Software Requirements Specification

for

SLOW-ARC

Version 1.1

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CSCI 5801 Group 4

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Revision History

Name	Date	Reason For Changes	Version

Shiva Cheruvu, Roshan Gokul, Eric Liu, Maurice Yu	Oct 3, 2023	Initial Version	1.0
Shiva Cheruvu, Roshan Gokul, Eric Liu, Maurice Yu	Oct 20, 2023	Instructor feedback	1.1

1. Introduction

1.1 Purpose

The SLOW-ARC system is designed to provide an affordable and precise ball-strike determination solution for slow-pitch softball games. Using cameras and rule-based software logic, the system captures the trajectory and position of the ball in 3D space relative to the batter and home plate. This enables accurate decisions on whether a pitch is a ball or a strike, in line with the Official Rules of Softball 2023. Intended to be as precise as an umpire, the system offers a blend of technological accuracy and cost-effectiveness, catering to local sports organizations that seek a modern approach to officiating.

1.2 Document Conventions

Italicized test: To represent descriptions; Bolded text: to represent titles/headings; Indentations represent subinformation of the previous heading.

1.3 Intended Audience and Reading Suggestions

The intended audience of this document is Softball league officials, umpires, players, engineers, and managers of these engineering teams. From a softball league standpoint, these are our clients and showing them how we would design the system will give us feedback on what to improve/change. From an engineering standpoint, this gives the blueprint of what the league wants for the SLOW-ARC system.

1.4 Product Scope

The SLOW-ARC system is a solution designed to revolutionize the decision-making process in slow-pitch softball. With the objective to provide an affordable yet effective alternative to high-end ball tracking systems, SLOW-ARC uses cameras to track pitches and determine their status as a ball or strike. The system's primary goals are to enhance the accuracy of pitch determination, offer cost-effective solutions for the softball league, and streamline the user engagement process.

1.5 References

IEEE Software Requirements Specification Template
2023 USA softball rulebook

2. Overall Description

2.1 Product Perspective

The Slow-Pitch Automated Review Calculation (SLOW-ARC) system uses just cameras when making determinations about whether a pitch is a strike or a ball in these softball games. This low threshold for equipment drastically reduces the cost to organizations, dropping the cost to hundreds of dollars per installation, instead of hundreds of thousands.

2.2 Product Functions

Within the SRS, we must have a system that first has the capability to track the softball, this means actually take a video of the ball based on the cameras used. Then we need some software to be able to interpret that video and analyze the data. Once this data is analyzed, we will have a reporting system to effectively communicate the data to umpires and teams.

2.3 User Classes and Characteristics

Umpire- Will use the system to verify data of pitches, will allow the umpire to be more widespread and view more games.

Equipment Team- Could be as few as one person, but need someone to set up the cameras in the most effective way possible and get the cameras to record accurately, and be available to adjust the equipment midgame.

Teams- Will be able to view the data to confirm any oversights, voice claims if for eg. cameras are not calibrated correctly.

2.4 Operating Environment

The operating environment will be a regular softball/baseball field. We will have the cameras to accurately examine the pitch. We are assuming that weather is not a factor and the field is always in playable conditions.

2.5 Design and Implementation Constraints

A large constraint is money. One of the main points of the SLOW-ARC is to provide an alternative to the systems that professional tennis and baseball use. Another constraint is simplicity. The cameras should be able to be set up in under 20 minutes to entice umpires to enforce the system. In addition, the data reporting should be on par with the USA 2023 Softball Handbook Rules. This is to ensure that the system does not follow baseball rules for example. In terms of software, we are planning to use databases to keep track of average speed, average ball, and the average result of a pitch. In addition, we want to have a limited amount of updates for the software to keep the software simple and ready to use for years at a time.

