FollowThrough: Requirements Document - Revision 0

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PROJECT INFORMATION

1.1 PREFACE

This Requirements Analysis is done following the Volere template.

1.2 BACKGROUND OF THE PROJECT

FollowThrough is to be a multi-platform system which can provide basketball players with real-time feedback on how to improve their shooting form. The hardware/software involved is to film the user while practicing, processing the information on the spot and returning usable advice which can change the players game for the better. The information is afterwards sent to the cloud where users may review their advice at home. It will also be designed to keep track of score for the users convenience.

Currently there is no affordable method for an everyday player to have professional assistance in improving their shot form. Follow through hopes to be provide basketball player with a cheap and accurate alternative to expensive coaching and training camps.

Ideally the project will be able to function on any laptop camera or webcam.

1.3 MOTIVATION

When practicing alone on the basketball court, players should be able to receive real-time feedback so that they know how to improve their skills. In most situations if a player is looking for somebody to assist them in perfecting their form, they will bring another person with them so that they may assess the player and provide suggestions as to how to fix any problems in their technique. Obviously this is not an optimal solution. Not everyone is able to have someone advising them at all times. Coaches are a possibility but can be extremely expensive and availability again becomes an issue.

1.4 CHALLENGES

- Ensuring FollowThrough runs efficiently with any modern laptop camera.
- Ensuring similar colours in the background do not hinder tracking.
- Ensuring user's manual is user friendly.
- Ensuring the average user can setup and successfully use FollowThrough.

1.5 GOAL

The aim of FollowThrough is to eliminate the need for shot assistance while on the basketball court. FollowThrough will be software that works with any camera and laptop to provide real time advice and feedback to basketball players right on the court. FollowThrough will also save the analysis of the shot to the cloud for later review.

1.6 RELEVANT FACTS AND ASSUMPTIONS

1.6.1 *Facts*

- A camera is required to use this software.
- The hardware associated with counting score is optional for the user.

1.6.2 *Assumptions*

- Users have a rudimentary knowledge of how to operate a computer.
- Users have a camera built into their device or an external usb web-cam.
- Users are able to follow instructions to setup and calibrate the device.

1.7 CONSTRAINTS

1.7.1 *Mandated Constraints*

Description: FollowThrough is to be very easy to set up. Setting up the physical portions of the product will be easy because of well thought out instructions to avoid confusion.
Rationale: The product has to be easy to use.
Fit Criterion: The product is to have minimal requirements for set-up.

Description: FollowThrough will provide both auditory and visual feedback to the user.
Rationale: This will increase the accessibility of the product and open it up to for use to people with disabilities and even further assist both auditory and visual learners.
Fit Criterion: The output will be extensively tested and approved before release.

Description: The product will be able to be used on a variety of operating systems such as Windows 7, 8, 10, Mac OSX etc.
Rationale: The product being cross-platform will make it easier for a large market of people to access.
Fit Criterion: The product will be tested on various platforms to ensure compatibility.

Description: The product will upload all the gathered information in a readable form to a cloud database and the user may access this later to review their progress.

Rationale: This will allow users to analyze and utilize the data tracked.
Fit Criterion: A page will be developed and tested to ensure it works fluidly.

1.7.2 *Schedule Constraints*

- Proof of Concept Demonstration November 21st25th 2016.
- Demonstration Revision 0 February 13th17th 2017.
- Final Demonstration Exam Period 2017.

1.7.3 *Budget Constraints*

- Budget constraints can be seen below in the cost/benefit analysis

1.8 naming conventions and definitions

1.8.1 *Definition of all Terms*

- **FollowThrough:** The name of the product at hand.
- **Arduino:** A simple micro-processing unit that can be programmed to complete various tasks.
- **OpenCV:** An open source computer vision and machine learning software library.

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CUSTOMER'S NEEDS

2.1 NEEDS OF THE CUSTOMERS

- Eliminate the need of other people being on the court to provide feedback.
- Provide real time advice to growing basketball players.
- To improve basketball shot form and shot technique.
- Works with many camera's and laptop's.
- Save data to be reviewed at a later date.

2.2 WHO ARE THE CUSTOMERS?

2.2.1 *The Customers*

- Basketball players of any skill level.
- Coaches, teams and schools
- Programmers interested in a practical application of image recognition.

2.2.2 *Priorities Assigned to Users*

- **Primary Users:** Regular basketball players.
- **Secondary Users:** Basketball coaches.
- **Tertiary Users:** Developers, testers and project supervisors.

