voice capabilities of the HoloLens) could be used to influence the game or invoke a command.

Audiences could be more engaged as well: instead of making the game static for them, the audience could get a choice about which power-up/downs and obstacles should appear in the game. In traditional games this would not be possible, but in an AR video game, that would not be an issue. Perhaps audience members could

even designate the distribution of power-ups to their favorite players. Engaging audiences into a sport would never be possible in traditional sports but in a superhuman sport as League of Lasers this would not be an issue.

7 CONCLUSION

Using motion-based gameplay, League of Lasers delivers an experience as never seen before. The goal is to give players a unique experience that stimulates interaction between players and is simple to understand, but provides a lot of fun. The game stimulates strangers to be physically near each other and create situations in which people can interact. League of Lasers does this by having fast paced, team-based competitive multiplayer, using simple to understand, but hard to master game mechanics. As an added bonus League of Lasers needs to be played while standing and stimulates players to move around, a nice bonus in a sedentary world.

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