2.6 Use Cases

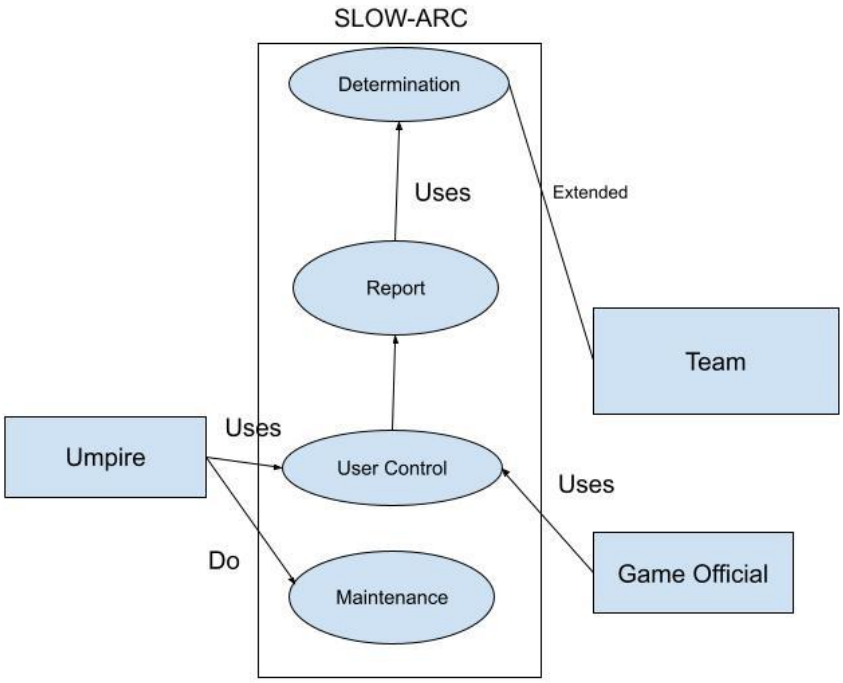
2.6.1 Determining System- The Camera Setup, part of the Determining System, involves configuring and positioning cameras to capture footage of the softball game. This system determines the optimal camera angles, positions, and settings to ensure accurate and comprehensive coverage of the game. It may include selecting the number and type of cameras, their placement around the field, and their settings for capturing clear images of the pitch, batter, and strike zone.Pitch Detection is a critical function within the Determining System. It involves the recognition and tracking of the softball as it is pitched from the pitcher to the batter.This process is to accurately detect and follow the trajectory of the softball, ensuring precise pitch data for analysis.The Batter and Strike Zone component within the Determining System focuses on tracking the batter's movements and defining the strike zone accurately. It uses technology or sensors to monitor the batter's position and the dimensions of the strike zone, ensuring that umpires and the reporting system have the correct information to make accurate calls during the game.

2.6.2 Reporting System-The Pitch Evaluation component of the Reporting System analyzes the data collected from the Determining System to assess the quality of each pitch. It may consider factors like pitch speed, trajectory, and location relative to the strike zone. This evaluation helps umpires, coaches, and players make informed decisions and provides valuable insights for post-game analysis. he Accuracy Requirements in the Reporting System establish the desired level of precision for the data generated by the system. This component sets the standards for how accurately pitch data, batter statistics, and strike zone information must be recorded and reported. It ensures that the system meets the needs of both game officials and those analyzing the game data. Integration is a crucial aspect of the Reporting System, as it involves connecting and sharing data with various stakeholders. This component ensures that pitch data, batter performance metrics, and other game information are seamlessly integrated with scoreboards, broadcast graphics, and other systems to provide real-time updates to fans, coaches, and players.

2.6.3 User Control System- The User Control System empowers users, such as umpires and game officials, with tools and interfaces to interact with and control the camera reporting system. This may include options to review plays, change camera angles, check data from previous games/plays, or access specific pitch data for decision-making. User Control ensures that those overseeing the game have the ability to manage and customize the system to meet their needs.

2.6.4 Maintenace System- The maintenance system is used to ensure that between plays, and between separate games, the cameras will be functioning properly. To ensure this, the camera goes into a diagnostic mode to check for software updates, battery life, hardware issues, and then lets the equipment team know about any issues that may arise.

Use case diagram:



2.7 User Documentation

-https://www.usasoftball.com/official-rulebook/

-A user manual on how to set up the cameras and use the system.

