# FOREST ACTIVITY MONITORING SYSTEM

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# Approval Sheet

This design project entitled “**Forest Activity Monitoring System**” prepared by Hannah Katrina A. Adsuara, Jazmine Rodeth A. Balasa, Benedick B. Icban and Lance Adrian A. Valdez of the Computer Engineering Department was examined and evaluated by the members of the Student Design Evaluation Panel and is hereby recommended for oral presentation and approval.

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# Major (Capstone) Design Experience Information

**CP520D2 DESIGN PROJECT 2**

**2nd Semester, SY 2014-2015**

|  |  |
| --- | --- |
| Student/Team  Group 2 | Hannah Katrina A. Adsuara  Jazmine Rodeth A. Balasa  Benedick B. Icban  Lance Adrian A. Valdez |
| Project Title | Forest Activity Monitoring System |
| Program Concentration Area | Software |
| Design Project Objectives | Project Objectives  The main objective of this project is to develop software applications for the Forest Activity Monitoring System that integrates image-processing technology in accordance with the engineering and software standards and consideration of trade-offs based on multiple constraints such as time, economic and performance.  Specific Objectives   * To develop an application that displays alerts on illegal logging and forest fire. * To provide a real-time monitoring of the forest that can be viewed by developed applications. * To test and evaluate the accuracy and functionality of the system. |
| Constraints |  |
| Time | The time to develop, implement and synchronize the software with the hardware such as sensors and cameras plays a big role in designing the project design. Software undergoes rigorous testing and debugging before deploying it to the market and/or industry. Time is the main factor to consider in designing the system.  The designers must adjust with the given time to finish the system. One of the plans that the designers proposed was to use agile process in developing the software and at the same time distributing modules equally to each member of the group. |
| Economic (Development Cost) | Development cost can have significant effects on the design. It requires the estimation of a number of items such as the extent of off-the-shelf-hardware requirements, design risks in implementing technologies to conform to the objectives the project and other related costs for the development of the system.  The designers have to provide a system that is economically feasible for implementation and development. They have to choose from a variety of options currently available in the market as well as choose the right software and other related applications. |
| Performance (Data Processing) | Software can be defined as an automation of passing and retrieving of data. Being said, reliability of data that the system provides is an important factor and also a constraint. The system must provide reliable data, which the hardware provides, as well as the processing of the said data.  The designers must provide reliable queries that can access and retrieve data from the database. A well-designed database and well-constructed queries is an effective way to overcome the constraint of reliability. |
| Standards |  |
| WordPress Roles and Capabilities | As stated on Section 3, a role defines a set of tasks a user assigned the role is allowed to perform. For instance, the [Super Admin](http://codex.wordpress.org/Super_Admin_Menu) role encompasses every possible task that can be performed within a [Network](http://codex.wordpress.org/Glossary#Network) of virtual WordPress [sites](http://codex.wordpress.org/Glossary#Site). The [Administrator](http://codex.wordpress.org/Roles_and_Capabilities#Administrator) role limits the allowed tasks only to those, which affect a single site. On the other hand, the [Author](http://codex.wordpress.org/Roles_and_Capabilities#Author) role allows the execution of just a small subset of tasks. The applications developed conform to all the task and set of functions that an administrator can use. |
| IEEE STD 730-1998 IEEE Standard for Software Quality Assurance Plans | As stated on Section 3, a role defines a set of tasks a user is allowed to perform. Each user is assigned a role. For instance, the [Super Admin](http://codex.wordpress.org/Super_Admin_Menu) role encompasses every possible task that can be performed within a [Network](http://codex.wordpress.org/Glossary#Network) of virtual WordPress [sites](http://codex.wordpress.org/Glossary#Site). The [Administrator](http://codex.wordpress.org/Roles_and_Capabilities#Administrator) role limits the allowed tasks to only those that affect a single site. On the other hand, the [Author](http://codex.wordpress.org/Roles_and_Capabilities#Author) role allows the execution of just a small subset of tasks. The applications developed conform to all the tasks and set of functions that an administrator can use. |
| Ameritech Graphical User Interface Standards and Design Guidelines | As stated on Section 5.3.2.1, a well- designed application minimizes the number and severity of errors. The closer the application matches the user’s task, the more likely errors be prevented. The use of interface objects like radio buttons, check boxes and pop-up menus serve to prevent errors, because the application relies on the user to make a choice from pre-defined sets. The applications provide a combo box that gives end-users option to choose from different channels on which they can view the live feed. |

# List of Tables

[Table 3‑1 Needed Cost for the Development of the System Using Design 1 15](#_Toc415502638)

[Table 3‑2 Needed Cost for the Development of the System Using Design 2 17](#_Toc415502639)

[Table 3‑3 Needed Cost for the Development of the System Using Design 3 19](#_Toc415502640)

[Table 4-1 Designers Raw Ranking for the Three Designs 29](#_Toc415502641)

[Table 4‑2 Comparisons of Three Designs based on Development Cost 32](#_Toc415502642)

[Table 4‑3 Query #1 Results 35](#_Toc415502643)

[Table 5‑1 Accuracy Results for Desktop Application 42](#_Toc415502644)

[Table 5‑2 Accuracy Results for Web Application 43](#_Toc415502645)

[Table 5‑3 Accuracy Results for Mobile Application 44](#_Toc415502646)

[Table 5‑4 Functionality Test Results of the Different Cameras deployed on the Prototype 45](#_Toc415502647)

# List of Figures

[Figure 1.1 Project Development 2](#_Toc415502650)

[Figure 3.1 Input Process Output 6](#_Toc415502651)

[Figure 3.2 System Flowchart 7](#_Toc415502652)

[Figure 3.3 Desktop Application Flowchart A 8](#_Toc415502653)

[Figure 3.4 Desktop Application Flowchart B 9](#_Toc415502654)

[Figure 3.5 Web Application Flowchart 10](#_Toc415502655)

[Figure 3.6 Mobile Application Flowchart 11](#_Toc415502656)

[Figure 3.7 Illustrative Diagram 12](#_Toc415502657)

[Figure 3.8 Raspbian OS interface 14](#_Toc415502658)

[Figure 3.9 Ubuntu Server 12.04 LTS Desktop 16](#_Toc415502659)

[Figure 3.10 Windows Server 2012 R2 interface 18](#_Toc415502660)

[Figure 3.11 Software Development Life Cycle 20](#_Toc415502661)

[Figure 3.12 Dataflow Diagram 21](#_Toc415502662)

[Figure 3.13 Login Page 22](#_Toc415502663)

[Figure 3.14 Map Layout of Forest 23](#_Toc415502664)

[Figure 3.15 Live-Feed Channels 23](#_Toc415502665)

[Figure 3.16 Home Page 24](#_Toc415502666)

[Figure 3.17 Forest Condition 24](#_Toc415502667)

[Figure 3.18 Live-Feed Channels 25](#_Toc415502668)

[Figure 3.19 Forest Condition 25](#_Toc415502669)

[Figure 3.20 Cameras with Channels 26](#_Toc415502670)

[Figure 3.21 Application Drawer 26](#_Toc415502671)

[Figure 3.22 Emergency Hotlines 27](#_Toc415502672)

[Figure 4.1 Sample Ranking scale for percent Difference 28](#_Toc415502673)

[Figure 4.2 Development time in hours 29](#_Toc415502674)

[Figure 4.3 Python Sample Code 30](#_Toc415502675)

[Figure 4.4 Java equivalent codes 30](#_Toc415502676)

[Figure 4.5 Percent Difference of Design 1 and Design 2 for Time Constraint 31](#_Toc415502677)

[Figure 4.6 Percent Difference of Design 1 and Design 3 for Time Constraint 32](#_Toc415502678)

[Figure 4.7 Percent Difference of Design 3 and Design 1 for Economic Constraint 33](#_Toc415502679)

[Figure 4.8 Percent Difference of Design 3 and Design 2 for Economic Constraint 34](#_Toc415502680)

[Figure 4.9 Tester Interface 35](#_Toc415502681)

[Figure 4.10 Percent Difference of Design 3 and Design 2 for Performance Constraint 36](#_Toc415502682)

[Figure 4.11 Percent Difference of Design 3 and Design 1 for Performance Constraint 37](#_Toc415502683)

[Figure 5.1 Final Design of the Prototype 39](#_Toc415502684)

[Figure 5.2 Graphical User Interface of the Desktop Application 40](#_Toc415502685)

[Figure 5.3 Graphical User Interface of the Web Application 40](#_Toc415502686)

[Figure 5.4 Graphical User Interface of the Mobile Application 41](#_Toc415502687)

[Figure 5.5 Evaluation Result for the Accuracy of the Detection of Illegal Logging 45](#_Toc415502688)

[Figure 5.6 Evaluation Result for the Accuracy of the Detection of Forest Fire 46](#_Toc415502689)

[Figure 5.7 Evaluation Result for the Functionality of Cameras 46](#_Toc415502690)

[Figure 5.8 Evaluation Result for the Ease of Using Desktop Application 47](#_Toc415502691)

[Figure 5.9 Evaluation Result for the Ease of Using Web Application 47](#_Toc415502692)

[Figure 5.10 Evaluation Result for the Ease of Using Mobile Application 48](#_Toc415502693)

[Figure 6.1 Company Logo 49](#_Toc415502694)

[Figure 6.2 Graphical User Interface of Desktop Application 50](#_Toc415502695)

[Figure 6.3 Graphical User Interface of Web Application 51](#_Toc415502696)

[Figure 6.4 Graphical User Interface of Mobile Application 52](#_Toc415502697)

# List of Abbreviations

**AVC**  Advanced Video Coding

**CCTV**  Closed Circuit Television Camera

**DBMS**  Database Management System

**DFD**  Data Flow Diagram

**DENR**  Department of Environment and National Resources

**GPS**  Global Position Satellite

**JDBC**  Java Database Connectivity

**JDK**  Java Development Kit

**LAN**  Local Area Network

**NDRRMC**  National Disaster Risk Reduction and Management Council

**ODBC**  Open Database Connectivity

**PAGASA** Philippine Atmospheric, Geophysical and Astronomical Services Administration

**RPi**  Raspberry Pi

**SDLC**  Software Development Life Cycle

**SQL**  Structured Query Language

**SVC**  Scalable Video Coding

**UMRBPL** Upper Marikina River Basin Protected Landscape

**URL** Uniform Resource Locator

# Table of Contents

[FOREST ACTIVITY MONITORING SYSTEM i](#_Toc415523861)

[Approval Sheet ii](#_Toc415523862)

[Major (Capstone) Design Experience Information iii](#_Toc415523863)

[List of Tables vi](#_Toc415523864)

[List of Figures vii](#_Toc415523865)

[List of Abbreviations ix](#_Toc415523866)

[Table of Contents x](#_Toc415523867)

[CHAPTER 1: PROJECT BACKGROUND 1](#_Toc415523868)

[The Project 1](#_Toc415523869)

[Project Objectives 1](#_Toc415523870)

[The Client 1](#_Toc415523871)

[Project Scope and Limitation 2](#_Toc415523872)

[Project Development 2](#_Toc415523873)

[CHAPTER 2: DESIGN INPUTS 4](#_Toc415523874)

[Design Constraints 4](#_Toc415523875)

[Design Standards 4](#_Toc415523876)

[Software Requirements 5](#_Toc415523877)

[CHAPTER 3: PROJECT/SYSTEM DESIGN 6](#_Toc415523878)

[Input-Process-Output 6](#_Toc415523879)

[System Flowchart 7](#_Toc415523880)

[Illustrative Diagram 12](#_Toc415523881)

[Software Design 13](#_Toc415523882)

