Weapon Zeroing and Warriors' Range Efficiency Analysis System of Small Arms for Bangladesh Army

Software Requirement Specification Document

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Chapter 1

Introduction

One of the most important aspects of basic soldering is weapon efficiency and its analysis. Weapon zeroing and its analysis is two major domain that works as a benchmark for getting success in various assignments. Zeroing is considered as a laborious and tiring factor. Therefore, most of our uniform personnel are very reluctant to maintain the correct procedure. Moreover, the manual system is less accurate, requires expert handling, firing result is never reconsidered or monitored, and not possible to monitor individual development.

1.1 Purpose

The project weapon zeroing system is intended to develop for army purpose. This system is to zero their weapons. This SRS will be a complete reference for the designers and the developers. It will be a brief on the process to complete the project. Apart from that, the designers or developers will get the idea of the weapon zeroing calculation and process from the SRS.

1.2 Scope

In the project of weapon zeroing, apart from hardware resources, software resources will be equally demanding. To fulfill the process the following software or applications will be required:

1. The image of the bulls eye where the bullets will hit is required. The deviation of the hit from the center is detected using an mobile application. The picture of the bulls eye will be processed and the mobile application will calculate the deviation from the center which will help to determine the MPI(Mean Point of Impact). The value of MPI will be sent to the central database for warriors' efficiency detection and to the hardware side through Arduino UNO.
2. The central database is an important part of this project. Here the data of the MPI is stored for efficiency reference of the warriors. The database will be reference of the performance of them. Apart from that, it will be used for future analysis of the warriors.
3. The next important part of the software side will be the programming of the Arduino to run the motos for zeroing the weapon.
4. Here in the project the later part, a web based application will be built. It will be a simulation of the whole system. The warriors' performance can be monitored through this web application. Besides, the warriors can be marked based on their efficiency.

5. The software applications mentioned above will be an important part of the project since the total performance of the warriors can be monitored through the proposed software system. Besides the hardware system designed for weapon zeroing will be controlled by the software developed.

Chapter 2

Overall Description

2.1 System Environment

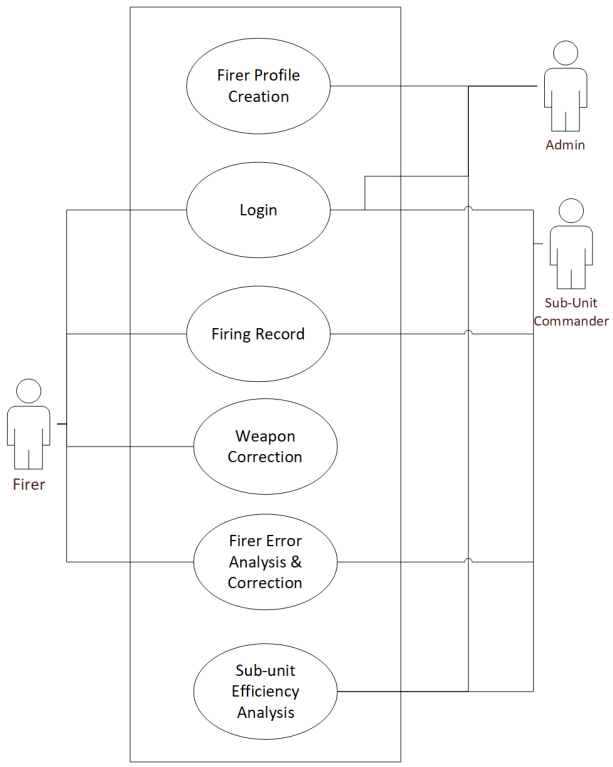

Figure 2.1: System Environment

1. There are total Four different actors working in the system environment. Administrator, who is overall responsible for creating and maintaining the system.
2. Firer, is the main focus audience who basically deals with different functions. He creates his portfolio and updates the system. This information sharing is done in real-time and the Arduino interface receives it through local network (WiFi/Bluetooth) whenever correction is required.
3. Sub unit commander basically keep track of his under commands. The firing errors and their required correction, improvement etc are monitored.

4. The cooperating system, which performs all internal function and step by step methods to complete requests from other actors.

2.2 Context Diagram

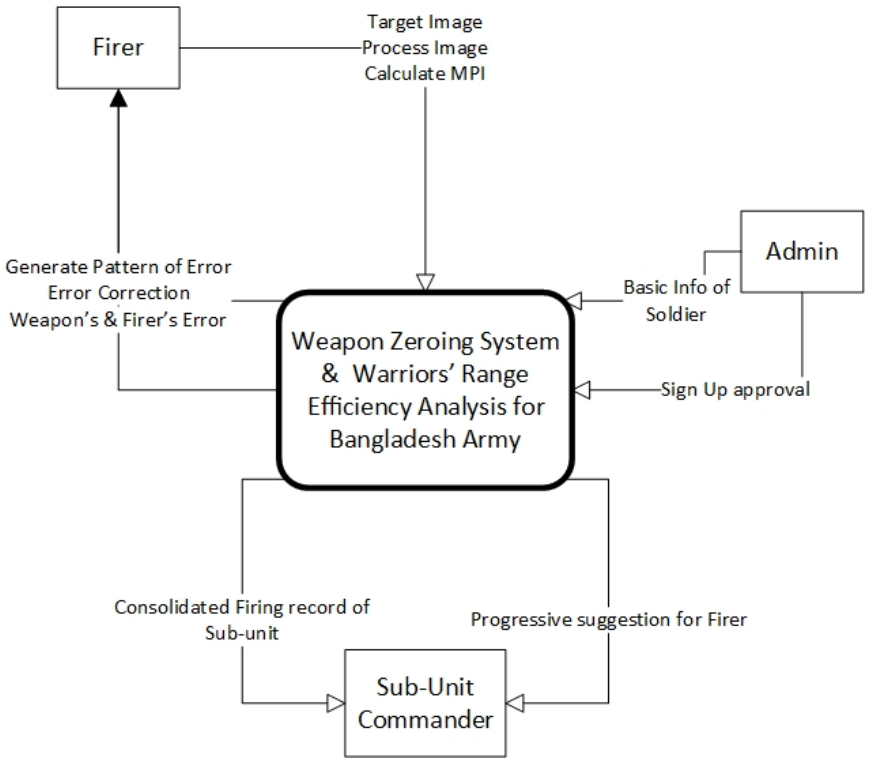

Figure 2.2: Context Diagram

1. A system context diagram in engineering is a diagram that defines the boundary between the system, or part of a system, and its environment, showing the entities that interact with it.
2. Here we have interaction with 3 actors with the system.
3. The data flow direction also indicates the functional procedure of the system.

2.3 Functional Requirements Specification

This section outlines the use cases for each of the actors separately.

2.3.1 Profile Management Use Case

Brief Description

1. Admin creates a user, can update their status, delete users on requirement, find user, lock user and unlock different users.

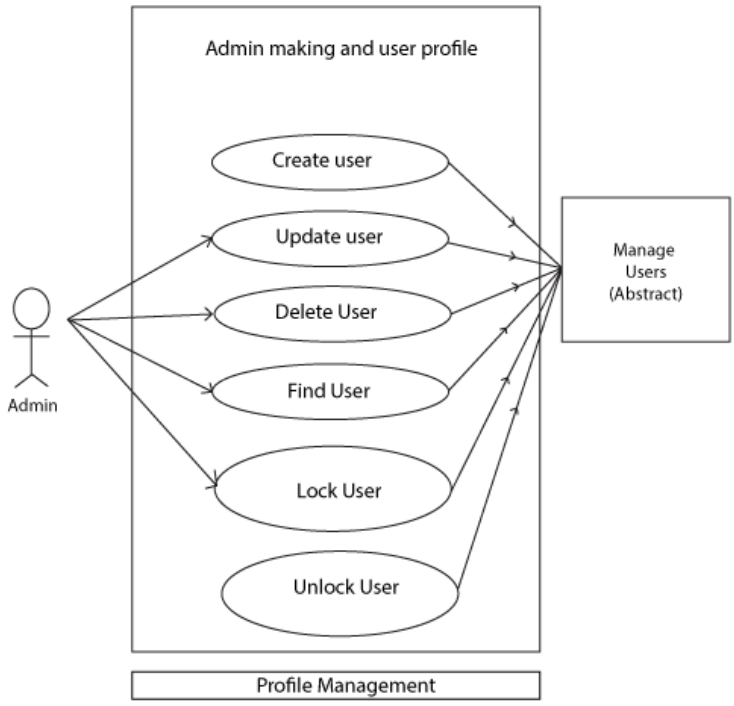

Figure 2.3: Profile Management

Initial Step-By-Step Description

1. Admin create a new user in the database.
2. Initial username and passwords are provided by the admin for the first time.
3. He can do necessary amendments to their status upon request from the sub unit commanders.

Tabular Description

Profile Management Use Case	
Actors	Admin
Description	Admin creates a user, can update their status, delete users on requirement, find user, lock user and unlock different users.
Data	Admin provides username and password to create user on request of commander.
Stimulus	Admin send username and password to user, lock, unlock, delete user.
Response	User profile is created in database and user use the system
Comments	User creation power is given only to the admin. No random person can't be user which ensures the security of the application.