2.8 Assumptions and Dependencies

Assumptions include the environment is never going to affect the SLOW-ARC system, and the ball the cameras will track will be constant. The system is dependent on accurate tracking software and trained equipment managers.

3. External Interface Requirements

3.1 User Interfaces

For the SLOW-ARC system, the user interface is crucial, especially for the User Control System. The User Control System interface will allow umpires and game officials to interact with the camera reporting system directly. This interface will provide options to review plays, change camera angles, access data from previous games/plays, or access specific pitch data. The design should be intuitive, ensuring that users can easily navigate and access desired functionalities. Graphical representations, like trajectories of pitches and batter statistics, can be included for better clarity

3.2 Hardware Interfaces

The primary hardware components for the SLOW-ARC system are the cameras. Their logical and physical interfaces will include connections to the processing unit, which will analyze the data, and other devices like display screens. Communication protocols to ensure real-time data transmission between the cameras and the processing system need to be robust. Power sources, either from direct electrical connections or batteries, and their backup mechanisms are also significant considerations.

3.3 Software Interfaces

The SLOW-ARC system will interact with several software components:

- *Video Analysis Software: To interpret the footage from the cameras and determine the trajectory and position of the ball.*
- *Database System: To store and retrieve data about pitch statistics, team/league data, and more.*
- *Reporting System: Analyzing and presenting data in a format beneficial for umpires, players, and coaches.*
- *Integration APIs: To ensure data synchronization with scoreboards, broadcast graphics, and other related systems.*
- *Connections to databases and other tools need to be secure to protect the integrity and privacy of the data.*

3.4 Communications Interfaces

To provide real-time updates and seamless communication between the different system components, robust communication protocols are necessary. Depending on the requirement, the SLOW-ARC system might employ FTP for data transfers or HTTP for web-based interfaces. Secure connections are crucial, especially if the data is transmitted over public networks. The system should also have provisions for encryption to ensure data security. Data transfer rates need to be high to ensure real-time updates, and synchronization mechanisms should ensure consistency across all data points.

4. System Features

4.1 Camera Setup

4.1.1 Description and Priority

The Camera Setup feature involves selecting the optimal number and type of cameras, placing them strategically around the field, and adjusting their settings. Priority: High.

4.1.2 Stimulus/Response Sequences

- *User selects the type and number of cameras.*
- *System provides feedback on camera suitability based on coverage area.*
- *User positions cameras around the box.*
- *System validates camera placements for optimal coverage.*
- *User adjusts camera settings.*
- *System confirms settings for optimal clarity.*

4.1.3 Functional Requirements

REQ-1:The camera setup will be capable of capturing data and output data of pitches during softball games in multiple forms of media.

REQ-2: The system shall be able to track the x and y axis trajectory of the ball from the release of the pitch till the end of the current pitch. The system will be able to capture data that is distinguishable to the rules of USA softball calls of strikes and balls.

4.1.4 Inputs and Outputs

Inputs: None

Outputs: None

4.2 Pitch Detection

4.2.1 Description and Priority

The Pitch Detection feature recognizes and tracks the softball's trajectory when pitched. It uses advanced technologies for this purpose. Priority: High.

4.2.2 Stimulus/Response Sequences

- *Pitch is thrown.*
- *Visual data is sent by cameras.*
- *System tracks and visualizes the trajectory of the softball.*
- *System captures pitch data metrics.*
- *System sent the data to the Pitch Evaluation System*

4.2.3 Functional Requirements

REQ-1: System shall continuously track the ball's movement from pitcher to batter.
REQ-2: System should store pitch data for subsequent analysis.

4.2.4 Inputs and Outputs

Inputs: Media

Outputs: Pitch data

4.3 Batter and Strike Zone

4.3.1 Description and Priority

This feature aims to accurately monitor the batter's movements and the strike zone's dimensions. Priority: Medium.

4.3.2 Stimulus/Response Sequences

- *Batter takes position.*
- *Visual data is sent by cameras.*
- *System determines and visualizes batter position and strike zone dimensions.*
- *System provides accurate batter position and strike zone data.*
- *System sent these data to the Pitch Evaluation System.*

4.3.3 Functional Requirements

REQ-1: System must utilize sensors or technology to monitor batter's movements.
REQ-2: System should accurately measure the strike zone's dimensions.
REQ-3: Data about batter and strike zone should be readily available for the Pitch Evaluation System.