[Design 1: Using Raspberry Pi and Java Programming Language & MySQL for the Back-End of the System 13](#_Toc415523883)

[Design 2: Using Ubuntu Server and Python Programming Language & IBM DB2 for the Back-End of the System 16](#_Toc415523884)

[Design 3: Using Windows Server and C# Programming Language & MS Access for the Back-End of the System 18](#_Toc415523885)

[Software Development Life Cycle 20](#_Toc415523886)

[System Algorithm 21](#_Toc415523887)

[Data Flow Diagram 21](#_Toc415523888)

[Graphical User Interface 22](#_Toc415523889)

[CHAPTER 4: DESIGN TRADE-OFFS 28](#_Toc415523890)

[Design Trade-offs 28](#_Toc415523891)

[Influence of Mulitiple Constraints, Trade-offs and Standards in the Final Design 37](#_Toc415523892)

[CHAPTER 5: FINAL DESIGN 39](#_Toc415523893)

[Final Design 39](#_Toc415523894)

[Test Procedures and Evaluation 41](#_Toc415523895)

[Test Procedures 41](#_Toc415523896)

[Test Evaluation 42](#_Toc415523897)

[Test and Evaluation Results 42](#_Toc415523898)

[Test Results 42](#_Toc415523899)

[Evaluation Results 45](#_Toc415523900)

[Conclusion 48](#_Toc415523901)

[CHAPTER 6: BUSINESS PLAN AND MODEL 49](#_Toc415523902)

[Business Plan 49](#_Toc415523903)

[Executive Summary 49](#_Toc415523904)

[General Company Description 49](#_Toc415523905)

[Products/Services Offered 50](#_Toc415523906)

[Marketing Plan 53](#_Toc415523907)

[Business Model 54](#_Toc415523908)

[REFERENCES 55](#_Toc415523909)

[APPENDICES 56](#_Toc415523910)

[APPENDIX A Raspberry Pi Datasheet 57](#_Toc415523911)

[APPENDIX B MySQL Datasheet 63](#_Toc415523912)

[APPENDIX C WordPress Roles and Capabilities 69](#_Toc415523913)

[APPENDIX D IEEE 730-1998 Standard for Software Quality Assurance Plans 75](#_Toc415523914)

[APPENDIX E Ameritech Graphical User Interface Standards and Design Guidelines 80](#_Toc415523915)

[APPENDIX F Computations for the Accuracy Results 88](#_Toc415523916)

[APPENDIX G Clients’ Evaluation Form 93](#_Toc415523917)

# PROJECT BACKGROUND

## The Project

Based on the 2013 Department of Environment and National Resources (DENR) statistics, the Philippines has an aggregate land area of 30 million hectares. This is made up of certified alienable and disposable land (47.3%) and forestland (52.7%). Forests are key factor to life forms. The richer the diversity of life, the greater the opportunity for medical discoveries, economic development and adaptive responses to new challenges such as climate change.

Local and international agencies contribute efforts on maintaining and protecting forests. The Philippine government passed laws such as Presidential Decree No. 1 that limits the use of timbers and appointing to the problems of forest fires or the illegal cutting of trees. Despite those efforts, deforestation is still a persisting problem because there is no available mechanisms that can monitor the forest are real-time.

As solution to the problem discussed, the designers decided to develop Forest Activity Monitoring System. The design monitors the forest with the use of cameras and sensors. Live feeds can be viewed using a desktop, web and mobile application. The design also sends alerts to the devices when there is an activity happening within the forest such as illegal logging and forest fires.

The project benefits government agencies under the Department of Environment and National Resources (DENR) and some non-government agencies that protect the welfare of the environment especially protected landscapes and virgin forests.

## Project Objectives

The main objective of this project is to develop software applications for the Forest Activity Monitoring System that integrates image-processing technology in accordance with the engineering and software standards and consideration of trade-offs based on multiple constraints such as time, economic and performance.

Specific Objectives

* To develop an application that displays alerts on illegal logging and forest fire.
* To provide a real-time monitoring of the forest that can be viewed by developed applications.
* To test and evaluate the accuracy and functionality of the system.

## The Client

The intended clients of the design are agencies and organizations that protect and manage protected landscapes that are threatened by deforestation and issues that may harm the ecosystem and balance of nature. As of now, the designers are coordinating with the Upper Marikina River Basin Protected Landscape (UMRBPL) located in Anitpolo, Rizal. The UMRBPL is open to technological innovation in terms of the protection and monitoring of all the rainforest located in the area.

## Project Scope and Limitation

The design centers on monitoring the activities happening in the forest namely illegal logging and forest fires. The system focuses on interpreting the data received from the prototype and deploying it into different applications. All the data interpreted are stored in the central database, which is deployed in the server.

The system provides three applications specifically desktop, web and mobile applications. The desktop application is intended for administrators and forest rangers. The web application can be accessed through connecting with the wireless router and typing in the correct Uniform Resource Locator (URL) of the Forest Activity Monitoring System. Lastly, the mobile application is developed for mobility and portability of end-users.

## Project Development

Figure 1.1 shows the steps and processes to develop the project. The designers use the engineering design to define the problem and solve it by following the steps listed below.

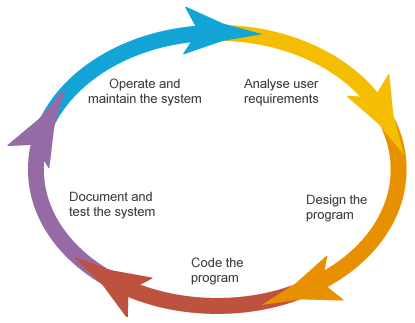


Figure 1.1 Project Development

**Analyze User Requirements**

The first step is analyzing what the users require in developing the project. The designers conducted series of interviews with the client to gather necessary data, forms and to recognize problems that exist within the forest. Forest activity monitoring in a consistent basis is a big challenge for forest rangers. The vast area that a protected landscape covers plays a big role in monitoring it. The larger the area the more number of forest rangers is needed to monitor the overall landscape. The problems are discussed by the designers to provide solutions.

**Design the program**

After discussing possible solutions to the problems, the designers must design a program to solve the problem. Designers must consider the devices that are used in accessing the application, the development cost, programming languages to be used, defining the data flow diagram and designing the interfaces.

**Code the program**

This phase is the actual coding and unit testing of the process by the development team.  After each stage, the developer may demonstrate the work accomplished to the client. Since tweaks and enhancements may be required, it is important for designers to be open-minded and flexible if and when any changes are necessary. This is normally the longest phase of the SDLC.  The finished product here is considered input to the Testing phase.

**Document and test the system**

Once the application is migrated to a test environment, different types of testing are conducted including integration and system testing. User acceptance testing is the last part of the testing process and is performed by the end users to ensure the system meets their expectations. At this point, defects may be found and more work may be required in the analysis, design or coding. Once all relevant parties obtain sign-off, implementation and deployment can begin.

**Operate and maintain the system**

The size of the project determines the complexity of the deployment.  Training may be required for end users, operations and on-call IT staff.  Rollout of the system may be performed in stages starting with one branch then slowly adding all locations or it could be a full-blown implementation.

One of two methods can be followed in a SDLC process.  Waterfall is the more traditional model and has a structured plan and requirements to be followed.  This method works well for large projects that may take many months to develop.  The Agile Methodology is more flexible in the requirements, design and coding process and is very iterative.  This process works best for smaller projects and expectations of continuous improvement to the application.  Whether you use one over the other also depends to a large extent on the corporation and skills of the Information Technology department.

# DESIGN INPUTS

## Design Constraints

The design entitled Forest Activity Monitoring System is bounded by specific parameters and design constraints to attain a system that conform to standards. The following are the constraints that were considered in the system:

**Time (Development)**

The time to develop, implement and synchronize the software with the hardware such as sensors and cameras plays a big role in designing the project. The software went through rigorous testing and debugging before deploying it to the market and/or industry. Time is the main factor to consider in designing the system.

The designers must adjust with the given time to finish the system. One of the plans that the designers proposed was to use agile process in developing the software and at the same time distributing modules equally to each member of the group.

**Economic (Development Cost)**

Development cost can have significant effects on the design. It requires the estimation of a number of items such as the extent of off-the-shelf-hardware requirements, design risks in implementing technologies to conform to the objectives of the project and other related costs for the development of the system.

The designers have to provide a system that is economically feasible for implementation and development. They have to choose from a variety of options currently available in the market as well as choose the right software and other related applications.

**Performance (Data Processing)**

Software can be defined as an automation of passing and retrieving of data. Being said, reliability of data that the system provides is an important factor and also a constraint. The system must provide reliable data, which the hardware provides, as well as the processing of the said data.

The designers must provide reliable queries that can access and retrieve data from the database. A well-designed database and well-constructed queries are an effective way to overcome the constraint of performance.

## Design Standards

The designers followed specific software standards for the development of the project design.

**WordPress Roles and Capabilities**

As stated on Section 3, a role defines a set of tasks a user is allowed to perform. Each user is assigned a role. For instance, the [Super Admin](http://codex.wordpress.org/Super_Admin_Menu) role encompasses every possible task that can be performed within a [Network](http://codex.wordpress.org/Glossary#Network) of virtual WordPress [sites](http://codex.wordpress.org/Glossary#Site). The [Administrator](http://codex.wordpress.org/Roles_and_Capabilities#Administrator) role limits the allowed tasks to only those that affect a single site. On the other hand, the [Author](http://codex.wordpress.org/Roles_and_Capabilities#Author) role allows the execution of just a small subset of tasks. The applications developed conform to all the tasks and set of functions that an administrator can use.

**IEEE STD 730-1998 IEEE Standard for Software Quality Assurance Plans**

As discussed in the Section 4.4.2.2 of this standard, the Software Design Description (SDD) shall depict how the software can be structured to satisfy the requirements in the Software Requirement Specification. The SDD shall describe the components and subcomponents of the software design, including databases and internal interfaces. The SDD shall be prepared as the Preliminary SDD (also referred to as the top-level SDD) and shall be subsequently expanded to produce the detailed SDD. With regards to implantation of this standard, the designers developed applications that follow the software quality assurance.

**Ameritech Graphical User Interface Standards and Design Guidelines**

As stated on Section 5.3.2.1, a well- designed application minimizes the number and severity of errors. The closer the application matches the user’s task, the more likely errors be prevented. The use of interface objects like radio buttons, check boxes and pop-up menus serve to prevent errors, because the application relies on the user to make a choice from pre-defined sets. The applications provide a combo box that gives end-users an option to choose from different channels on which they can view the live feed.

## Software Requirements

**Java Programming Language**

Java Programming Language is one of the languages that the designers considered using in designing the desktop and mobile application, intended for administrators of the target client. Netbeans IDE and Eclipse IDE were used in developing the said applications respectively.

**PHP and HTML/CSS**

PHP was used as the script for the functionalities of Web Application and Mobile Application. All forms of the web application implements the use of PHP. HTML and CSS were used to design the webpage of the project design. The web page is intended for end-users to provide data about the forest and its status.

**Database Query**

Database Queries was used to manage the data that can be gathered from the outputs of the blackbox to the database in the server

# PROJECT/SYSTEM DESIGN

## Input-Process-Output

Figure 3.1 shows the procedures and processes in designing the project. All the inputs are prepared and gathered before undergoing the processes. The process is made up of different engineering methodologies needed toward in the accomplishment of the project.



**OUTPUT**

**PROCESS**

**INPUT**

Figure 3.1 Input Process Output

The inputs are made up of knowledge requirements, hardware requirements, software requirements and multiple constraints and engineering standards. The knowledge requirements consist of programming, data manipulation and image processing. The said requirements are the essential parts in developing the system.