2.3.2 Profile Creation Use Case

Brief Description

1. In Login part firer enter his credentials and Admin approves it.

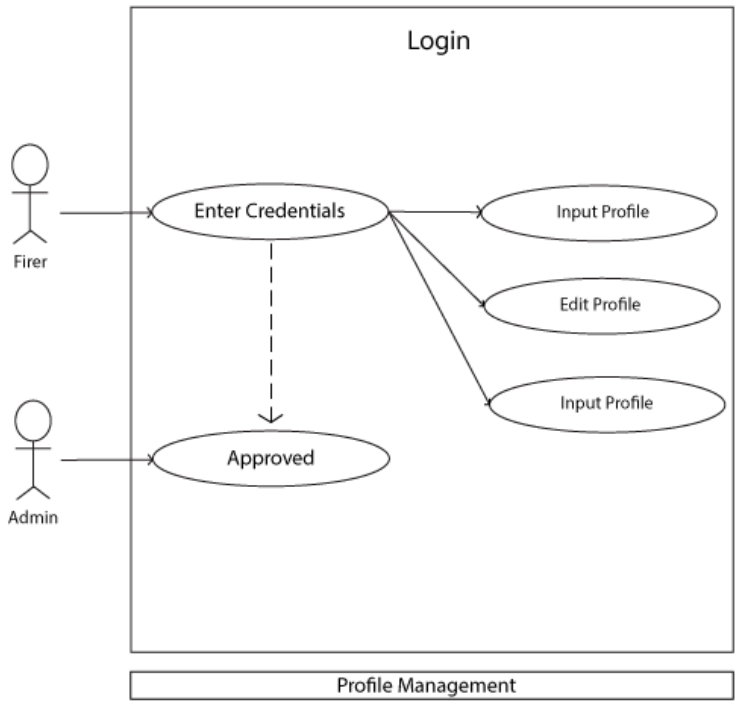

Figure 2.4: Profile Creation

Initial Step-By-Step Description

1. User log in to their profile.
2. Update user profile with necessary information.
3. User can check his records for future references.

Tabular Description

Profile Creation Use Case	
Actors	Admin, Firer.
Description	In Login part firer enter his credentials and Admin approves it.
Data	Firer provides his credentials to the system and admin approves it verifying it.
Stimulus	Firer provides credentials and admin approves.
Response	Firer profile becomes completely updated through his process of providing his credentials.
Comments	User needs to update the profile providing credentials and admin need to verify and update it. As a result, less scope of fake or wrong data or user.

2.3.3 Firing Record Use Case

Brief Description

1. Firer takes record of his target by taking snap and keeps record in their profile.

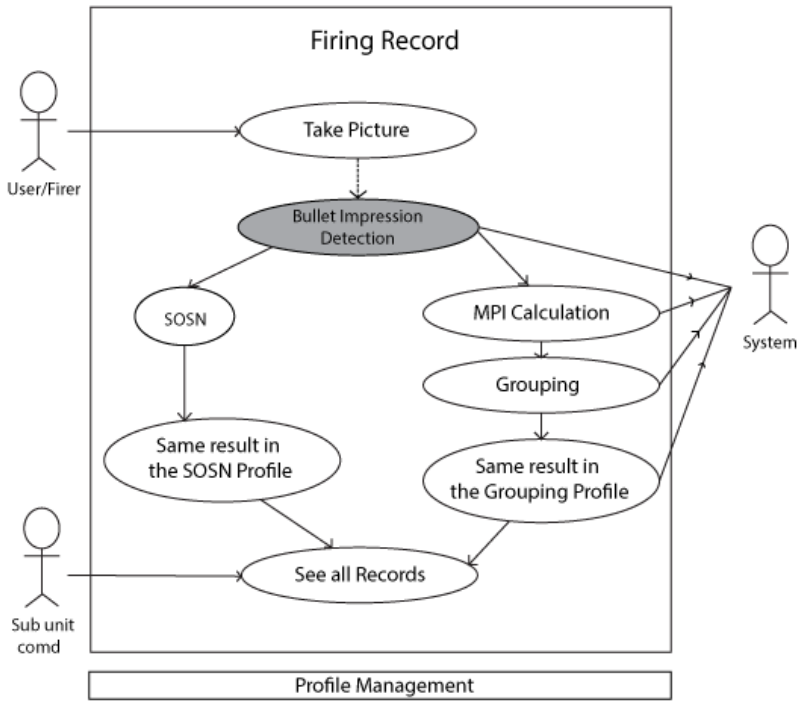

Figure 2.5: Firing Record

Initial Step-By-Step Description

1. User take picture.
2. From this picture Bullet Impression will be detected.
3. System start MPI calculation and give the result and start grouping and save the result in the grouping profile.
4. System start SOSN and save the result in the SOSN profile.
5. Sub unit commander can see all records.

Tabular Description

Firing Record Use Case	
Actors	User(Firer), Sub-unit commander, System
Description	Firer takes record of his target by taking snap and keeps record in their profile.
Data	Collection of firing image from target for MPI calculation and generating result for observation of sub-unit commander.
Stimulus	Firer takes picture input which in result provides MPI. Data is processed as result for sub-unit commander.
Response	MPI is generated from input image which zero the weapon and Sub-unit commander can observe the performance of the firer.
Comments	Image taken from target plays the vital role in total process since it calculates the MPI for weapon zeroing and analyze the performance of the firer.

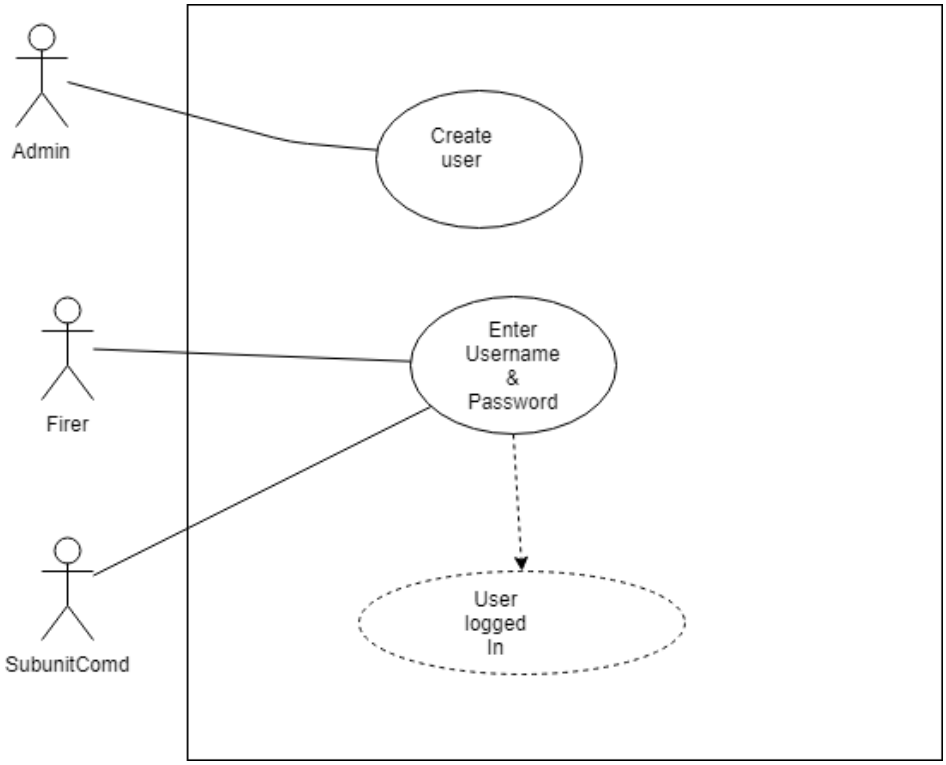

Figure 2.6: User Log In

2.3.4 Login Use Case

Brief Description

1. Different actors log in to their profile using credentials.

Initial Step-By-Step Description

1. Admin, Firer and Sub Unit Commander get their login credentials from administrator.
2. Using the provided username and password actors log in to their profile and do necessary adjustments.

Tabular Description

Login Use Case	
Actors	Admin, Firer, Sub Unit Commander
Description	Different actors log in to their profile using credentials. Admin, Firer and Sub Unit Commander get their login credentials from administrator. Using the provided username and password actors log in to their profile and do necessary adjustments.
Data	The data sent are Weapon name, time of shooting, number of shooting the Firer performed, number of success, number of correction required .
Stimulus	User login system provide users to review his activities.
Response	The summarized data is sent to the AI based software for further analysis.
Comments	A report is generated for each Firer.