4.3.4 Inputs and Outputs

Inputs: Media

Outputs: Batter position and strike zone data

4.4 Pitch Evaluation

4.4.1 Description and Priority

Pitch Evaluation determines a pitch based on the data received. Priority: High.

4.4.2 Stimulus/Response Sequences

- *Pitch data, Batter position and Strike Zone data is received.*
- *System evaluates the pitch based on the data.*
- *System generates a determination.*

- *System sent the determination to the User Control & Notification System.*
- *System sent Pitch, Batter position and Strike Zone data, along with the determination of the pitch to Database Collection*

4.4.3 Functional Requirements

REQ-1: System shall analyze factors like pitch speed, trajectory, and location.
REQ-2: System should generate evaluations assisting decision-making.
REQ-3: Post-game pitch analysis insights should be available.

4.4.4 Inputs and Outputs

Inputs: Pitch,Batter position and Strike Zone data

Outputs: Determination

4.5 User Control & Notification

4.5.1 Description and Priority

The User Control feature provides users with the ability to interact with the system and control its functionality, ensuring intuitive and secure access. The Notification feature will provide a result that is visible to the user upon request.
Priority: Medium

4.5.2 Stimulus/Response Sequences

- *System receives the determination of pitches.*
- *User access interfaces to review plays, change camera angles, or view pitch determination.*
- *System provides an intuitive and responsive interface with requested data or functionality.*

4.5.3 Functional Requirements

REQ-1: A user-friendly interface shall be developed for reviewing plays, changing camera angles, and accessing pitch data.
REQ-2: Users shall be able to customize system settings based on their specific needs.
REQ-3: The system shall implement security measures to prevent unauthorized access.
REQ-4: Ensure the system provides feedback for any user actions, including any errors or failures.

4.5.4 Inputs and Outputs

Inputs: Determination

Outputs: Visible determination to the user

4.6 Database Collection

4.6.1 Description and Priority

The Database Collection feature aims to maintain and manage a structured collection of team and league data for easy retrieval and analysis.
Priority: High

4.6.2 Stimulus/Response Sequences

- *User inputs or queries team/league data.*
- *System stores, retrieves, or manipulates data as per user instructions, reflecting changes instantaneously.*

4.6.3 Functional Requirements

REQ-1: The system shall provide a robust database system capable of handling large volumes of team and league data.
REQ-2: Implement backup and recovery mechanisms for data security.
REQ-3: Ensure database integrity through regular maintenance and checks.
REQ-4: Provide querying capabilities to extract specific data subsets for analysis.

4.6.4 Inputs and Outputs

Inputs: Stats recorded from a match

Outputs: Stats recorded from a match

5. Other Nonfunctional Requirements

5.1 Performance Requirements

Requirement: The system shall be 95% accurate when determining pitches
Reason: If the system is not accurate, then there would be no point in using it.

Requirement: The system shall be portable to the point where all equipment can fit into a compressed car.
Reason: Having a portable system allows the system to be moved across fields very quickly.

5.2 Safety Requirements

Requirement: The cameras shall not hinder the safety of the players by interfering with any natural motion any player makes during the game.
Reason: We do not want the system to hinder any part of the game. The cameras should be there to view the players, not to hit them.

Requirement: The cameras/camera equipment shall be easy to setup to ensure no hassle on the equipment team
Reason: Not only does this prevent the equipment team from dealing with larger parts to set up with, it provides a much more convenient system.