The hardware requirements consist of the Wireless Router, Closed Circuit Television Camera (CCTV) and Sound & Vibration Sensors. The wireless router is used as a bridge of the hardware components and software. It gives out IP addresses to the devices that are connected to the system. The CCTV provides the live feed for the end-users and provides the images that are used in implementing image processing technology. Lastly, the sensors are the one to detect abnormalities within the forest and send the data to the software.

The software requirements consist of JAVA Programming, PHP and HTML/CSS and Database Queries. PHP Scripting for the Web Application can be uploaded in a domain intended for Internet users to constantly update them in the condition of the forest. Android programming for the convenience of the common end-users of the system, in which they can view news and updates and at the same time live feeds of the forest.

The process in the illustration refers to the engineering methods to be taken. The data gathering in which all the possible technologies that can be used in development are researched as well as methods are best to achieve the objectives of the project.

## System Flowchart

Figure 3.2 shows how the system works from the initialization of the hardware components such as the CCTV and the sensors up to the output generated in the desktop, web and mobile applications. It also discusses the system behavior when certain conditions meet.

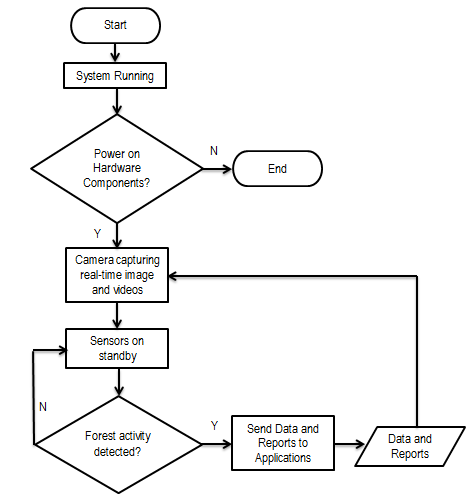


Figure 3.2 System Flowchart

The process starts by initializing and powering on the hardware components on accepting inputs from the CCTV and sensors that are deployed in the forest. The inputs are then passed to the devices through the wireless router and processed within the desktop application using image processing. The processed data can now be viewed in applications.

**Desktop Application**

The desktop application works from the logging in as a user up to the output of generated information from the sensors and CCTV.

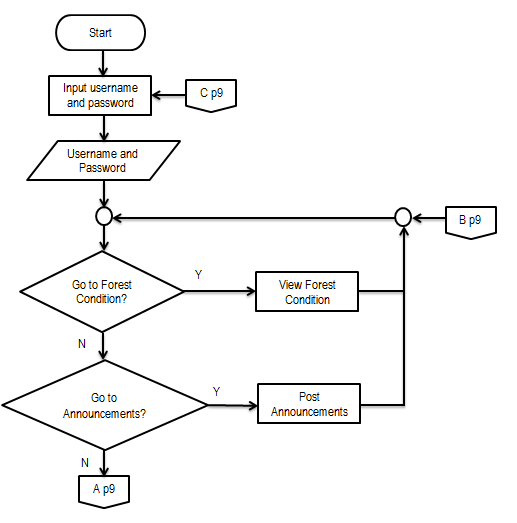


Figure 3.3 Desktop Application Flowchart A

As illustrated on Figures 3.3 and 3.4. The desktop application starts by logging in. A user is given several functions such as viewing forest condition, posting announcements, viewing of camera channels and reviewing inquiries and reports.

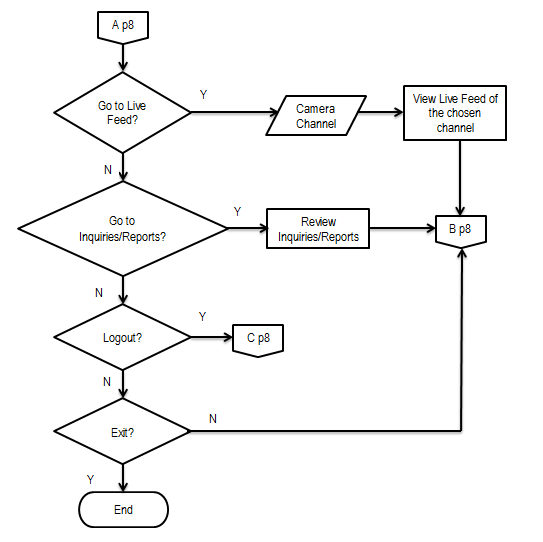


Figure 3.4 Desktop Application Flowchart B

**Web Application**

Figure 3.5 shows the flow of the web application. The web application is intended for basic users to provide updates and current reports and announcements in the forest vicinity.

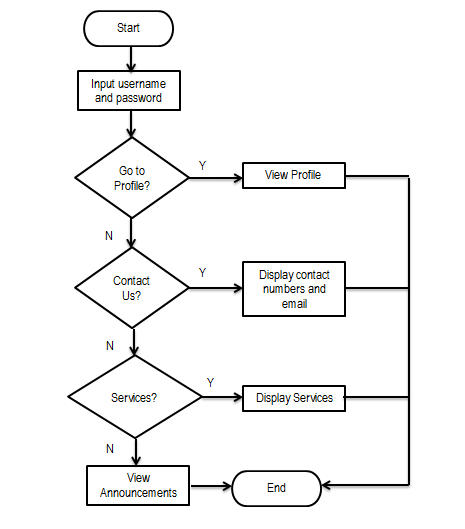
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Figure 3.5 Web Application Flowchart

The process in the web application starts with a login prompt for a user to use and acquire functions of the application depending on the accessibility of that user. A user can view current reports and announcements and contact the developers or officials if an issue arises.

**Mobile Application**

Figure 3.6 shows the processes involved in the mobile application from logging in up to acquiring functionalities of the system as viewing of profile, viewing announcements and viewing of live feed.

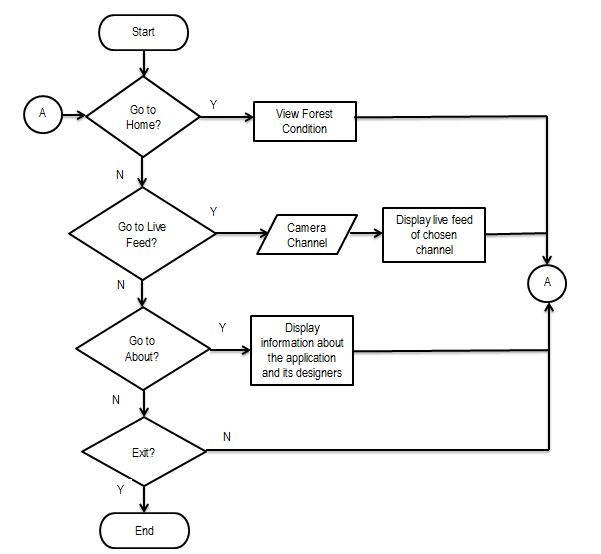


Figure 3.6 Mobile Application Flowchart

The process in the mobile application also starts with a login prompt from the user and provides three functions such as viewing of live feeds, updates including current reports and announcements and report a problem if ever an issue occurs.

## Illustrative Diagram

Figure 3.7 shows the illustrative diagram and the components used in the design of the project. Each component is enumerated below:

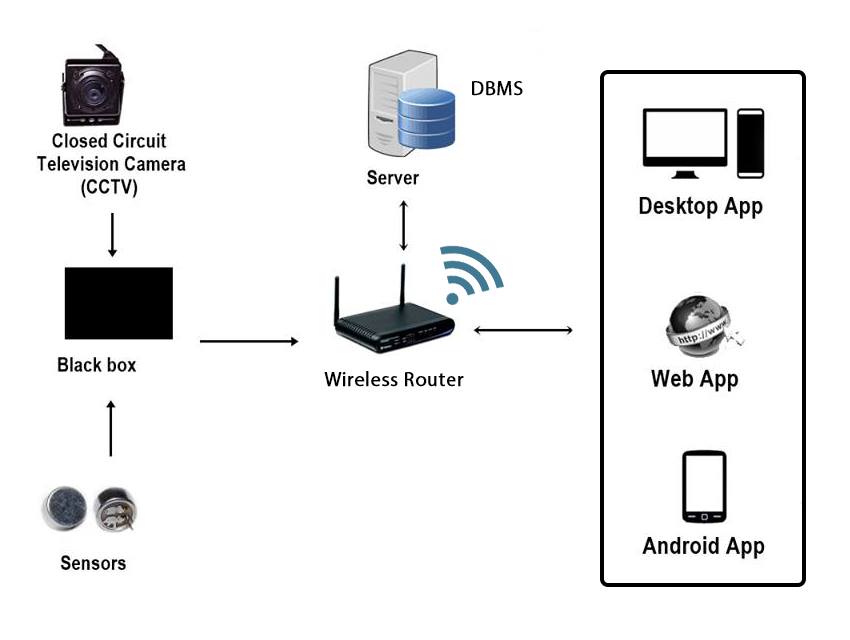


Figure 3.7 Illustrative Diagram

**Wireless Router**

Wireless Routers are devices that allow computers to connect to a local area network (LAN) through wireless connections. It is used as a bridge to connect the hardware components as well as the Closed Circuit Television Camera (CCTV).

**Closed Circuit Television Camera (CCTV)**

CCTVs are installed within the forest vicinity for surveillance purposes of what is really happening in the forest. This is the primary source of live feeds that can be viewed in the applications.

**Server**

A server is a program that awaits and fulfills requests from client programs in the same or other computers. Images and Databases are saved in the server. The desktop application communicates with the server to provide all necessary information for the end-users.

**Database Management System (DBMS)**

Database Management System is a collection of programs that enables the users to store, modify, and extract information from a database.

**Blackbox**

The blackbox contains all the electrical components that the hardware team designed to provide data needed by the software team.

## Software Design

The functionality of the design is to process all the data coming from the sensors and cameras deployed within the prototype of the system. The desktop application acts as the core of the system in receiving and processing the said data.

In determining the needed parameters for the detection of illegal logging and forest fires, the designers created a mechanism to simulate cutting of trees that produces sound and vibration simultaneously to send frequency data and installed cameras for a continuous snapshot of the top view and implement image processing technology by the desktop application.

Desktop, Web and Mobile Application have stand-alone coding schemes to provide the end-users the live-feed of the cameras. The server handles all the information processed by the blackbox and also contains the database of the system, web pages and images for the Web Application. The programming languages used for the development of Web and Mobile Application are PHP and Java respectively. The codes for the

All the applications followed certain standards discussed on Chapter 2 (pp. 4). Administrators of each application were given certain privileges stated on standard of WordPress Roles and Capabilities (see Appendix C). The applications also went through rigorous planning and assessment before implementation defined by the Standards for Software Quality Assurance Plans (see Appendix D). Lastly, the most important thing for end-users was the GUI of each application. The designers considered the Ameritech Standards for Graphical User Interface (see Appendix E).

### Design 1: Using Raspberry Pi and Java Programming Language & MySQL for the Back-End of the System

#### Programming Language

The core of the system for all the processing of data received from the blackbox coming from the sensors and cameras is the desktop application. The programming language used is the Java Programming Language. Java is a class-based and object-oriented programming language.

The main function of the desktop application is the image processing for the detection of forest fires. The library JAVACV is imported to support image processing in the java development kit (JDK). It is used to fetch images, captured by the camera, from the server containing the database and processed it for the coded algorithm.

The application is intended for administrators and forest rangers. The designers made use of classes and objects for the development and also conform to the standard stated on WordPress Roles and Capabilities (see Appendix C) for the set of functions that an administrator of a certain program has.