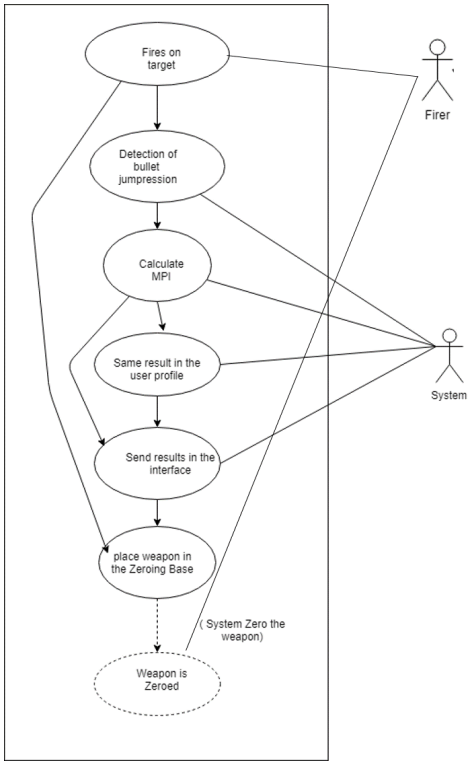

Figure 2.7: Correction of Weapon

2.3.5 Correction of Weapon Use Case

Brief Description

1. Weapon is placed in the zeroing base and the weapon is zeroed if correction is required.

Initial Step-By-Step Description

1. Firer takes snap of their target.
2. Using the Android Apps, image processing is done.
3. Bullet impressions are identified and MPI calculation is performed by the coordinating system.
4. Necessary correction parameters are send to the interface ff correction is required.
5. Firing data are saved in individual firing record in user profiles.

Tabular Description

Correction of Weapon Use Case	
Actors	Firer, Sub Unit Commander
Description	Weapon is placed in the zeroing base and the weapon is zeroed if correction is required. Firer takes snap of their target. Using the Android Apps, image processing is done. Bullet impressions are identified and MPI calculation is performed by the coordinating system. Necessary correction parameters are send to the interface if correction is required.
Data	The data sent are target image, MPI data.
Stimulus	This system provide necessary calculation for correction of weapon.
Response	Firing data are saved in individual firing record in user profiles.
Comments	If firing is not accurate then this process generate necessary data.

2.3.6 Firer's Error Analysis and Firing Correction Use Case

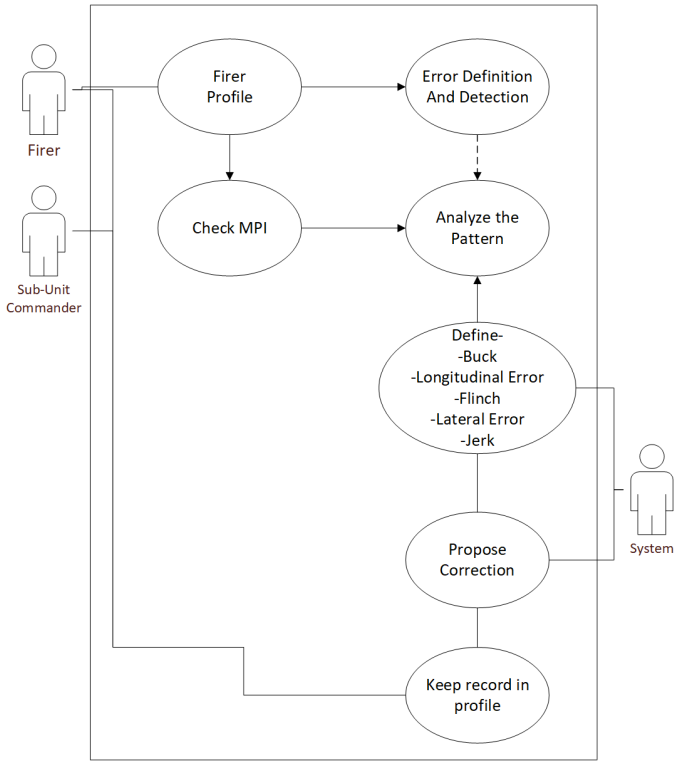

Figure 2.8: Firer's Error Analysis and Correction

Brief Description

1. Firer's error is identified and necessary correction mechanisms are suggested for future improvements.

Initial Step-By-Step Description

1. Get record from firer's profile.
2. Analyse with the test data available with the coordinating system.
3. Checks the pattern of error.

4. Provides detail analysis of the error eg buck, jerk etc.
5. Basing on the types of error necessary correction is suggested.

Tabular Description

Firer's Error Analysis and Firing Correction Use Case	
Actors	Firer, Sub Unit Commander
Description	Analyze with the test data available with the coordinating system. Checks the pattern of error and provides detail analysis of the error eg buck, jerk etc. Basing on the types of error necessary correction is suggested.
Data	Correction data, firer's record, calculation of error.
Stimulus	Firer's error is identified and necessary correction mechanisms are suggested for future improvements.
Response	Basing on the types of error necessary correction is suggested to the analyzer
Comments	Necessary correction is suggested by analyzing available test data.

2.3.7 Sub Unit Efficiency Analysis Use Case

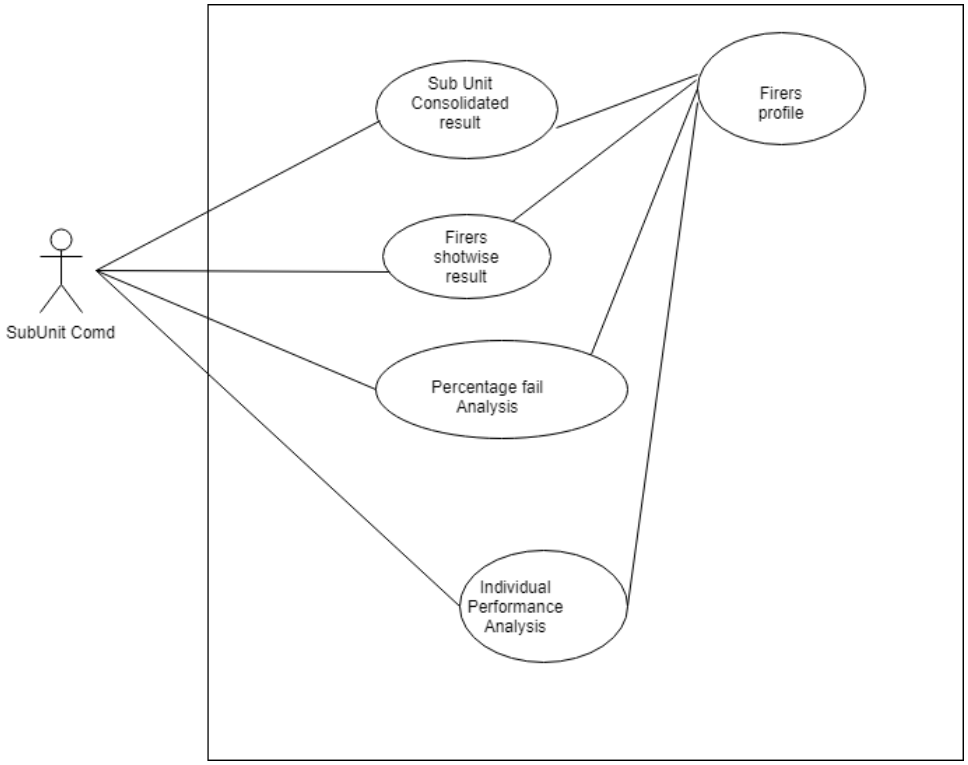

Figure 2.9: Sub Unit's Efficiency Analysis

Brief Description

1. Sub unit commander can visualize the standard of the unit firer. This navigation will help in keeping track of his under commands' firing results.

Initial Step-By-Step Description

1. Sub unit commander can perform percentage wise pass/fail calculation.
2. He can pursue weak firers' and can provide necessary correction in addition to the application.

Tabular Description

Sub-Unit Efficiency Analysis Use Case	
Actors	Sub unit commander.
Description	Sub unit commander visualize the standard of the unit firer. This navigation will help in keeping track of his under commands' firing results and performed percentage wise pass/fail calculation. He can pursue weak firers' and can provide necessary correction in addition to the application.
Data	Correction data, firer's record, calculation of error, pass/fail calculation.
Stimulus	After analyzing data Sub unit commander can provide necessary correction.
Response	After provide necessary correction Firer's change their certain activities.
Comments	Visualization is done by sub unit commander and necessary instructions are done by the firer's.

2.4 User Characteristics

Following section contains the characteristics of the users. In this system, we have three main users: Firer, Sub-Unit Commander, Admin. Their characteristics is described below based on four main criteria: Education Level, Experience, Disabilities, Technical Expertise.

User Characteristics			
	Firer	Sub-Unit Commander	Admin
Education Level	The firer has basic educational qualification which is enough to use the system.	The personal has enough educational qualification to watch the system and the result, reports.	He must have high educational qualifications to maintain the system. Since the system will be under his control so he must have profound knowledge.
Experience	His basic experience of firing will be enough. Once he is shown the process of using the system, he will be capable to use it.	He doesn't require much expertise to use the system since his task will to login and observe the performance of the firers in report.	He must be highly experienced to handle the system. He needs to maintain the system and deal with user accounts. In some cases, the system performance will be dependent on the expertise of the admin.
Disabilities	-	-	-
Technical Expertise	Not much technical expertise is required for the firer. He needs to deal with few buttons, forms and take image.	Not much technical expertise is required for him since he only needs to log in and observe the performance of the firer using few buttons and input fields.	This person must be highly technical expert. His technical skill is required to maintain the system, control the users and report to the developers in case of any problem of the system.