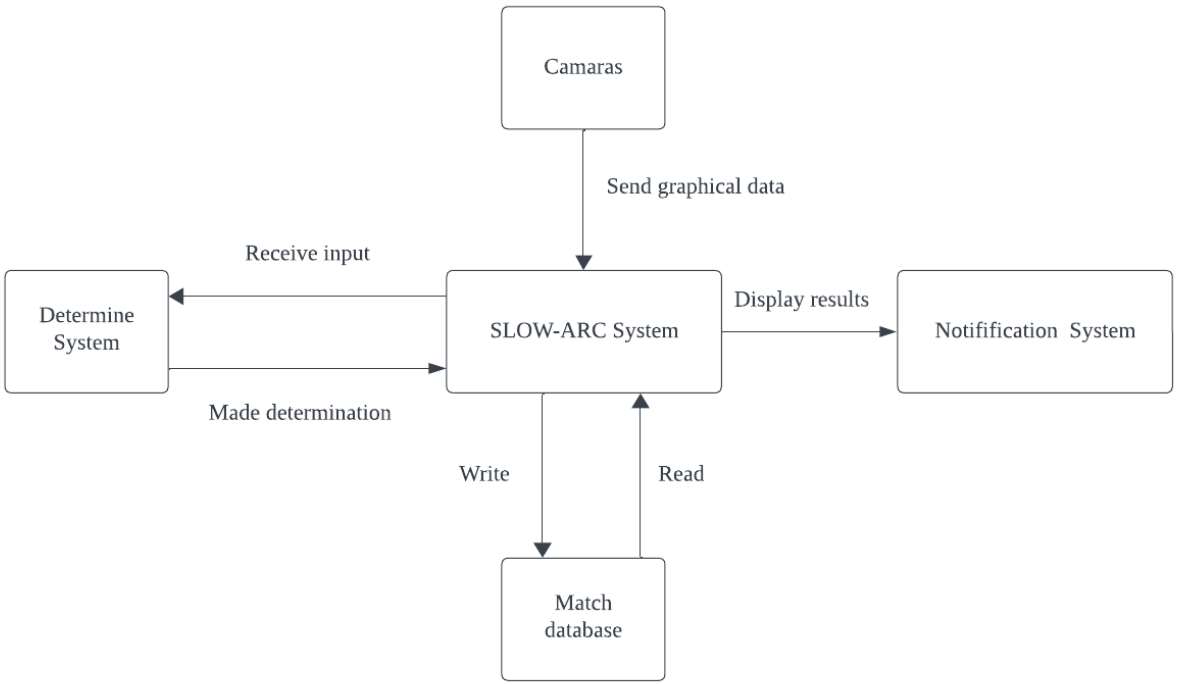
5.3 Software Quality Attributes

The view of the cameras can be changed quite drastically. Due to fields that may have different environments than others, such as fences, we can move the view to accommodate for all fields. The application to view the data will be available on all application stores so no phone is limited from viewing the data.