2.2.3 *User Participation*

- Users must set up the hardware in the appropriate locations.
- Users must create their own accounts where the information will be saved.

2.2.4 *Maintenance Users*

- The Developers of the project.
- The Testers of the project.

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FUNCTIONAL REQUIREMENTS

3.1 INPUTS REQUIREMENT

The inputs will include the user taking the shot the laptop is setup to measure, as well as prior registration on our website from the user if they wish to track their progress overtime.

3.2 OUTPUTS REQUIREMENT

The output will include a detailed description of the user's shot arch presented to them in an easily readable format. A comparison will be shown between the user's shot arc and the ideal one for basketball. It will also include their shot success rate presented to them via the web interface. Also on the web application there will be statistics and other data that will showcase the user's progress over a long period of time.

3.3 INTERFACES REQUIREMENT

The program will have two user interfaces. The first one will be available offline and will be a live view of the users shot and a login portal. Everytime the user takes a shot,the local program will give feedback both on screen and will also give an auditory signal. The second interface will be the web application once they log into their account online. This will present the same kind of information but will also showcase the user's entire history with the program, not only recent shot data.

3.4 ALGORITHM COMPLEXITY REQUIREMENT

The algorithm used in OpenCV to track the ball will be simple enough to run on any modern laptop without trouble or intensive CPU usage. It will not use proprietary software or drivers that would only run on select devices.

3.5 FAULT TOLERANCE REQUIREMENT

The application will be accurate enough to give the user meaningful feedback about how close their shot arc is to the ideal basketball shot arc. It will at the very least indicate to the user if their shot arc is too high or low. This application is designed to be usable by anyone with a modern laptop camera, not only those with high end cameras. As a result there will likely be some slight inaccuracies with the ball tracking but nothing that will prevent this application from providing useful information.

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NON-FUNCTIONAL REQUIREMENTS

4.1 look and feel requirements

4.1.1 *Appearance Requirements*

The graphical interface designed to provide the user with feedback will be very simple to understand. It will be designed to display properly on all modern web browsers.

4.1.2 *Style Requirements*

Stylistically the software and hardware will not be obtrusive to the user in any sense.

4.2 usability and humanity requirements

4.2.1 *Ease of Use Requirements*

A guide will be provided that will instruct the user on how to set up the application. For the web application where the data will be sent, the interface will be intuitive so that the user will be visually guided to relevant information.

4.2.2 *Personalization and Internationalization Requirements*

FollowThrough will have very few elements in which translation is needed. Basketball statistics are referenced in similar manners all over the world, mostly in English.

4.2.3 *Learning Requirements*

The only part that requires learning in the case of this product would be setting up the hardware in appropriate positions. That will be accommodated for by giving the user a guide. The rest of the program is fairly straight forward and requires nothing more than common sense.

4.2.4 *Understandability and Politeness Requirements*

This product will use terminology that is friendly for any user and on top of that will also hide any unnecessary processes from the user to avoid confusion.

4.2.5 *Accessibility Requirements*

The product will give both auditory and visual instruction throughout its features to ensure accessibility.

4.3 PERFORMANCE REQUIREMENTS

4.3.1 *Speed and Latency Requirements*

FollowThrough will provide feedback in real time to the user. This means that within a few seconds of recognizing the ball has been shot the user should hear or see some feedback.

4.3.2 *Safety-Critical Requirements*

This product was not built to work during inclement weather. It must be protected from the rain or not used outside.

4.3.3 *Precision or Accuracy Requirements*

This product will return to the user information that is accurate with only a small degree of error so that the player does not find FollowThrough detrimental to their form.

4.3.4 *Reliability and Availability Requirements*

This product is designed to be used on a Basketball court and will be available to anyone who wishes to purchase the equipment and set up the devices..

4.3.5 *Robustness Requirements*

In the case of battery failure or any sort of power related disruption the product is to save any data that it can.

If any component of the product becomes disconnected the software will inform the user so that they may remedy the problem.

4.3.6 *Capacity Requirements*

As of right now the capacity of the product is only a single person. This may change in a later revision.

4.3.7 *Scalability or Extensibility Requirements*

FollowThrough is to be able to scale from one device to another and work cross-platform.

4.3.8 *Longevity Requirements*

This product is designed to last as long as any average computer.

4.4 operational and environmental requirements

4.4.1 *Expected Physical Environment*

The expected physical environment for this product would be on the Basketball court.

4.4.2 *Requirements for Interfacing with Adjacent Systems*

As mentioned previously this product is to work with various operating systems on various devices.