2.5 Comparative Discussion of the System

Zeroing weapon is an important part of firing process. The present system to zero the weapon is completely manual. Based on the firing, only efficient soldiers can zero the weapon perfectly. Previously number of firing was less so this was not concern. But now the number of firing has increased to great extent. However number of expert soldiers to zero the weapon has not increased to that extent. So it has become difficult for soldiers to fire since weapon which has not done zero will not fire accurately.
The system proposed here brings the solution to the problem. It has been made manual apart from taking photo of the target. The manual calculation of zeroing is no more required since the system will calculate the zeroing value. Apart from that dependency on expert soldiers will reduce for zeroing the weapon since the proposed system interface will zero the weapon automatically based on the calculated zeroing value.
Currently, the zeroing results are stored on papers which is troublesome and analysis of the result is not possible. But in the proposed system, the zeroing results will be stored in database and analysis of the result will help to find out the efficiency of soldiers.
Therefore the zeroing system will ease the process of weapon zeroing.

2.6 Data Flow Diagram

A data-flow diagram (DFD) is a way of representing a flow of a data of a process or a system (usually an information system) The DFD also provides information about the outputs and inputs of each entity and the process itself. The data-flow diagram is part of the structured-analysis modelling tools. In this section, the DFDs of the system are given for each of the use cases discussed above.

2.6.1 Profile Management

The profile management data flow diagram is at Figure 2.10.

2.6.2 Profile Creation

The profile creation data flow diagram is at Figure 2.11.

2.6.3 Firing Record

The firing record data flow diagram is at Figure 2.12.

2.6.4 Login

The login data flow diagram is at Figure 2.13.

2.6.5 Correction of Weapon

The correction of weapon data flow diagram is at Figure 2.14.

2.6.6 Firer's Error Analysis and Firing Correction

The firer's error analysis and firing correction data flow diagram is at Figure 2.15.

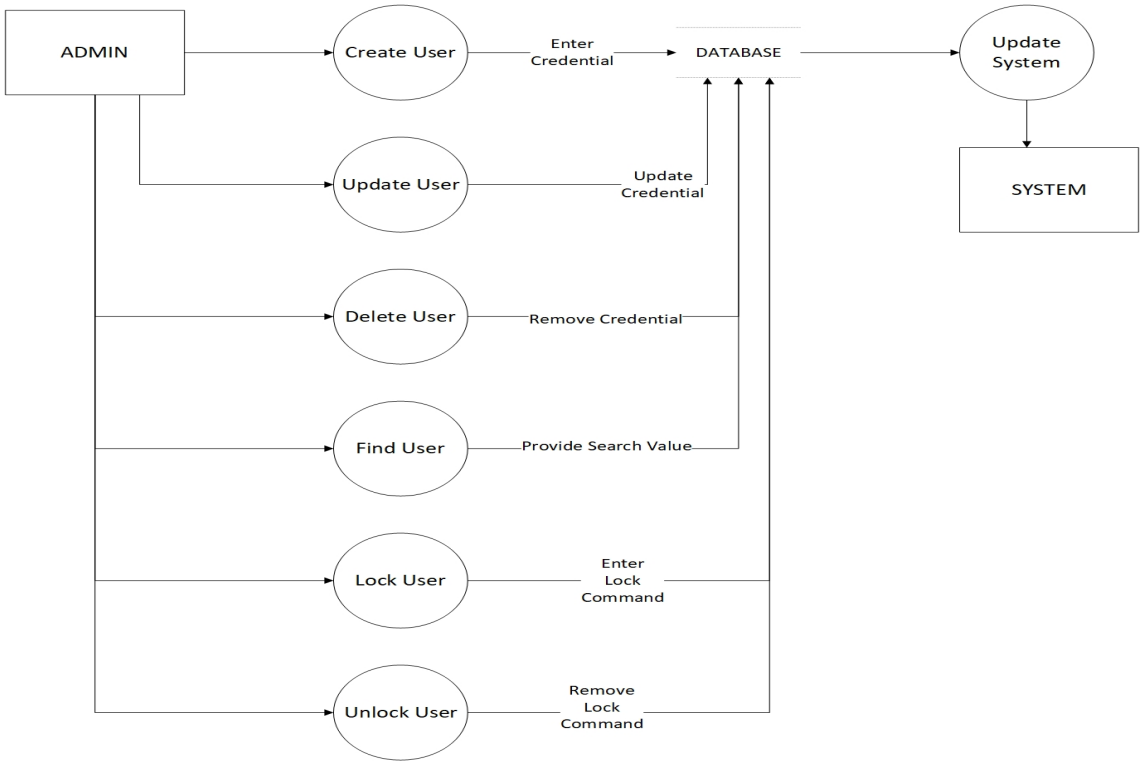

Figure 2.10: Profile Management DFD

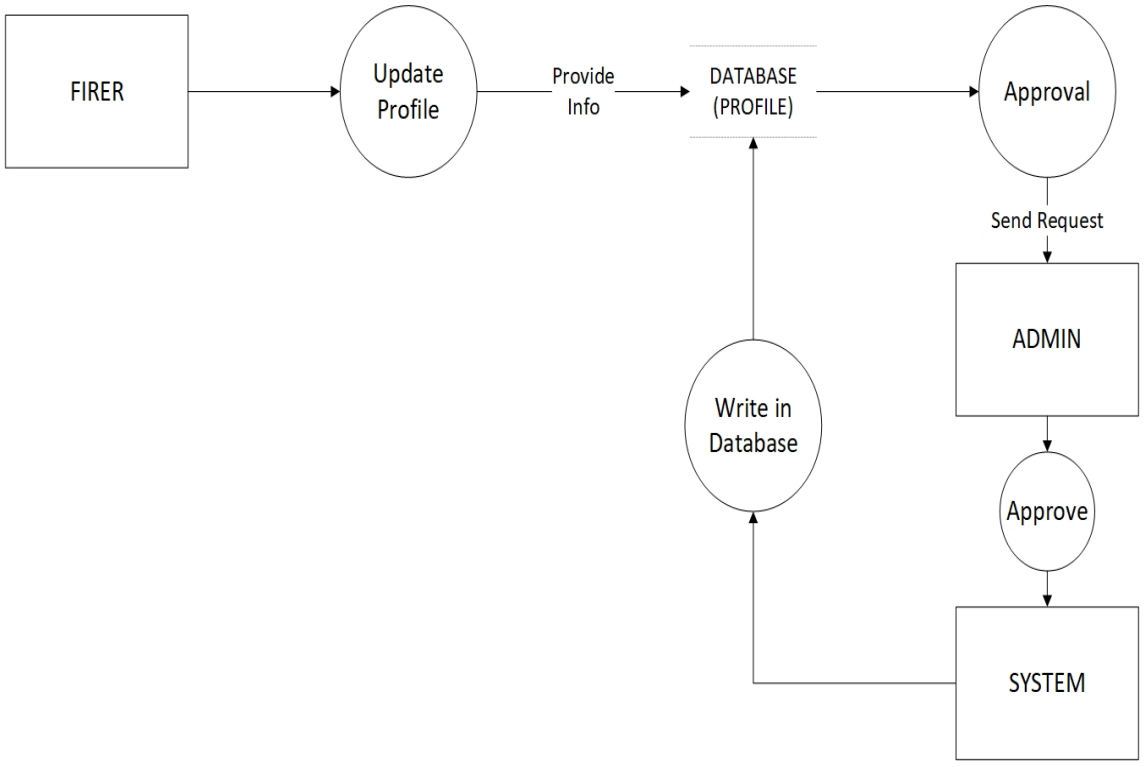

Figure 2.11: Profile Creation DFD

2.6.7 Sub Unit Efficiency Analysis

The sub unit efficiency analysis data flow diagram is at Figure 2.16.