6. Other Requirements

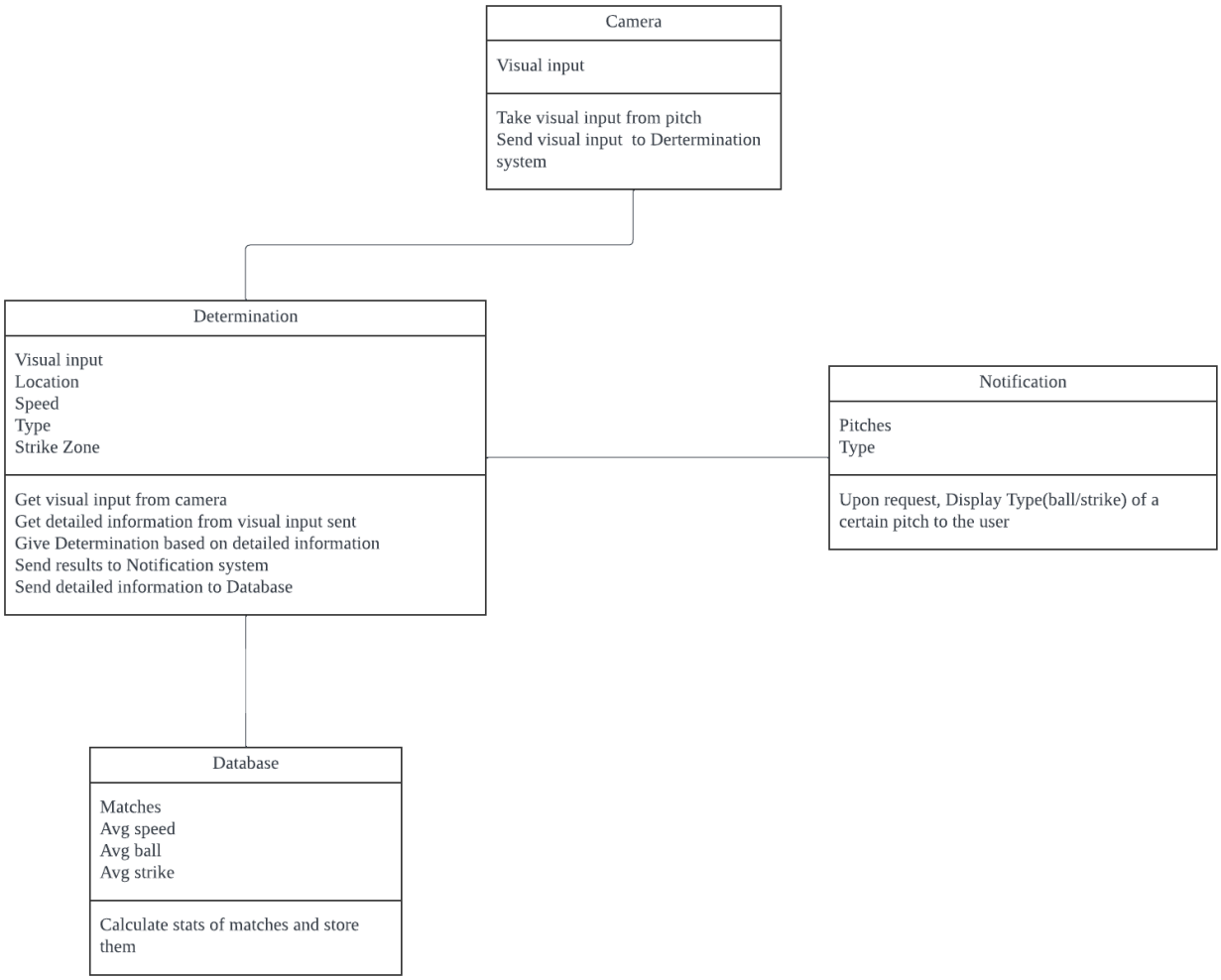
Appendix A: Analysis Models

Context Diagram:



The system can be divided into four subsystems: Camara, Determination, Notification and Match database. Camara System will send graphical data of a pitch and send them to the Determine System. The Determined system will receive input from the Camera System and give determination. The result will be displayed to the user by Notification system. Match database will record each matches' stats.

Structural Diagram:

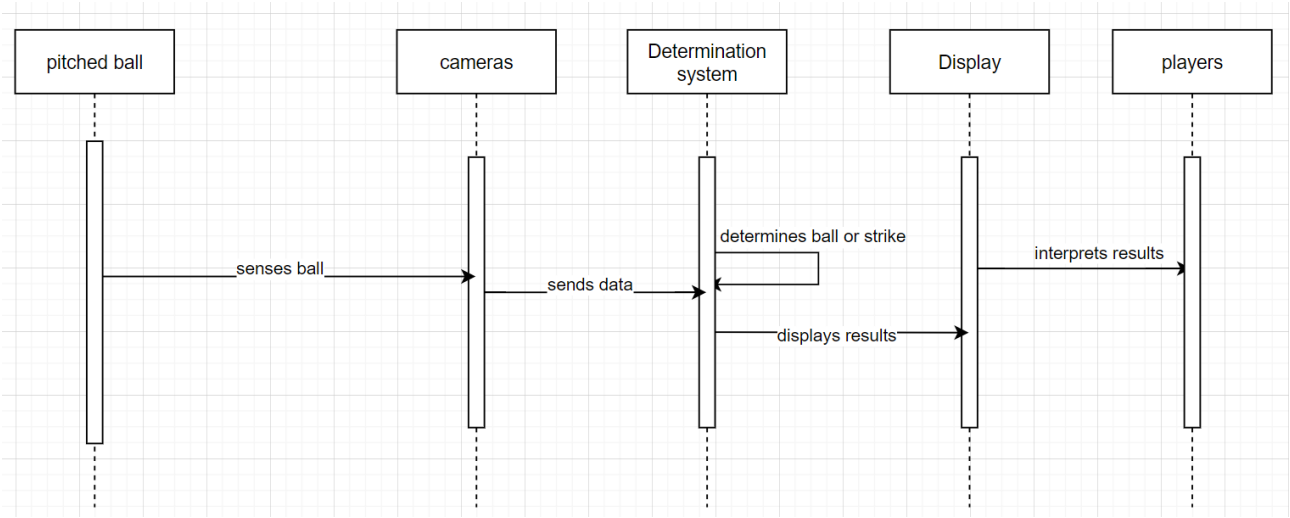


Camara System will take visual input of a pitch and send them to the Determine System. The Determined system will receive visual input from the Camera System, get detailed information(location speed, strike zone location) from pictures and give determination(type), then it will send the results(type) of that pitch to the notification system and send the detailed information to the database.

The notification system will display results to the user when they request it.

The database will manage stats (avg speed, avg ball/strike) of matches and provide access to these information when needed.

Sequence Diagram:



The sequence of events starts with the ball being sensed by the cameras which send the input information to the SLOW-ARC system which then processes it and sends a determination to the display which displays the result.

Appendix B: Requirements Review Report

Requirements Review

for

[SLOW-ARC System]

Reviewed Document title: SLOW-ARC Requirements and Use Cases
Reviewed Document version: 1.0
Reviewers: Yifei Liu, Maurice Yu, Shiva Cheruvu, Roshan Gokul

Date of review:10/19/23
References: Appendix C, Instructor feedback

Location	Description	Category	Resolution

4.1 - 4.6 Inputs and outputs	Based on Instructor feedback, Inputs are unspecified.	1.*Complete*	Added specified inputs and outputs for the process
4.5.1 Description	Based on Instructor feedback, this description is ambiguous.	4. *Precise, unambiguous, and clear*.	Added specific description to develop a deeper understanding for the system and reduce ambiguity.
2.1 Product Perspective	Based on Instructor feedback, the exact number of cameras is redundant.	5. *Relevant*	Remove the specification on the number of cameras.
2.6 Use cases	Based on Instructor feedback, more use case is needed.	1.*Complete*	A new use case is added

Appendix C: Requirements Checklist

Checklist of Individual Requirements

1. *Complete*.

   The information covers all aspects of this user function.

2. *Consistent*.

   The information for this user function is internally consistent. There are no conflicting statements.

3. *Correct*.

   The item is free from error.

4. *Precise, unambiguous, and clear*.

   The item is exact and not vague; there is a single interpretation; the meaning of each item is understood; the specification is easy to read. Use well defined terms and enough information. Terms such as “high”, “low”, “quick”, etc. are unacceptable. Define all terms and use measurable quantities.

5. *Relevant*.

The item is pertinent to the problem and its solution.

6. *Testable*.

Can the requirement be tested? If so, are the test cases defined. During program development and acceptance testing, it will be possible to determine whether the item has been satisfied.

7. *Understandable*.

Difficult language should not be used. Be clear. If formal notations are used, make sure they are easy to understand. Figures and tables are helpful, but must be explained.

8. *Expressed in the User's Language*.

All requirements shall be expressed using no design and in the users terminology.

9. *Traceable*.

The item can be traced to its origin in the problem environment. Also, you must be able to find who originated a requirement, who wrote it, what other requirements does this one impact, etc. This information is essential to make a document usable and changeable.

10. *Feasible*.

The item can be implemented with the available techniques, tools, resources, and personnel, and within the specified cost and schedule constraints

11. *Prioritized*.

The priority of this item relative other requirements has been recorded.

12. *Classified for Stability.*

Is this requirement stable of volatile. This is essential to know when planning for change and when other requirements rely on a volatile requirement.

13. *Free of unwarranted design detail.*

The requirements specifications are a statement of the requirements that must be satisfied by the problem solution, and they are not obscured by proposed solutions to the problem.