#### Server

The Raspberry Pi (RPi) as illustrated on Figure 3.8 functions as the server of the system. The required power supply of the RPi is at least 700mA at 5v for it to operate properly. It contains the database of the system and all the web pages for the web application. Raspbian is installed for the operating system of the RPi. It requires at least 8GB SD Card for its memory. For the datasheet of the RPi see Appendix A.

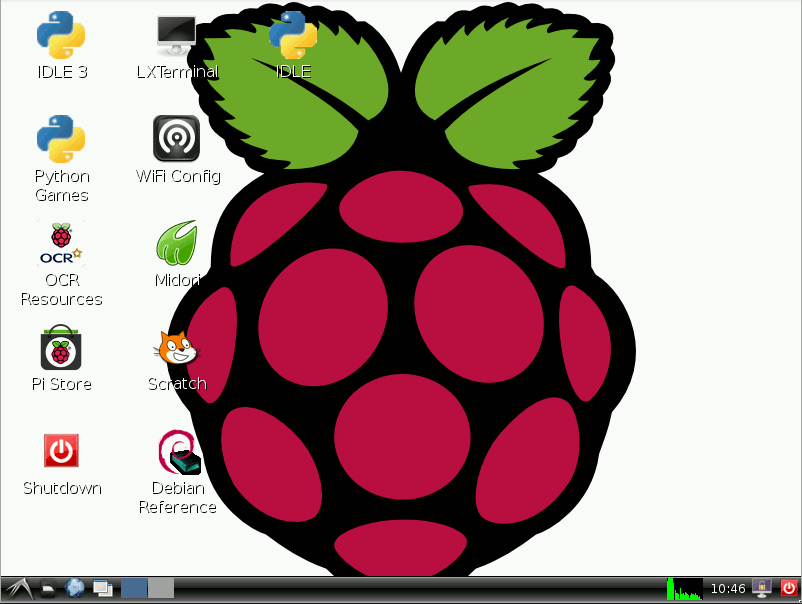


Figure 3.8 Raspbian OS interface

#### Database Management System

The database management system used is the MySQL. It is known to be the world’s most popular open-source database. The MySQL™ software delivers a very fast, multi-threaded, multi-user, and robust SQL (Structured Query Language) database server. MySQL Server is intended for mission-critical, heavy-load production systems as well as for embedding into mass-deployed software. Oracle is a registered trademark of Oracle Corporation and/or its affiliates. MySQL is a trademark of Oracle Corporation and/or its affiliates, and shall not be used by Customer without Oracle's express written authorization. Other names may be trademarks of their respective owners.

**Time**

The designers considered Java to be the core programming language because of the familiarity of the programmers and at the same time it provides classes for easy manipulation of functions. Java usually takes a lot of time to develop a single application but supported with many libraries and supports integrated development environment (IDE).

**Economic**

RPi is ideal to use as the server of the system because it only requires one-time purchase and feasible to handle all the data that the prototype sends. The operating system that was used was the Raspbian OS which is downloadable for free.

#### Development Cost

Table 3‑1 Needed Cost for the Development of the System Using Design 1

|  |  |
| --- | --- |
| **Application Developers** | **Cost** |
| Java Developer | ₱43, 500.00 |
| Web Developer | ₱37, 375.00 |
| Android Developer | ₱36, 329.00 |
| Database Developer | ₱14, 000.00 |
| **Materials** |  |
| Raspberry Pi (RPi) | ₱2, 300.00 |
| 8GB SD Card | ₱600.00 |
| **Software & Application Tools** |  |
| MySQL | ₱0.00 |
| **TOTAL** | ₱134, 104.00 |

For the development cost of the system as shown in Table 3-1, several materials and personnel expenses are considered. The three developers for each of the application are paid with the average monthly salary of developers by their expertise. The zero (0) cost for the MySQL is because the software is open-source and does not require any payment for its services.

**Performance**

MySQL is one of the known and popular open-source databases. The designers used it as the main database management system and can run through different platforms at fast execution times of queries. One of the factors also is the familiarity with the said DBMS along with the needed queries to make a connection between applications to the server.

### Design 2: Using Ubuntu Server and Python Programming Language & IBM DB2 for the Back-End of the System

#### Programming Language for Desktop Application

The Python Programming Language is used for the development of the desktop application. It has efficient high-level data structures and a simple but effective approach to object-oriented programming. Python’s elegant syntax and dynamic typing, together with its interpreted nature, make it an ideal language for scripting and rapid application development in many areas on most platforms.

The python imports the library OpenCV. OpenCV provides real-time image processing which is essential for the detection of forest fires. The top camera takes snapshots of smoke (if any) for comparison of the previous and the new image and detects a certain percentage to declare that a forest fire is currently happening on a certain sector.

#### Server

The design is to have a virtual machine to run an Ubuntu Server 12.04 LTS. It contains the IBM DB2 database and all the web services that the web application offers to the end-users. Along with the system unit that runs the desktop application, a virtual machine can be processed along with it to remove one physical component.

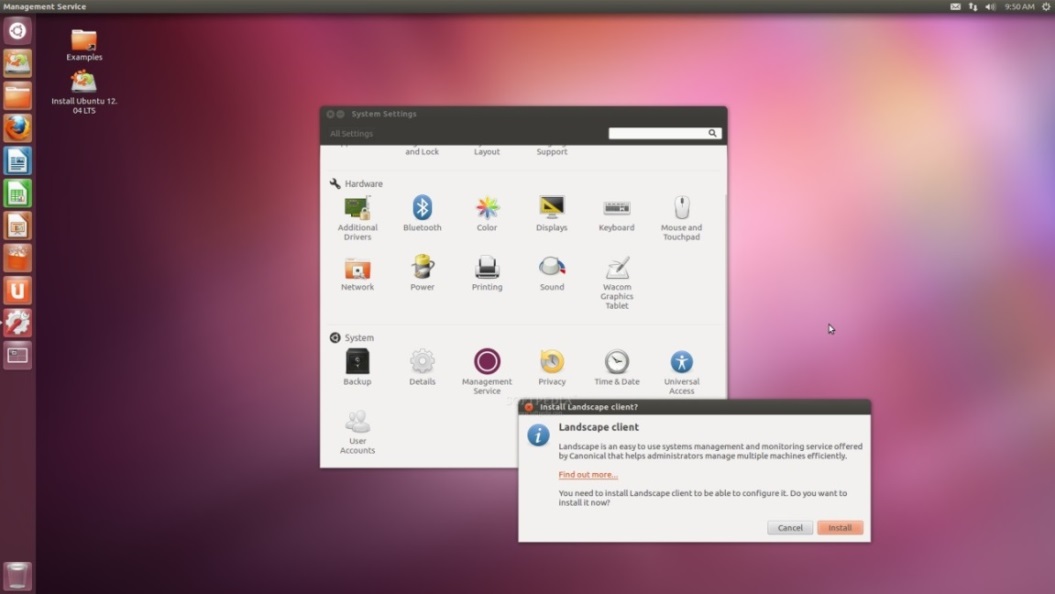


Figure 3.9 Ubuntu Server 12.04 LTS Desktop

Figure 3.9 shows the user interface of the Ubuntu Server 12.04 LTS when successfully installed into a virtual machine or even in a system unit itself.

#### Database Management System

IBM DB2 database software offers industry leading performance, scale, and reliability on your choice of platform from Linux, UNIX and Windows to z/OS.

**Time**

Python provides the shortest amount of time to code because it does not need unnecessary characters like braces and parentheses. It just follows a syntax typing mode of programming that consumes a less time. The project is time-bounded so the designers considered Python as the core of the system.

**Economic**

The designers considered using Ubuntu Server to act as the server of the whole system. Installation of Ubuntu Server does not require any cost and can be downloaded free on the Internet. The use of Ubuntu Server is for the future implementation of the system. Ubuntu Server can handle a lot of information and data at the same time which is feasible for a large number of end-users.

#### Development Cost

Table 3‑2 Needed Cost for the Development of the System Using Design 2

|  |  |
| --- | --- |
| **Application Developers** | **Cost** |
| Python Developer | ₱36, 329.00 |
| Web Developer | ₱37, 375.00 |
| Android Developer | ₱36, 329.00 |
| Database Developer | ₱14, 000.00 |
| **Software & Application Tools** |  |
| Ubuntu Server 12.04 LTS | ₱0.00 |
| IBM DB2 | ₱1, 810.00 |
| **TOTAL** | ₱125, 843.00 |

For the development cost of the system as shown in Table 3-2, several materials and personnel expenses are considered. The three developers for each of the application are paid with the average monthly salary of developers by their expertise. Zero (0) cost for the Ubuntu Server 12.04 LTS is because the software is open-source and does not require any payment for its services.

**Performance**

IBM DB2 serves a number of different operating system platforms. According to IBM, DB2 leads in terms of database market share and performance. It can be also accessed from any application program using Microsoft’s Open Database Connectivity (ODBC) and Java Database Connectivity (JDBC).

### Design 3: Using Windows Server and C# Programming Language & MS Access for the Back-End of the System

#### Programming Language for Desktop Application

C# was chosen as the back-end of the system for the desktop application because it provides a whole lot of functions. The only drawback of the C# is the presentation of its user interface.

The core of the system for all the processing of data received from the blackbox coming from the sensors and cameras is the desktop application. The programming language used is the C# Programming Language. C# has the drawback regarding its user interface but overall it works properly in handling and processing all the necessary data.

The main function of the desktop application is the image processing for the detection of forest fires. The library OpenCV is imported to support image processing. It is used to fetch images, captured by the camera, from the server containing the database and processed it for the coded algorithm.

#### Server

The design is to have a virtual machine to run a license Windows Server 2012 R2 Essentials. It contains the Microsoft Access database and all the web services that the web application offers to the end-users. Along with the system unit that runs the desktop application, a virtual machine can be processed along with it to remove one physical component. As shown in Figure 3.10, the interface of Windows Server 2012 R2.

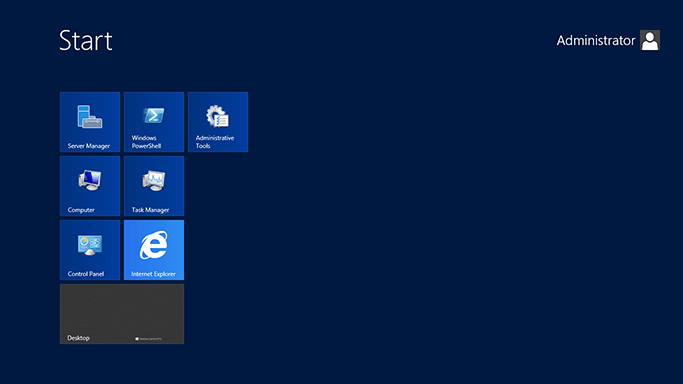


Figure 3.10 Windows Server 2012 R2 interface

#### Database Management System

Microsoft Access, also known as Microsoft Office Access, is a database management system from Microsoft that combines the relational Microsoft Jet Database Engine with a graphical user interface and software-development tools. It is a member of the Microsoft Office suite of applications, included in the Professional and higher editions or sold separately.

**Time**

C# is one of the oldest programming language and proven to take a less time in developing a certain application. It does not also require any Integrated Development Environment (IDE).

**Economic**

Windows Server costs a lot when being implemented as the server of the system but provides a whole lot of functions that whole system may ask for. A future implementation of the project is in mind of the designers in the time that the Windows Server was used as the server.