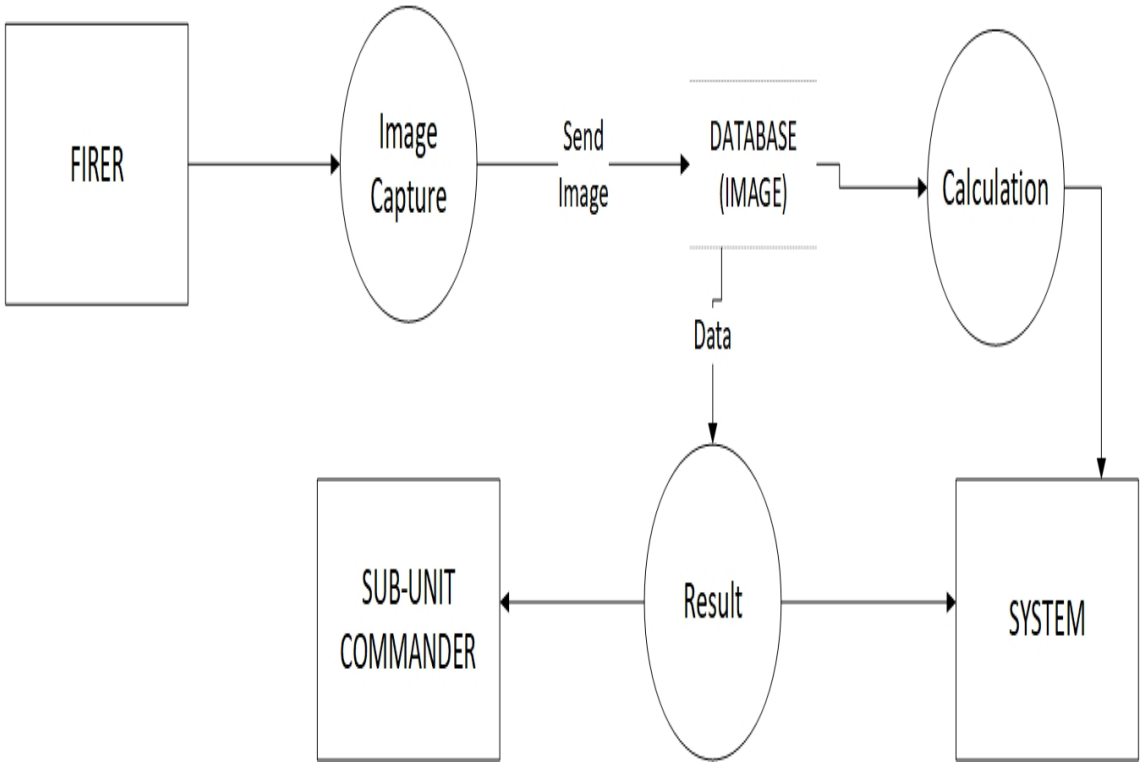

Figure 2.12: Firing Record DFD

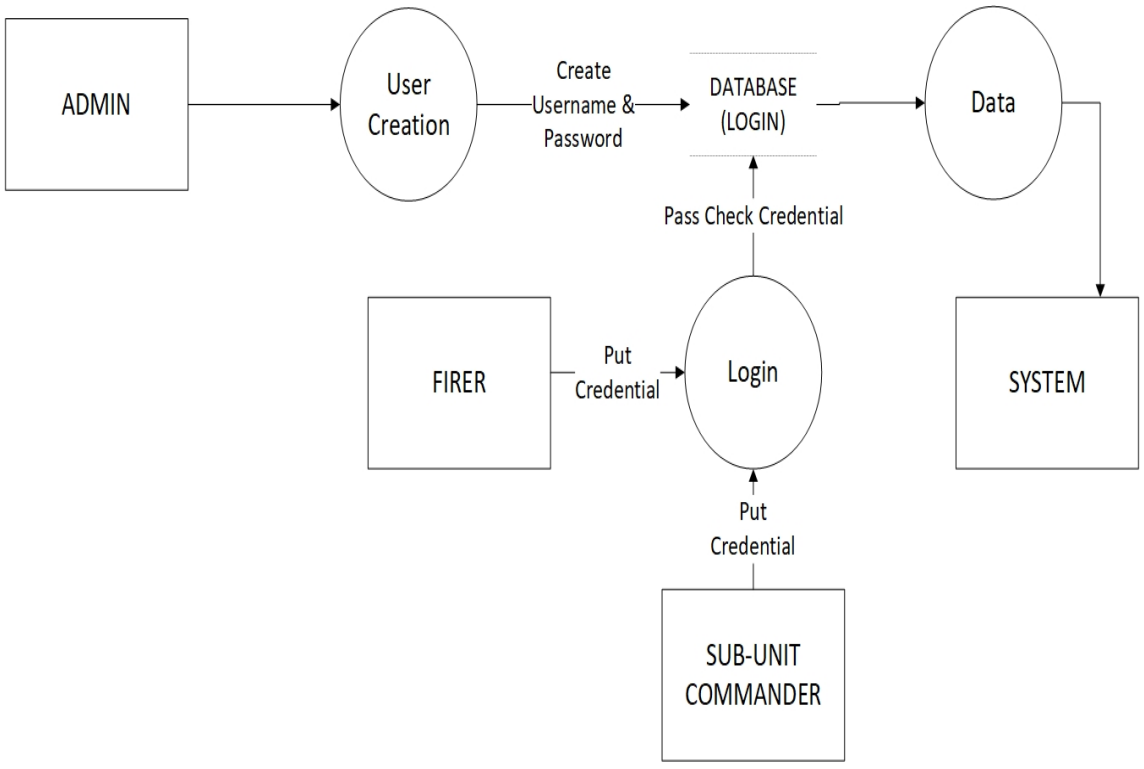

Figure 2.13: Login DFD

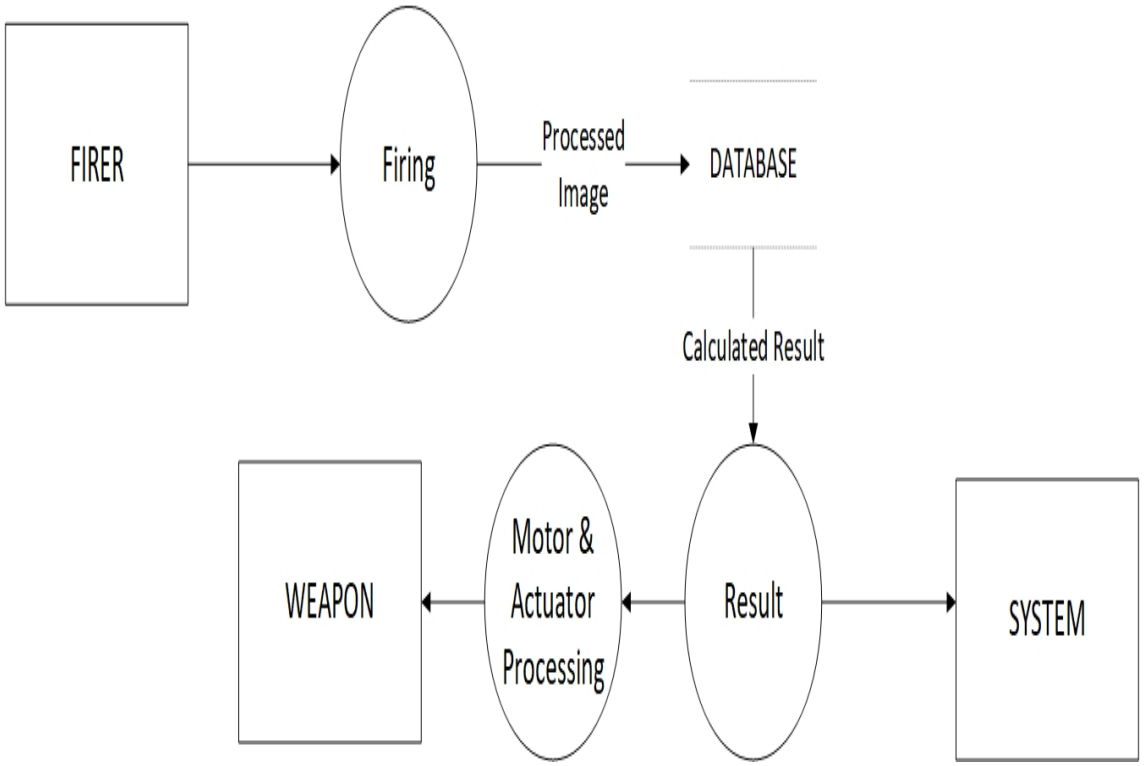

Figure 2.14: Correction of Weapon DFD

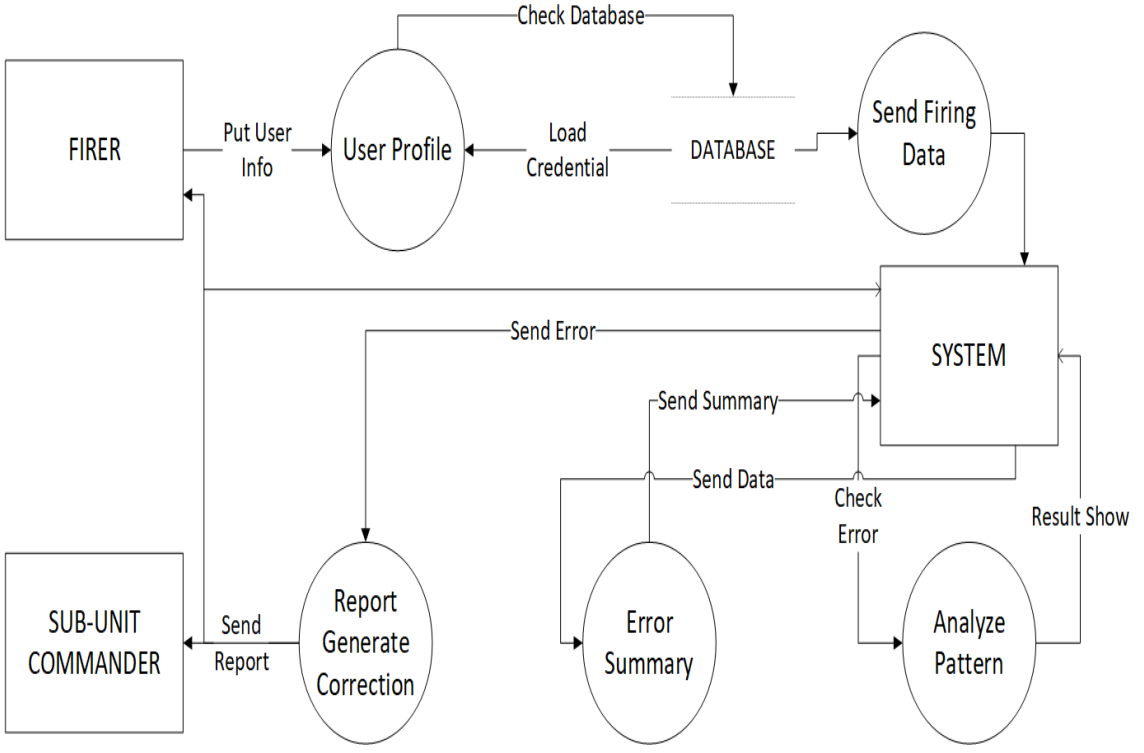

Figure 2.15: Firer's Error Analysis and Firing Correction DFD

2.7 Non-Functional Requirements

2.7.1 Testing

This section covers the problems aroused during the implementation of features of the project.

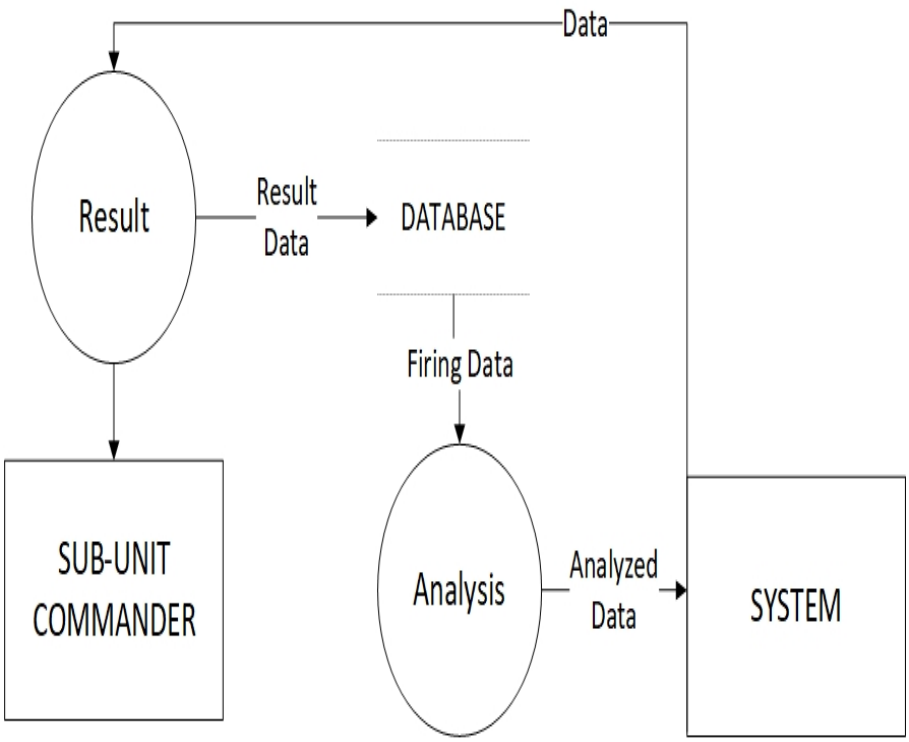

Figure 2.16: Sub Unit Efficiency Analysis DFD

- Feature/Module#1
  - Name of Feature: Erroneous image processing of the target using mobile application.
  - Input Type: Image captured by mobile camera.
  - Expected Output: Bullet impression detection.
  - Testing Type: Integration Testing
  - Criteria: Accuracy problem. The processed image can't detect real time bullet holes exactly. Besides, when two bullets pass through single hole, the detection process becomes difficult.

- Feature/Module#2
  - Name of Feature: Capacity problem while passing numeric data from mobile application to the hardware device through Bluetooth.
  - Input Type: Send error amount from mobile application to the hardware device.
  - Expected Output: The hardware is expected to receive the exact value sent by the application.
  - Testing Type: Integration Testing.
  - Criteria: Accuracy problem. If value sent from mobile application to hardware device is more than 4 digit it can't read that value. So in case if the application generate error value of more than 4 digit, it is to be trimmed to 4 digit and then sent to the hardware.

- Feature/Module#3
  - Name of Feature: Image cropping problem of the target image.
  - Input Type: Take image using mobile camera.
  - Expected Output: The application is expected to crop the target part of the image trimming the surroundings image.

  - Testing Type: Performance Testing.
  - Criteria: Currently manual crop is done which can not completely trim the surrounding unwanted view apart from the target view. However in next versions of the project the crop is desired to be done using AI which will trim the unwanted view of the surroundings and result in better performance in cropping.

- Feature/Module#4
  - Name of Feature: Data can not be sent simultaneously twice at a time.
  - Input Type: Send weapon error correction data from mobile application to machine.
  - Expected Output: Machine receive correction data from application to zero the weapon.
  - Testing Type: Load and Stress Testing.
  - Criteria: Load testing is done here which checks that the maximum at a time only one set of data can be sent. This maximum limit of data sending is also illustration of the result of stress testing.

- Feature/Module#5
  - Name of Feature: Linear correction can not be done using motor but it is done using linear actuator.
  - Input Type: Rotate linear motor to correct the weapon laterally.
  - Expected Output: Move the weapon correction tip laterally as per required correction.
  - Testing Type: Integration Testing.