4.4.3 *Productization Requirements*

This product will require installation both physically and on the Basketball court.

4.4.4 *Release Requirements*

This product must be complete by April 2017 for its final demonstration.

4.5 system features to fulfill needs requirement

The system will feature an algorithm that will track the user's shot arc and compare it to the ideal shot arc in basketball. This will fulfill then user's need to measure their shot's accuracy and form. It will then provide the user feedback on their laptop as well as optionally online on how exactly to improve their shot. This will fulfill the user's need of shot improvement.

4.6 subsystem requirement

The system will be split into 3 parts.

4.6.1 *Laptop Requirements*

There will be the laptop which will run the necessary software and track the ball's position and arc in the air with its camera.

4.6.2 *Basket Device Requirements*

There will be a device on the basket itself that will track shot success rate and the players position on the floor and send that information back to the laptop.

4.6.3 *Web Server Requirements*

There will be the web server which will record the user's data over time from the laptop which the user can access later via web interface to track progress.

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RESOURCES NEEDED

5.1 RESOURCES

- The laptops built in camera.
- The system interface of whichever operating system the user is on.
- FollowThrough tracking software

5.2 IMPLEMENTATION ENVIRONMENT

- The tracking software will be written in OpenCV.
- The web interface will be written in a combination of PHP, HTML, CSS, and javascript
- The camera will be the computers default webcam.
- The remaining hardware will be on the Arduino.

5.3 OPERATION ENVIRONMENT

- A basketball court.
- The users home.

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SYSTEM FEASIBILITY

6.1 ECONOMIC

The end goal of this hardware is to be able to be used by the general population, which means costs must be kept relatively low. We wish our users to be able to purchase the hardware for and set up their own FollowThrough system as we will not be selling or distributing the product. This economic feasibility report will include analysis of costs, benefits, and project timing.

6.1.1 *Costs*

The below lists all expected costs, direct and indirect, with an approximation of how much it will cost.

Direct Costs:

- Purchase of hardware pieces that the FollowThrough utilizes
  - Arduino/Raspberry Pi ($50)
  - Distance sensor ($15)
  - Webcam ($25)
- Purchase of basketballs for testing ($20)
- Renting gym space for testing ($150)
- Web server costs ($40)

Indirect costs:

- Six months of development time from four student developers (No cost)

Total Costs: $300.00

6.1.2 *Benefits*

The benefits of this project are non-monetary since it will be open source. However, the project does provide non-monetary benefits to not only the creators, but anyone who uses the open source software.

- Allowing players to further improve their basketball skills without incurring massive costs.
- Creating an open source version of the software in an attempts to lower costs.
- Completing the capstone course at McMaster University.

6.1.3 *Analysis*

Since the development costs for this project are so low there is very little downside to developing a product like this. The benefits of a developing this system far outweigh the minor monetary costs, therefore this analysis shows that the project should proceed.

6.2 TECHNICAL FEASIBILITY

6.2.1 *Method of production*

Inputs have been listed above under costs. There is no limit in availability of hardware, however there is limited availability of gym time which could be a limiting factor in our ability to test. A potential problem with the development of the system will be whether features have to be cut to fit the development period into a six month time frame. Developing three separate subsystems will take a significant amount of time and unfortunately we cannot devote ourselves full time to this project.

6.2.2 *Production technique*

For the development of this project we will use synchronous development. The tasks of the project will be divided and the three subsystems will be developed at the same time by different developers. This will allow optimal use of developer time and allow us to demonstrate functionality of all subsystems as development occurs.

6.2.3 *Project requirements*

All project requirements are listed above.

6.2.4 *Project Location*

This project does not have a specific location, the device should be able to be moved and be used on any basketball court. One limitation to this is outdoor use, in which favorable weather is necessary.

6.3 ALTERNATIVES

Currently the main alternative to FollowThrough is the use of a Shooting Coach. This has been the established way to improve shooting percentages from the beginning of basketball. However, in recent years there have been a few ventures into comprehensive systems to track shooting statistics. The current system that we hope FollowThrough will be able to compare to is Noah. The Noah system provides similar stat tracking functionality (arc, depth, left/right) and allows a player to track their analytics via the web. However, Noah comes at a large cost of nearly $4000.00 for use on only one half of a basketball court, a full court system costs nearly $5000.00. At this price point only large institutions would be able to provide their players with this service. FollowThrough hopes to provide the ability for any player to purchase the components and setup the system by themselves.