#### Development Cost

Table 3‑3 Needed Cost for the Development of the System Using Design 3

|  |  |
| --- | --- |
| **Application Developers** | **Cost** |
| C# Developer | ₱33, 323.00 |
| Web Developer | ₱37, 375.00 |
| Android Developer | ₱36, 329.00 |
| Database Developer | ₱14, 000.00 |
| **Materials** |  |
| Windows Server 2012 R2 Essentials | ₱22, 044.00 |
| Microsoft Access | ₱4, 840.00 |
| **TOTAL** | ₱147, 911.00 |

For the development cost of the system as shown in Table 3-3, several materials and personnel expenses are considered. The three developers for each of the application are paid with the average monthly salary of developers by their expertise.

**Performance**

MS Access provides a stand-alone application that can store and send data to the applications and the server of the system. The construction of queries was coded in the simplest form and still provides the needed output for the system. A simple and well-constructed query increases the performance of the database management system and at the same time the passing of data through the network.

### Software Development Life Cycle

The Software Development Life Cycle (SDLC) process applies to information system development projects ensuring that all functional, user requirements, agency strategic goals and objectives are met. The SDLC that was used was the Agile Process (see Figure 3.11) The SDLC provides a structured and standardized process for all phases of any system development effort.

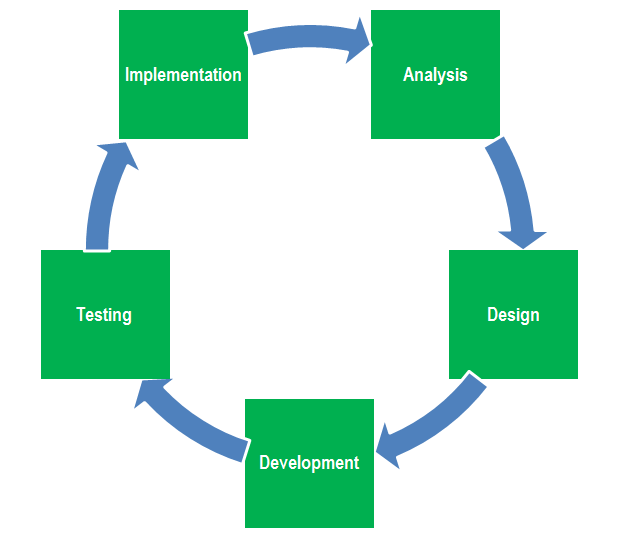
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Figure 3.11 Software Development Life Cycle

SDLC contains the following stages:

1. **Analysis**

The initial phase started by defining the requirements that the client needs. The group then did necessary research for technologies and processes that can be useful in designing the project.

2. **Design**

When the project really starts to take form, the designers planned out all the inputs, outputs, interfaces, processes for the project and created the system design specification from this data. The database design must also be finalized. The requirements were translated into representation of the software that can be assessed for quality before coding begins.

3. **Development**

The development phase was where the group started to connect the desktop application with the web and mobile application.

4. **Testing**

In this phase, the final output was tested with the forest rangers and administrators of the client.

5. **Implementation**

There were three stages of implementation a) Coding - In this process, the design was translated into a machine-readable form and if the design was performed in a detailed manner, code generation can be accomplished mechanistically. b) Testing - After coding, the team made a prototype model to ensure that system meets the needs of the customers. c) Installation - The designers installed the product and convert it into customer existing format.

### System Algorithm

The system focused on illegal logging and forest fire. The illegal logging is detected through the prototype’s mechanism that produces sound and vibration simultaneously. A forest fire is detected through the use of image processing technology. The top camera captures snapshots that were used for the image processing. The sound and vibration sensors and CCTV sends data to the blackbox for processing. Then, the blackbox filters the frequency data and provides information to the Raspberry Pi.

All the information can now be fetched by the different applications.

### Data Flow Diagram

A data flow diagram (DFD) is a graphical representation of the flow of data through an information system, modeling its process aspects. A DFD is often used as a preliminary step to create an overview of the system, which, can be elaborated. The DFD of the system is shown in Figure 3.12

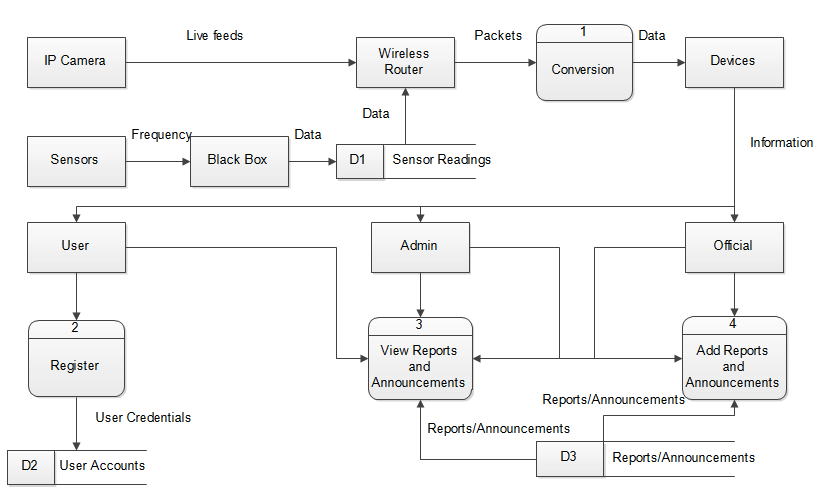


Figure 3.12 Dataflow Diagram

The data have to undergo multiple stages and procedures as it passes through the system. The starting values are the data that is transmitted by the hardware components. The data is sent to the devices including web and mobile applications.

The processes include the conversion of the frequency data that is sent by the router into the desktop application and can be viewed with the web and mobile application. The output of the live feed videos from the cameras can be viewed in the desktop application and mobile application for mobility and portability of end-users.

### Graphical User Interface

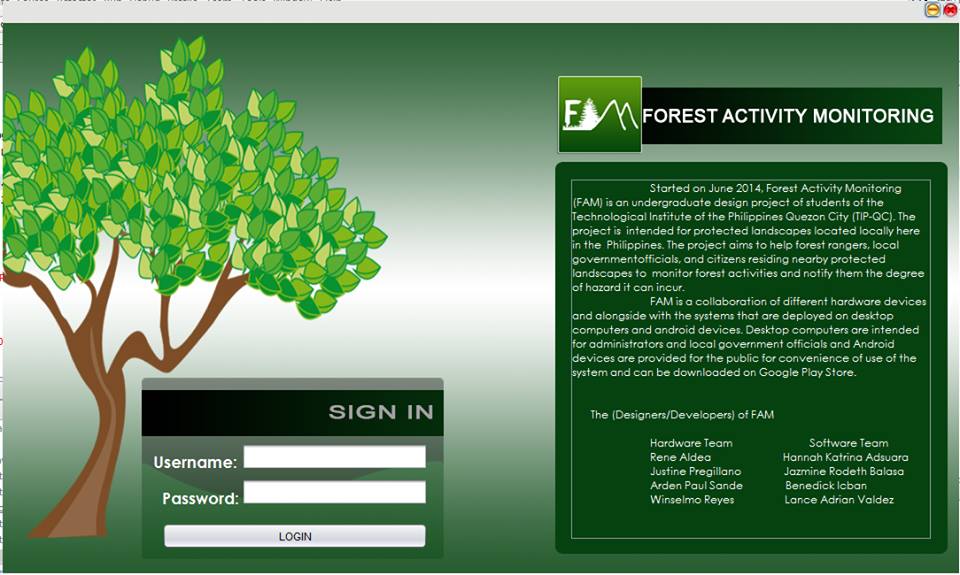
The designers provided user interfaces for the desktop, web and mobile applications that are illustrated below.

#### Desktop Application

The application is deployed in the offices of the forest rangers and officials of the client to provide them the authority in creating and updating information that are sent out to the web and mobile application.

Once the application starts it prompts the Login Page as shown in Figure 3.13. The application provides four level of access to users classified as super administrator, administrator, officials and basic users. Administrator roles are discussed on Chapter 2 and can be further reviewed on Appendix C.

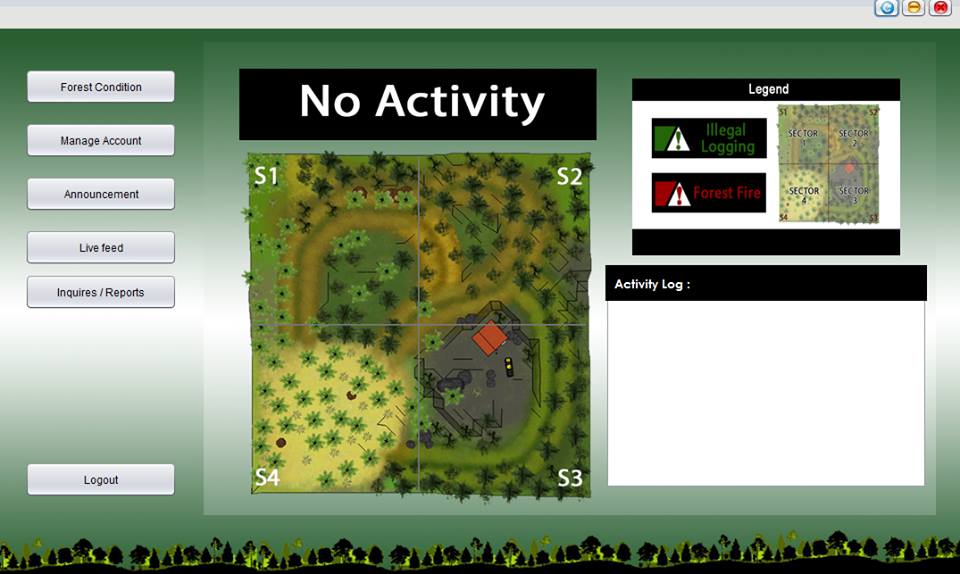
Minimize and Exit Button

****

Sign-in / Login credentials

Figure 3.13 Login Page

As illustrated on Figure 3.14, the map layout of the forest. The layout is the graphical representation of the top view of the forest. The layout is also divided into four sectors which alerts end-user if there is an illegal logging or forest fire happening in the forest.



Logout Button

Current Forest Condition

Forest Sectors

Services Offered

Forest Activity Legend

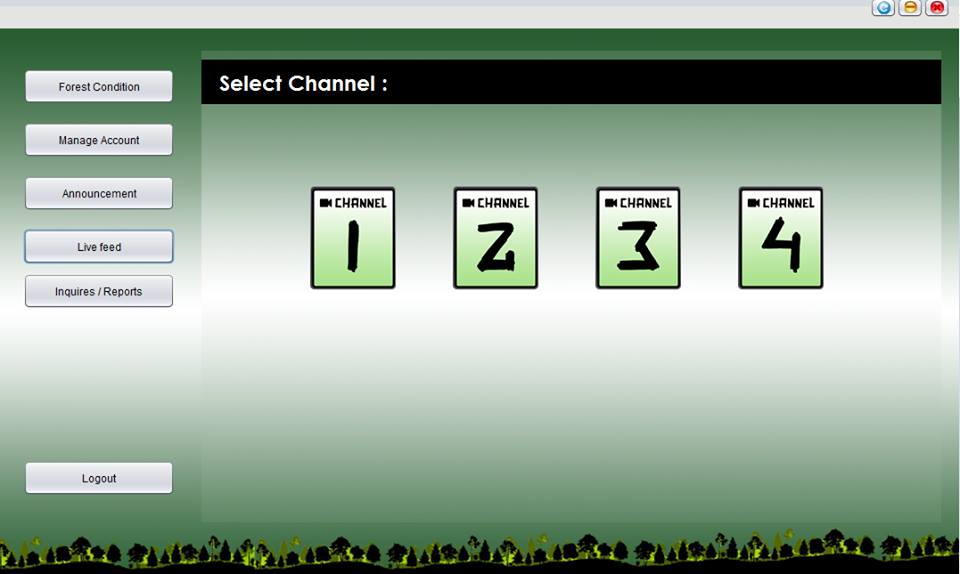
Minimize and Exit Button

Activity Log

Figure 3.14 Map Layout of Forest

As shown in Figure 3.15, desktop application provides four (4) different channels for the live feed of the forest. Users can choose from one of those and can monitor the forest.