  - Criteria: The linear correction is not possible by motor. If motor is used the complexity of correction increases. So to ease the process of linear correction the linear actuator is used.

2.7.2 Performance Requirements

A system may be required to present the user with a display of the number of records in a database. This is a functional requirement. How current this number needs to be, is a non-functional requirement. If the number needs to be updated in real time, the system architects must ensure that the system is capable of displaying the record count within an acceptably short interval of the number of records changing. Sufficient network bandwidth may be a non-functional requirement of a system. Other examples include:

- Accessibility
- Adaptability
- Data Integration
- Operability
- Durability
- Robustness
- Stability
- Testability
- Usability
- Extensibility
- Reusability
- Integrability

2.7.3 Safety Requirements

The machine developed here works with the weapon. It's required that the user must be careful and conscious while using the device. There are sensitive circuit connections which might get harmed due to careless movement of device. The minute and precise accessories like motor, arduino must be taken care properly.

2.7.4 Security Requirements

Being a system developed for military use, the security concern is vital. There must be steps so that outsiders can't get access to the system or database.

2.7.5 Software Quality Attributes

Software Quality Attributes are: Correctness, Reliability, Adequacy, Learnability, Robustness, Maintainability, Readability, Extensibility, Testability, Efficiency, Portability.

Chapter 3

Specific Requirements

This section contains all the software requirements at a level of detail sufficient to enable designers to design a system to satisfy those requirements, and testers to test that the system satisfies those requirements. Throughout this section, every stated requirement is externally perceivable by users, operators, or other external systems. These requirements include at a minimum a description of every input (stimulus) into the system, every output (response) from the system and all functions performed by the system in response to an input or in support of an output

3.1 External Interfaces

This contains a detailed description of all inputs into and outputs from the software system. It complements the interface descriptions in section 2 but does not repeat information there. However section 2 presents information oriented to the customer/user while section 3 is oriented to the developer.

3.1.1 User Interface

The UI screenshots of the mobile application have been attached while describing the purpose of each interface.

1. Login UI: This UI (Fig.3.1) allows the firer to login to the system providing the username and the password.
2. Home Activity: This UI (Fig. 3.2) allows user to watch his own profile. Besides the user can select the type of firing he will do from the drop down menu. Then the user can tap to capture image button to capture image of the target and proceed to calculatio for zeroing.
3. Correction Activity: This UI (Fig. 3.3) displays the processed image data. It shows the correction value of the firing.

