

The logo of the University of Twente, featuring the text "UNIVERSITY OF TWENTE." in white capital letters on a black rectangular background.

Requirement Analysis Document

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1. Introduction

The product we are designing is an interactive augmented reality game where a virtual game is played by real world inputs. The game will consist of a projected image on a wall where there will be targets that the player needs to hit. The player can hit these targets by throwing a tennis ball at the wall that the image is projected on. This tennis ball will be tracked by two cameras. When the tennis ball hits the wall the Pi will use the cameras to pinpoint the location of impact (it also uses the cameras to notice when the ball has hit the wall) and use that information for the gamelogic.

1.1. Purpose:

The purpose of our application is for it to be a fun game but also to be a good way to train eye-hand coordination. We like the idea of making a game which includes augmented reality. This application is good for eye-hand coordination because of the throwing aspect and social interaction because you can challenge your friends to beat your high score.

1.2. Limitations of the current system (If any):

There are other systems that will be able to track tennis balls however there is no fun element of the game in current systems that use the same technique and methods as us.

1.3. Intended Audience

The game is for children and adolescents. They will like this interactive game where they can throw balls at the wall. They can train their eye-hand coordination while having fun. With this intended audience we will keep in mind that certain imagery is not suited for them and will keep an eye on child friendliness.

1.4. Define SMART Goals:

This section is used to list down the target/expected results from the project. All the goals should be written in a SMART (Specific + Measurable + Attainable + Relevant + Time-bound) way.

Specific (What)	Measurable (Up to)	Attainable (How)	Relevant (Why)	Time-bound (When)
<i>1. To be able to track a (tennis) ball in a live camera videostream</i>	<i>By calculating the difference between the system's guess of location and the actual location we see on the screen.</i>	<i>By making use of video recognition software or techniques.</i>	<i>The game needs the input of the location where the tennis ball hits the wall.</i>	<i>By the end of sprint 3</i>
<i>2. To create a user-friendly interface so that the user can easily play the game</i>	<i>By asking possible future users to play the game and tell us how they like the interface (user testing)</i>	<i>Taking notes during the testing phase of possible future users.</i>	<i>Having a user-friendly interface makes it easier for the player to start and play the game, which enhances the experience.</i>	<i>By the end of sprint 3</i>
<i>3. To create an integrated system with a sensor which can detect the ball throw game.</i>	<i>To measure delay time, success rate/ errors on any integrated parts.</i>	<i>By choosing suitable hardwares (camera and projector) and algorithms.</i>	<i>To ensure the game works and minimize the delay/ errors as well as improve user experiences.</i>	<i>By the end of sprint 3.</i>
<i>4. To use a security system that makes sure passwords are safe</i>	<i>By testing with strong and weak passwords</i>	<i>By giving input of not safe passwords</i>	<i>Accounts need to be protected against attacks</i>	<i>By the end of sprint 4</i>
<i>5. To add a competitive element to the game.</i>	<i>By asking possible future users to play the game and tell us how they like the interface (user testing)</i>	<i>By introducing a scoreboard system in which users can compare their results with each other.</i>	<i>Competitive elements motivate the players more and make it more fun to play against friends.</i>	<i>By the end of sprint 4</i>

- 1.5. **Scope:** This section is required to write about the important resources to achieve the goals of your system. The technology used to develop your project (methods/algorithms, software requirements, hardware requirements), the duration of the project, and the project constraints should be included here. The project constraints can be any technical hiccups, lack of resources, internal and external conditions (boundary conditions), etc. that can help further to avoid the related problems in the future during execution. In short, you can utilize this section to write about the limitations and boundaries of your project.

- **Software:**

- + Programming language: Python for algorithm and backend, Javascript, HTML, CSS for frontend, SQL for database.
- + Algorithms: Image processing, Object and movement recognition.
- + Libraries: Python libraries for algorithm and database connectivity.
- + Database: postgresSQL via utwente bronto.

- **Hardware:**

- + At the heart of the system is a Raspberry Pi 4. It is connected to a projector, which will display the interface on the wall.
- + Sensors: we have two cameras. One of the cameras will be used to check when the ball hits the wall and the other camera will look where the ball has hit the interface.
- + Projectors: we use one projector to display the game with the shooting objectives.

- **Interfaces:**

- + The program uses the Internet via WiFi to communicate with an online database, and HDMI to connect with the projector.

- **Limitations:**

- + The system has to be set up before you can play the game. This will take some time and also calibration every time you will play in a different environment.
- + There is a possibility that the system will not detect the tennis ball, in that case the throw is a fail.
- + There is a possibility that the speed of the tennis ball is too high in comparison with the number of frames the camera can process, then it can be impossible to detect at which moment the ball has hit the wall.
- + The system depends on the light and background environment, which can affect the correctness of the camera when it captures the screen (the image on the wall). For example the system might react differently to a black background than to a white background.

2. Product features:

This section describes the functionality that you want to have in your product such as the components used for the application and its functionality, appearance, performance in terms of speed/time, etc. You can specify them in the form of functional and non-functional requirements. [A minimum number of 7 requirements \(9 in case of selecting an existing application\) is to be expected for your application. That includes functional as well as non-functional requirements cumulatively. However, it is highly probable that you will need more than the minimum amount to fully cover all the requirements.](#)

2.1 Functional requirements:

Write the requirements that are directly connected with the functionality of the application.

- Users can register a new account and log in to the system.
- The system can detect when and where a tennis ball hits the wall and objectives.
- The system can control the projector to update the game situation correctly in real time
- Users are kept updated with the current score while playing.
- The system can update the online scoreboard through the Internet.

2.2 Nonfunctional requirements:

Write the requirements that are not the specific actions for your application but improve the quality of the system. This can be related to the storage capacity, performance requirements, Security requirements (*Refer to the checklist given in SBD document-Phase 1*), etc.

- The system will be able to process user data(login credentials, score) no longer than 5s.
- The updating game situation's delay should be less than 3s.
- There are no duplicate players in the high score list.
- The passwords for registering should have high security standards.
- The user interface should be user friendly with pleasing interaction.
- The input of the camera should be well protected, such that it cannot be misused.

3. Conclusion:

This document gives an explanation about all the requirements needed for our game: **Ball on the Wall**. The most important part of the project will be **tracking the tennis ball through space**. We will use **two cameras** to achieve this. We will also have to allocate time to making a visually attractive interface.

4. **Reference:** List the existing literature (documents/articles/blogs/research papers) references you have considered for finalizing the project idea.

Raspberry pi connected to a camera: <http://domoticx.com/raspberry-pi-webcams-gebruiken-via-usb/>

Raspberry pi connected to a projector:

<https://projects-raspberry.com/connect-raspberry-pi-to-projector-or-tv/>

Image processing algorithm: <https://opencv.org/releases/>