Services Offered



Camera Channels

Logout Button

Minimize and Exit Button

Figure 3.15 Live-Feed Channels

#### Web Application

The web application is hosted with the use of public domain of the Internet so that every user can access the application with use of web browsers connected to the Internet.

In accessing the website application, the application shows news from the DENR and other environmental issues that the country currently faces shown in Figure 3.16. It also provides weather forecasts coming from the Philippine Atmospheric, Geophysical and Astronomical Service Administration (PAGASA).



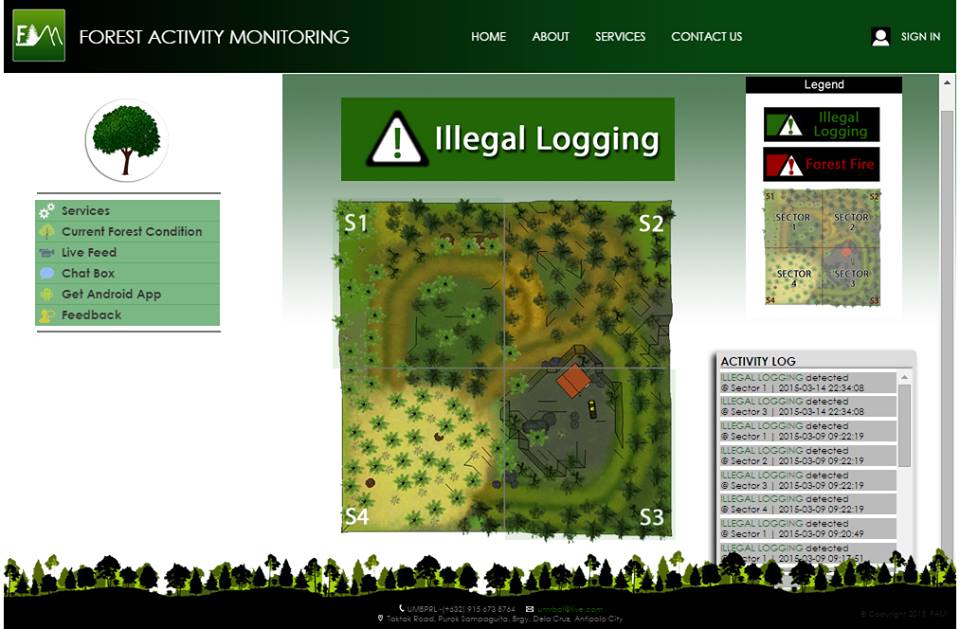
Weather Forecast

Advertisements

Announcements

Figure 3.16 Home Page

As illustrated on Figure 3.17, one of the main features of the web application is to show the condition of the forest by quadrant and know what the condition, namely: Illegal Logging and Forest Fires.



Services Offered

Activity Log

Forest Activity Legend

Forest Sectors

Current Forest Condition

Figure 3.17 Forest Condition

The application also provides live feed coming from the cameras deployed in the forest (refer to Figure 3.18) and at the same time provide five (5) channels. Channel 0 gives the overall view of the forest; Channel 1, 2, 3 and 4 provides the view of Quadrant One (1), Two (2), Three (3) and Four (4) respectively.



Camera Channels

Services Offered

Figure 3.18 Live-Feed Channels

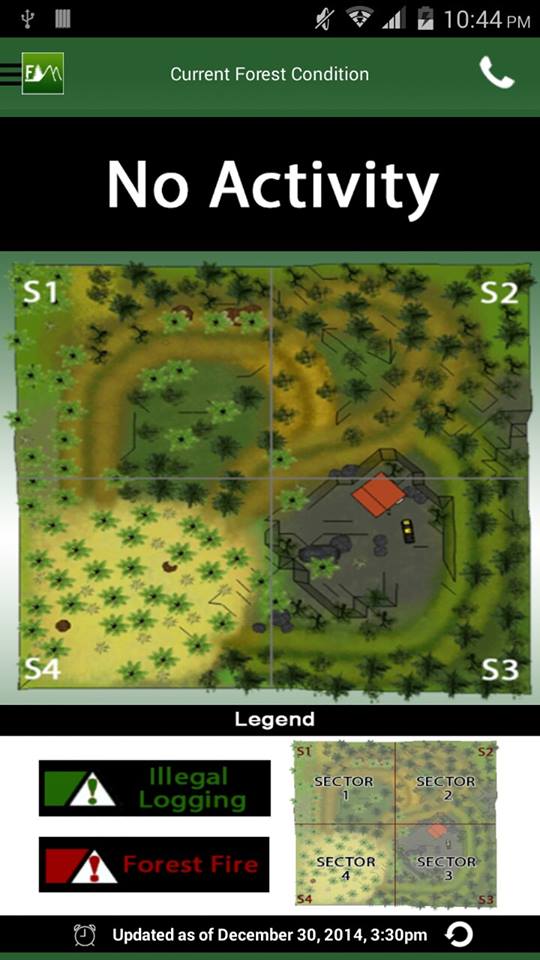
#### Mobile Application

A mobile application is developed for the convenience of users and to provide the same features as the web application as discussed. Another factor that was considered is the portability of an android device that can be easily accessed just by installing the application and connecting to the server of the system.

The forest is divided into four quadrants and shows the condition of each quadrant with a specific legend as shown in Figure 3.19. The conditions in which user can see are as follows: Illegal Logging and Forest Fire.

Emergency Hotlines

Application Drawer



Legend of Forest Conditions

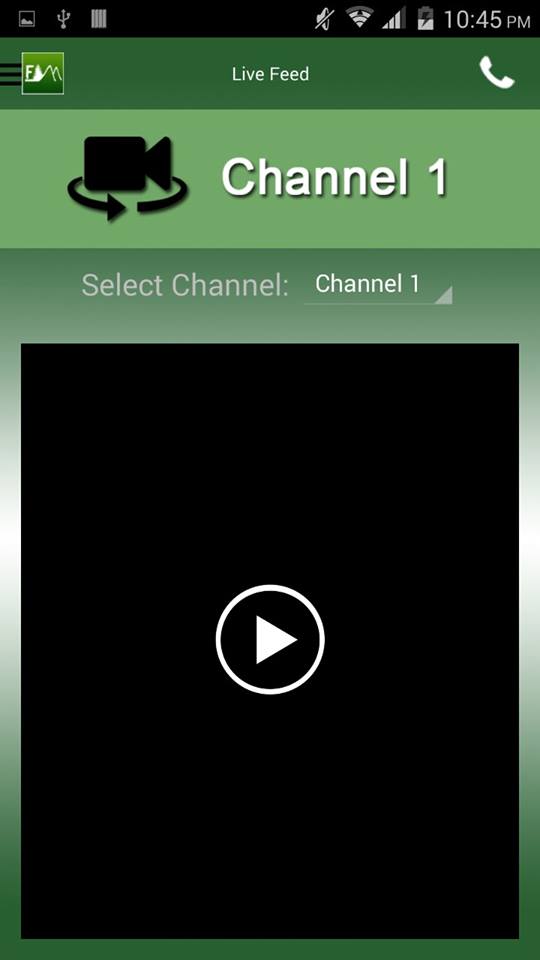
Reload Button

Forest Layout divided into four sectors

Current Forest Condition

Figure 3.19 Forest Condition

As illustrated on Figure 3.20, mobile application provides live feed coming from the cameras deployed within the forest. The user can choose from 5 different channels to surveillance all parts of the forest.Channel 0 gives the overall view of the forest; Channel 1, 2, 3 and 4 provides the view of Quadrant One (1), Two (2), Three (3) and Four (4) respectively.

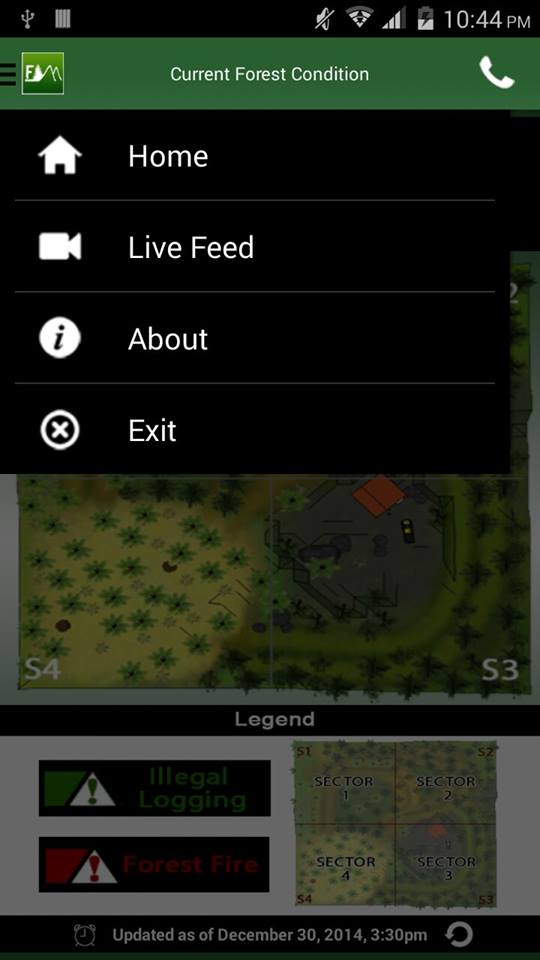


Live feed of the selected channel

Camera Channel Selection

Figure 3.20 Cameras with Channels

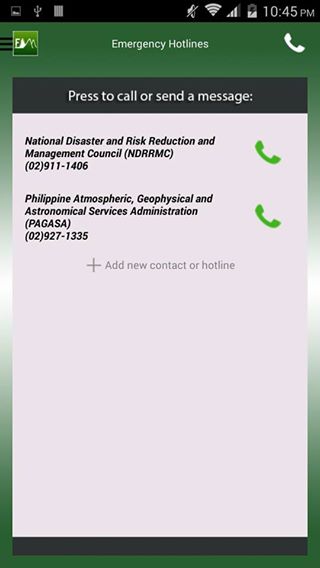
As seen on Figure 3.21, is the application drawer that defines the functions that user is given, namely: Redirecting to Home, Live Feed, Updates, About, Report a Problem and Exiting the application.



Application Drawer

Figure 3.21 Application Drawer

A user can view some of the emergency hotlines that can be dialed in case of unwanted accidents and emergencies (illustrated on Figure 3.22).



Add Hotline

Contact Details

Figure 3.22 Emergency Hotlines

# DESIGN TRADE-OFFS

## Design Trade-offs

Trade-offs are goals that are set to satisfy the time, economic and performance constraints. Trade-offs used to analyze an alternative solution and compare different programming languages and database management system in order to achieve the objectives of the project. The languages used for the design should not take a lot of time in developing it, the cost of development and implementation is feasible and does not lag behind in terms of time. The construction of queries in the database should provide fast execution time because the project is time bounded.

The design for Forest Activity Monitoring System, trade-offs on the programming languages that were used namely: Java, Python and C# for time constraint, the servers to be implemented: Raspberry Pi (RPi), Ubuntu Server 14.02 LTS and Windows Server 2012 R2 Essentials for the economic constraint and the database management system to be used: MS Access, MySQL and IBM DB2 for the performance constraint.