3.1.2 Hardware Interface

The system architecture is attached in Figure 3.4 The short description of the materials used in the hardware interface is given below:

1. Arduino Mega: The Arduino Mega is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer

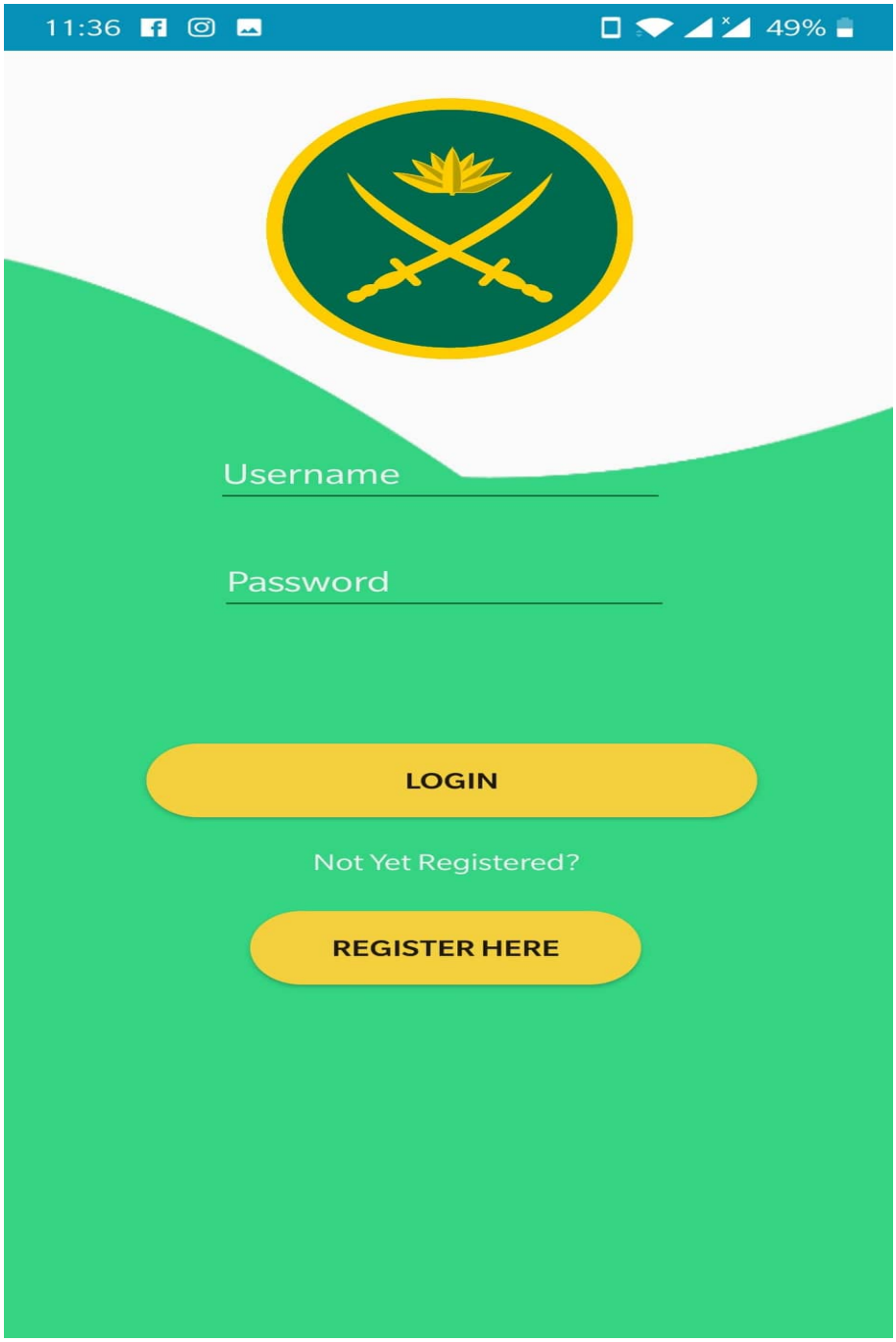

Figure 3.1: Login

with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Mega board is compatible with most shields designed for the Uno and the former boards Duemilanove or Diecimila.

2. Linear Actuator: A linear actuator is an actuator that creates motion in a straight line, in contrast to the circular motion of a conventional electric motor. Linear actuators are used in machine tools and industrial machinery, in computer peripherals such as disk drives and printers, in valves and dampers, and in many other places where linear motion is required. Hydraulic or pneumatic cylinders inherently produce linear motion. Many other mechanisms are used to generate linear motion from a rotating motor.

3. Gear Motor: A gear motor is a specific type of electrical motor that is designed to produce high torque

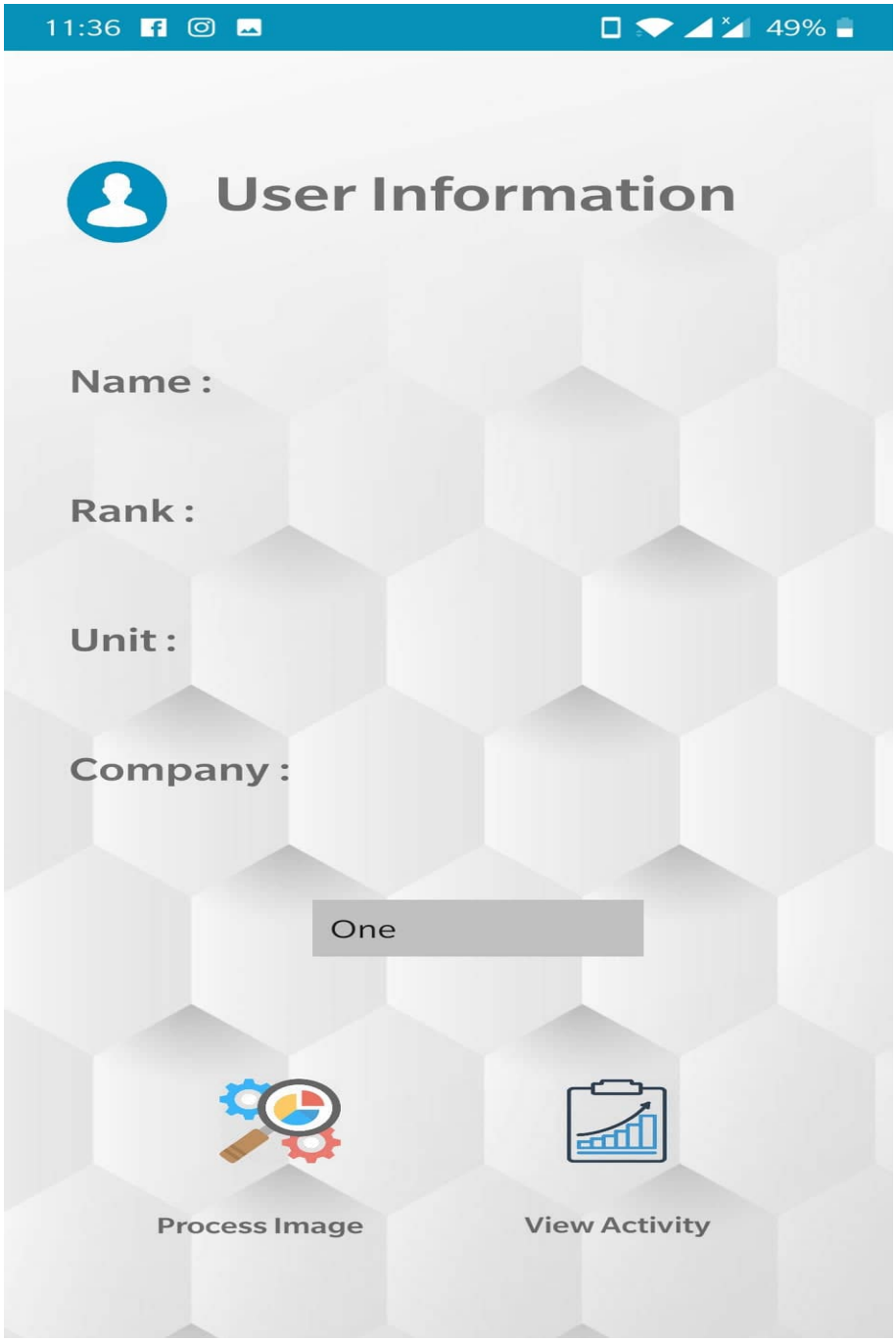

Figure 3.2: Home Activity

while maintaining a low horsepower, or low speed, motor output. Gear motors can be found in many different applications.

4. Rotary Encoder: A rotary encoder, also called a shaft encoder, is an electro-mechanical device that converts the angular position or motion of a shaft or axle to analog or digital output signals. There are two main types of rotary encoder: absolute and incremental.

5. Pinion: A pinion is a round gear—usually to the smaller of two meshed gears—used in several applications, including drivetrain and rack and pinion systems.