In order to determine the desirable materials that were pursued in the latter design stage, the selection uses the trade-off strategies (Otto and Antonsson, 1991). Using the method of imprecision, the ranks normalized by the range of the ranking. Also, the importance ratings normalized by their sum. The results of this calculation are shown on Table 4-1.

Computation of ranking for ability to satisfy criterion of materials:

Eq 4.1

Eq. 4.2

Governing rank is the subjective choice of the designer. The governing rank is based on the initial estimated value the designer has initially selected. The designers also subjectively give the value for the criterion importance and ability to satisfy the criterion. The subordinate rank is a variable that indicates percentage distance from the governing rank along the rank scale. The subordinate rank computed based on Eq. 4.2.

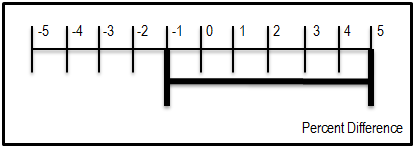


Figure 4.1 Sample Ranking scale for percent Difference

Figure 4.1 shows that the distance determined by getting the product of the percent difference and the number of scale which is 10. The number of stride from the governing value is determined by the product.

After considering the design constraints, the designers came up with the initial rankings on the designs to be used. The explanations and discussion on how the designers came up with the raw ranking values are shown and computed below.

Table 4-1 Designers Raw Ranking for the Three Designs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Decision Criteria** | **Criterion’s Importance**  **(on a scale of  0 to 5)** | **Ability to satisfy the criterion**  **(on a scale from -5 to 5)** | | |
| **Design 1** | **Design 2** | **Design 3** |
| 1. Time (Development) | 5 | 5 | -3 | 3 |
| 2. Economic (Development Cost) | 4 | 4 | 3 | 4 |
| 3. Performance (Data Processing) | 3 | 4 | 4 | 3 |
| **Over-all Rank** | | **53** | **9** | **40** |

*Reference:* (Otto, 1991)

In determining the trade-offs of the software designs, the designers allocated respective values of importance per criterion. For the data processing, the designers set the criterion importance to three (3) due to the consideration of incoming data from the devices and sensors deployed in the forest. The designers decided to set the importance of Economic Constraint to four (4) since in software development, costs plays big role for all the software components to be working and communicating efficiently. Thus, it depends on the services that paid, including the developers. The importance of time development of the system has been set to five (5) since the project making and system implementation are time-bound.

**Trade-off 1: Time (Development)**

Productivity is probably the most important factor when choosing a language.  As the founder of Slideshare, Jonathan Boutelle said when asked if he regretted using Ruby instead of Java in his response was that the question was moot, that he would not even be there talking if he had use Java. Sure Java would have scaled better and Ruby had concurrency issues but Slideshare would not have succeeded, at least not as fast, or possibly not even existed had they used Java.

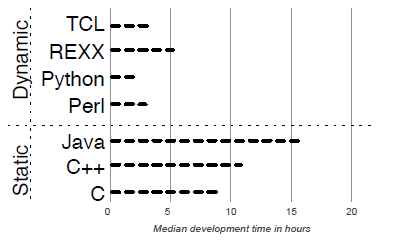


Figure 4.2 Development time in hours

Figure 4.2 shows the development time in hours of different programming languages. As the figure implies, Java development consumes the most time and Python development the least time. The C++ and C developments lie between the two.

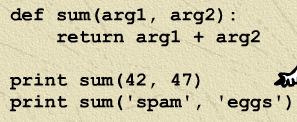


Figure 4.3 Python Sample Code

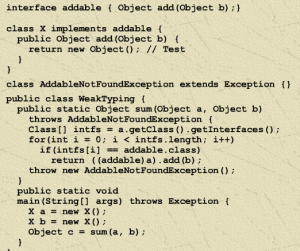


Figure 4.4 Java equivalent codes

Figure 4.3 gives a sample code that is written using the Python Programming Language and Figure 4.4 gives the equivalent code in Java Programming Language. This clearly shows the advantage of Python over Java in terms of coding scheme.

**Computation of Ranking for Development Time for Design 2:**

As shown on Table 4-1, the designers gave a rank of 5 for Design 1 since it has the longest time to develop in terms of hours as discussed above and used it as the governing rank for the computation of the subordinate rank of Design 2.

Using Eq. 4.1:

c

Eq. 4.3

Eq 4.3 shows the computation for the percent difference of Design 1 and Design 2.

Using Eq. 4.2:

Eq. 4.4

The designers used the value of 0.818 that was obtained from Eq. 4.3 and gave Design 2 a rank of -3 based on the computation shown in Eq. 4.4.

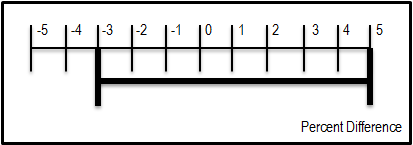


Figure 4.5 Percent Difference of Design 1 and Design 2 for Time Constraint

Figure 4.5 shows the graph between Design 1 and Design 2, where Design 1 with a value of 5 as the Governing rank and Design 2 with a value -3 as the Subordinate Rank.

**Computation of Ranking for Development Time for Design 3:**

As shown on Table 4-1, the designers gave a rank of 5 for Design 1 since it has the longest time to develop in terms of hours as discussed above and used it as the governing rank for the computation of the subordinate rank of Design 3.

Using Eq. 4.1:

Eq. 4.6

Eq. 4.5

Eq. 4.5 shows the computation for the percent difference of Design 1 and Design 3.

Using Eq. 4.2:

The designers used the value of 0.1818 that was obtained from Eq. 4.5 and gave Design 3 a rank of 3 based on the computation shown in Eq. 4.6.

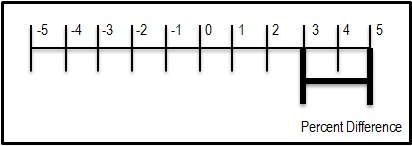


Figure 4.6 Percent Difference of Design 1 and Design 3 for Time Constraint

Figure 4.6 shows the graph between Design 1 and Design 3, where Design 1 with a value of 5 as the Governing rank and Design 3 with a value 3 as the Subordinate Rank.

**Trade-off 2: Economic (Development Cost)**

Development cost plays a vital role for the trade-off of each design. In every implementation of a system, development cost is considered if a certain company can pay the services of the software and applications that are currently used within the system. The cost for the developers’ skills in developing a certain application for the system is also considered.

Table 4‑2 Comparisons of Three Designs based on Development Cost

|  |  |
| --- | --- |
| **Designs** | **Cost** |
| Design 1: Using Raspberry Pi and Java Programming Language & MySQL for the Back-End of the System | ₱134, 104.00 |
| Design 2: Using Ubuntu Server and Python Programming Language & IBM DB2 for the Back-End of the System | ₱125, 843.00 |
| Design 3: Using Windows Server and C# Programming Language & Microsoft Access for the Back-End of the System | ₱147, 911.00 |

Table 4-2 shows the difference of three designs with the development cost.

**Computation of Ranking for Economic Constraint for Design 1:**

As shown on Table 4-1, the designers gave a rank of 5 for Design 3 since it has the highest for development and implementation as discussed above and used it as the governing rank for the computation of the subordinate rank of Design 1.

Using Eq. 4.1:

Eq. 4.7

Eq 4.7 shows the computation for the percent difference of Design 3 and Design 1.

Using Eq. 4.2:

Eq. 4.8

The designers used the value of 0.103 that was obtained from Eq. 4.7 and gave Design 1 a rank of 4 based on the computation shown in Eq. 4.8.

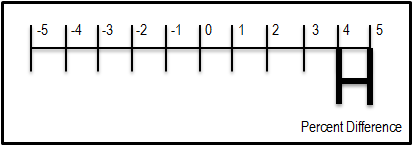


Figure 4.7 Percent Difference of Design 3 and Design 1 for Economic Constraint

Figure 4.7 shows the graph between Design 3 and Design 1, where Design 3 with a value of 5 as the Governing rank and Design 1 with a value 4 as the Subordinate Rank.

**Computation of Ranking for Development Time for Design 2:**

As shown on Table 4-1, the designers gave a rank of 5 for Design 3 since it has the longest time to develop in terms of hours as discussed above and used it as the governing rank for the computation of the subordinate rank of Design 2.

Using Eq. 4.1:

Eq 4.9 shows the computation for the percent difference of Design 3 and Design 2.

Using Eq. 4.2:

The designers used the value of 0.165 that was obtained from Eq. 4.9 and gave Design 2 a rank of 3 based on the computation shown in Eq. 4.10.

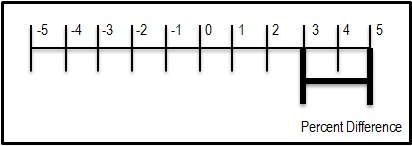


Figure 4.8 Percent Difference of Design 3 and Design 2 for Economic Constraint

Figure 4.8 shows the graph between Design 3 and Design 2, where Design 1 with a value of 5 as the Governing rank and Design 2 with a value 3 as the Subordinate Rank.

**Trade-off 3: Performance (Data Processing)**

DBMS short for database management system plays a major role in most real-world projects that require storing, retrieving, and querying digital data. For instance, dynamic websites, accounting information systems, payroll systems, stock management systems all rely on internal databases as a container to store and manage their data. Many software development firms today are developing and producing DBMS systems that cost between zero dollars in case of free and open-source DBMSs, and thousands of dollars in case of proprietary DBMSs. In particular, each DBMS is characterized by a set of diverse functional and non-functional features and specs each having their advantages and disadvantages. One of which is performance, which determines how fast a DBMS can process and execute queries. This paper presents a comparative study from a performance perspective between five different DBMSs available today on the market.

**Testing Platforms**

The testing carried out on a Dual-Processor, Intel Xeon E5649, 6x2 Cores, processor, clocked at 2.53GHz with 32GB of random access memory (RAM) and 2TB of secondary storage capacity. The operating system is MS Windows Server 2008, 64-bit.

**Tester**

The tester is a computer application developed using C#.NET under the .NET Framework 4.0. It performs two tasks: First, automatically populate the database tables with 1,000,000 rows prior to test execution and execute the actual SQL queries. Figure 4.4 shows the main GUI interface of the tester.



Figure 4.9 Tester Interface

**Testing Process**

Different SQL queries were executed over the different five DBMS under test. In fact, these queries have different level of complexity; they range from simple type to very complex type. It is worth noting that all five databases are populated with dummy 1,000,000 records of data prior to starting the testing process.

This is a very simple query whose task is to retrieve rows without any conditions or joins:

SELECT \* FROM Item;

Table 4‑3 Query #1 Results

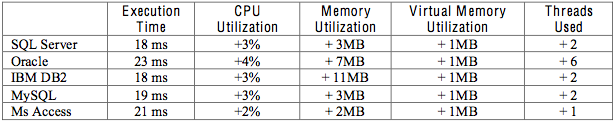


Table 4-3 tallies the execution time, CPU utilization, Memory Utilization, Virtual Memory Utilization and Threads Used of the different DBMS. For the computations in the trade-off table, the designers consider the execution time of each DBMS used in different designs. For the computation of each DBMS execution times are considered.

**Computation of Ranking for Performance for Design 2:**

As shown on Table 4-1, the designers gave a rank of 5 for Design 3 since it has the fastest execution time compared to the two designs as discussed above and used it as the governing rank for the computation of the subordinate rank of Design 2.

Using Eq. 4.1:

Eq 4.11 shows the computation for the percent difference of Design 3 and Design 2.

Using Eq. 4.2:

The designers used the value of 0.143 that was obtained from Eq. 4.11 and gave Design 2 a rank of 4 based on the computation shown in Eq. 4.12.