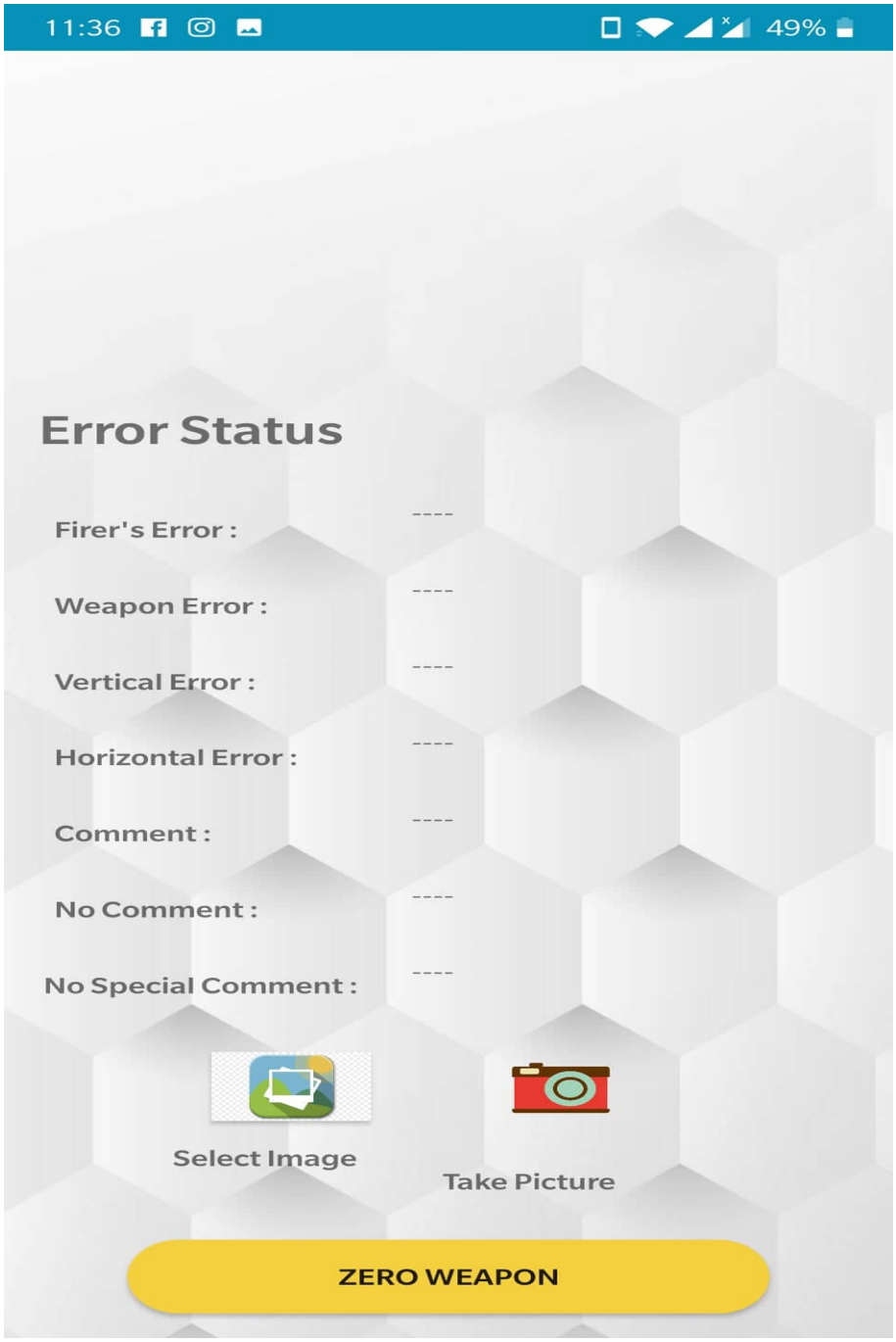

Figure 3.3: Correction Activity

3.1.3 Software Interface

The required software specifications of the system are discussed below:

1. OpenCV: OpenCV (Open Source Computer Vision Library) is an open source computer vision and machine learning software library. OpenCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in the commercial products.

2. mySQL: MySQL is a freely available open source Relational Database Management System (RDBMS) that uses Structured Query Language (SQL). SQL is the most popular language for adding, accessing

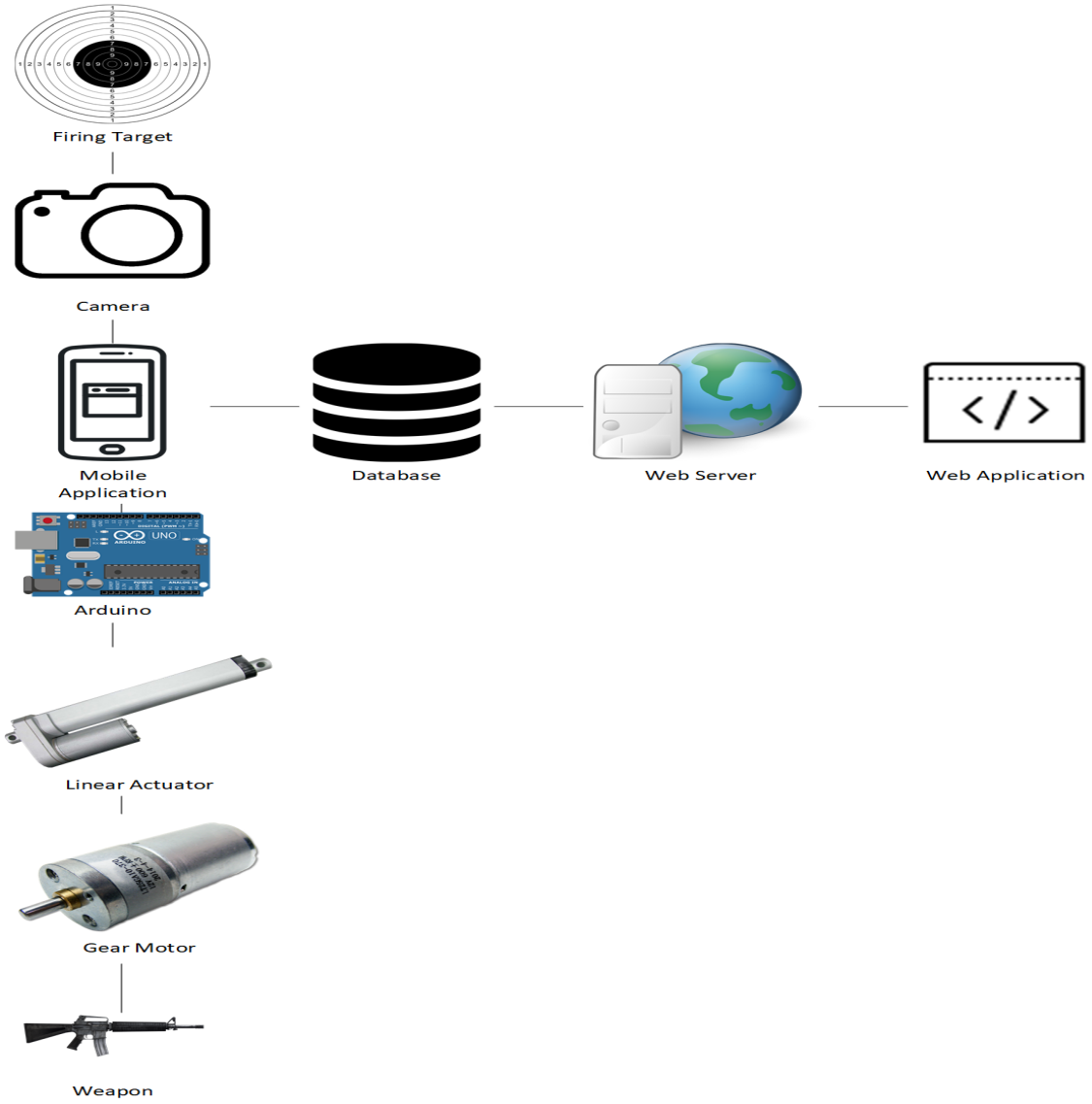

Figure 3.4: System Architecture

and managing content in a database. It is most noted for its quick processing, proven reliability, ease and flexibility of use.

3. phpMyAdmin: phpMyAdmin is a free software tool written in PHP, intended to handle the administration of MySQL over the Web. phpMyAdmin supports a wide range of operations on MySQL and MariaDB. Frequently used operations (managing databases, tables, columns, relations, indexes, users, permissions, etc) can be performed via the user interface, while you still have the ability to directly execute any SQL statement.

3.1.4 Communication Interface

The communication process used in the system are discussed below:

1. In computer networking, localhost is a hostname that means this computer. It is used to access the network services that are running on the host via the loopback network interface. Using the loopback interface bypasses any local network interface hardware. Records of all user information is stored in a

mysql database which shares connection with all the devices through wifi/cable network. Therefore, a localhost server is required with web, php, mysql facilities.

2. Arduino Bluetooth Module: It sends data from android app to the arduino. The image processed data from app will be sent to the arduino for correction of the weapon through the bluetooth.

3.2 Design Constraints

It specifies design constraints that can be imposed by other standards, hardware limitations, etc.

3.2.1 Hardware Constraints

1. For the horizontal correction the front sight tip base need to be moved laterally according to the required calculation. For doing so in the initial plan was a challenge. At first It was planned to use the stepper motor. But this motor can not move in horizontal plane. After failing, linear actuator was used. To hold the base from both side a customized holding system is built.

2. The stepper motor could not produce required torque. So we used the gear motors. But gear motor can not be controlled by rotation angle. So we fixed rotary encoder with that.

3.2.2 Software Constraints

1. Records of all user information is stored in a mysql database which shares connection with all the devices through wifi/cable network. Therefore, a localhost server is required with web, php, mysql facilities.

2. The greatest challenge of the project is to process the image taken from the target and detecting the bullet pierced holes accurately along with the coordinates of them.

Appendices

The following documents are attached hereby:

1. Project Plan
2. Base File
3. Project Proposal
4. System Architecture
5. Work Flow Diagram