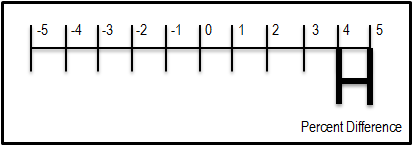


Figure 4.10 Percent Difference of Design 3 and Design 2 for Performance Constraint

Figure 4.10 shows the graph between Design 3 and Design 2, where Design 3 with a value of 5 as the Governing rank and Design 2 with a value 4 as the Subordinate Rank.

**Computation of Ranking for Performance for Design 1:**

As shown on Table 4-1, the designers gave a rank of 5 for Design 3 since it has the fastest execution time compared to the two designs as discussed above and used it as the governing rank for the computation of the subordinate rank of Design 1.

Using Eq. 4.1:

Eq 4.13 shows the computation for the percent difference of Design 3 and Design 1.

Using Eq. 4.2:

The designers used the value of 0.095 that was obtained from Eq. 4.13 and gave Design 1 a rank of 4 based on the computation shown in Eq. 4.14.

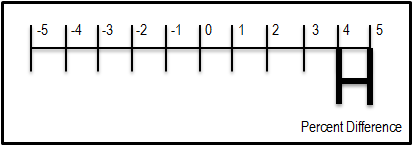


Figure 4.11 Percent Difference of Design 3 and Design 1 for Performance Constraint

Figure 4.11 shows the graph between Design 3 and Design 1, where Design 3 with a value of 5 as the Governing rank and Design 1 with a value 4 as the Subordinate Rank.

## Influence of Mulitiple Constraints, Trade-offs and Standards in the Final Design

The constraints, trade-offs and standards contribute to the design of this project aligned with its objectives. The constraints have been the consideration to the factors that may affect the project. These constraints have also been used as criteria for trade-off table, the comparison of the different designs laid out by the designers. The comparisons have been determined through the studies that other designers conducted.

**Criterion 1: Time**

The development time of the project was one of the challenges that the designers encountered. Since the project is time-bounded, designers must consider its time constraint. Programming languages differ in their development times, as one may be faster to develop than the other. There are many things to consider when discussing the development time in terms of programming languages. One of the things that the designers consider is the programming language to be used.

The designers based on the study that has been conducted to measure the comparison of development times of different programming languages. As figure 4.1 suggests, Python Programming language stands out compared to the languages defined. Figure 4.2 and 4.3 shows the coding scheme of Python over Java. It clearly shows that Python uses the least of lines while Java consumes a lot of lines.

Although Python stands out in the study regarding development times, the familiarity of programming languages of the designers is taken into consideration. Development time still depends on the knowledge of the programmers. The designers chose Java Programming Language for the Desktop and Mobile Application and PHP Scripting for Web Application.

**Criterion 2: Economic (Development Cost)**

The main element of the development is the kind of server to use. The server contains the central database and the images needed for implementing image processing. There are a variety of servers available from physical components to virtual machines.

The designers considered the cost of implementation and installation. The designers chose from Raspberry Pi, Ubuntu Server 12.04 LTS and Windows Server R2 Essentials. The RPi acts a server with a hardware component and the remaining uses virtual machine for implementation.

The designers decided to go with the Raspberry Pi out of the three options because virtual machines take a lot of memory in a system unit when installed. An RPi acts as minicomputer and can provide services to act as a server.

**Criterion 3: Performance (Data Processing)**

The DBMS to be used is the center of the data within the project. DBMS contains the necessary data coming from the blackbox. Different DBMS may use different schemes in processing data but still uses the same query.

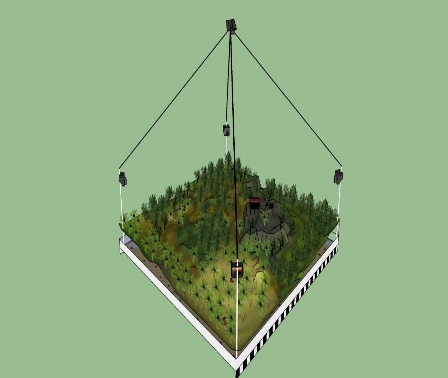
The three DBMS that the designers focused on choosing are the MS Access, MySQL and IBM DB2. Figures 4.5, 4.6 and 4.7 shows the results and conclusions provided by the study “A Comparative Study on the Performance of the Top DMBS Systems” by Youssef Bassil in histogram and graph form. There is also no definite DBMS that stands out as the figures imply. Just like in programming languages, the designers consider the familiarity of the DBMS to be used.

The designers used the MySQL DBMS as the database language for the project. Familiarity with it is the criterion that the designers consider in choosing it between the other two. Another advantage of MySQL is that it is open-source and free to use.

# FINAL DESIGN

## Final Design

The designers have presented and discussed several constraints that affect the final system and performance of the applications that was integrated with the prototype, these constraints have proven that the best and ideal to consider was Design 1 using Java Programming Language for Desktop Application, Raspberry Pi (RPi) as the server and MySQL as for the relational database management system, tabulated data in Chapter 4 (see Table 4-1) proved that the said design was the ideal among the three (3) due to the highest ranking it produced in the Trade-off strategies in engineering.



Closed Circuit Television Cameras

v

Figure 5.1 Final Design of the Prototype

Figure 5.1 shows the final design of the Forest Activity Monitoring System with Android Technology. Cameras are placed on the steel supports and another camera on the topmost part. The drawer contains the blackbox components. The hook pins are for the simulation of illegal logging. Hooks can be pulled to simulate a cutting of a tree and produces sound and vibration simultaneously. The design also has three (3) power supplies: electrical outlets, battery and the solar panel. It is provided with a great quantity of power supply to support 24/7 monitoring of the forest.

As shown in Figure 5.2, the desktop application provides set of functions for the administrators and forest rangers such as checking the forest condition, accessing the cameras on different channels and managing all the users of the system.



Forest Sectors

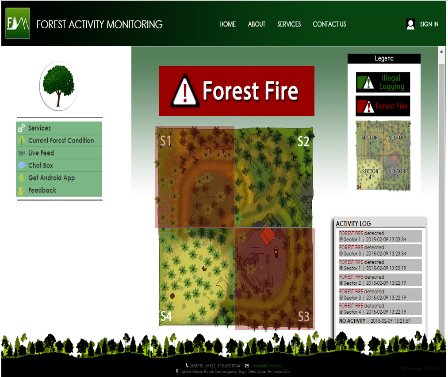
Current Forest Condition

Forest Activity Legend

Activity Log

Figure 5.2 Graphical User Interface of the Desktop Application

The web application is accessible through connecting with the network of the FAM System. The web pages are uploaded onto the server (Raspberry Pi) and users can check on the forest condition, view live feeds from different channels and interact with other users (see Figure 5.3).



Services Offered

Forest Sectors

Current Forest Condition

Activity Log

Forest Activity Legend

Figure 5.3 Graphical User Interface of the Web Application

Mobile application is made for portability and convenience of the users. Users must also connect first with the network of the system for them to view the information on the application. As shown in Figure 5.4, the user interface for the mobile application consists of the application drawer, current forest condition, emergency hotlines and reload button.

Application Drawer



Reload Button

Legend of Forest Conditions

Forest Layout divided into four sectors

Current Forest Condition

Emergency Hotlines

Figure 5.4 Graphical User Interface of the Mobile Application

## Test Procedures and Evaluation

### Test Procedures

Based on the specific objectives found in Chapter 1 (pp. 1), the project was tested on its functionality and accuracy. The functionality of the system depends on the accessibility of the applications on the cameras installed on the prototype. The basis of the accuracy of the system should refer on the applications’ alerts on illegal logging and forest fires.

**Accuracy Test**

The system tested for the accuracy in detection of illegal logging. If the system can detect an illegal logging activity when a tree has been cut using the prototype’s mechanism and can be seen through the three (3) different applications with the correct sector where the said tree is located. The system was also tested for the accuracy in detection of forest fire. If the system can detect the smoke that is created using the same principle used on e-cigarettes and can send the correct information on which sector is on fire the three (3) different applications, the system is said to be accurate.

The designers also calculated the accuracy with the use of percentage accuracy formula. The formula for percentage accuracy is:

Eq. 5.1

Where: √ represents that a trial is successful and shows alert on application with the correct sectors. On the other hand, X means an unsuccessful trial for the accuracy test.

**Functionality Test**

The system is tested for the functionality of applications in viewing live-feeds from the cameras deployed in the prototype. There are three (3) cameras installed on the prototype. The top view, channels 2 and 3 located on the steel posts.

### Test Evaluation

The evaluation procedure depends upon the criteria that are given to the client. The client should rate the evaluation form regarding on the functionality and accuracy of the three (3) applications and if it meets the objectives of the system.

## Test and Evaluation Results

### Test Results

The following test results were acquired through the procedures mentioned in the testing procedures in the previous section.

**Accuracy Test Result**

The designers have calculated the accuracy of results based on the accuracy of the applications to provide alerts on illegal logging and forest fire to correct sectors.

**For Desktop Application**

The values generated in this section are for the desktop application.

Table 5‑1 Accuracy Results for Desktop Application

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Sector** | **Forest Condition** | **Trial** | | | | | **Average Accuracy Per Condition** |
| **1** | **2** | **3** | **4** | **5** |
| **1** | Illegal Logging | **√** | **√** | **√** | **√** | **√** | **100.00** |
| Forest Fire | **√** | **√** | **X** | **√** | **√** | **80.00** |
| **2** | Illegal Logging | **√** | **√** | **√** | **√** | **√** | **100.00** |
| Forest Fire | **√** | **√** | **√** | **√** | **√** | **100.00** |
| **3** | Illegal Logging | **X** | **√** | **√** | **√** | **√** | **80.00** |
| Forest Fire | **√** | **√** | **√** | **√** | **√** | **100.00** |
| **AVERAGE ACCURACY** | | | | | | | **95.00** |

Table 5-1 shows the results that the desktop application provided on alerts on illegal logging and forest fire. The values are taken through the use of the prototype’s mechanism for illegal logging and simulating a smoke through sectors one (1) to three (3). The following shows the calculation of the values on Average Accuracy per Condition and Average Accuracy of Table 5-1. See Appendix F Section A for the computations of the values seen on the table.

The result of average accuracy for the detection of illegal logging and forest fire in the desktop application is 93.33% and greater than 90.00% (as the standard percentage for accuracy), therefore the application can provide accurate alert on each sector depending on the forest condition detected by the prototype.

**For Web Application**

The values generated in this section are for the web application.

Table 5‑2 Accuracy Results for Web Application

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Sector** | **Forest Condition** | **Trial** | | | | | **Average Accuracy Per Condition** |
| **1** | **2** | **3** | **4** | **5** |
| **1** | Illegal Logging | **√** | **√** | **√** | **√** | **√** | **100.00** |
| Forest Fire | **√** | **√** | **√** | **√** | **√** | **100.00** |
| **2** | Illegal Logging | **√** | **√** | **√** | **√** | **√** | **100.00** |
| Forest Fire | **X** | **√** | **√** | **X** | **√** | **60.00** |
| **3** | Illegal Logging | **√** | **√** | **√** | **√** | **√** | **100.00** |
| Forest Fire | **√** | **√** | **√** | **√** | **√** | **100.00** |
| **AVERAGE ACCURACY** | | | | | | | **95.00** |

Table 5-1 shows the results that the web application provided on alerts on illegal logging and forest fire. The values are taken through the use of the prototype’s mechanism for illegal logging and simulating a smoke through sectors one (1) to three (3). The following shows the calculation of the values on Average Accuracy per Condition and Average Accuracy of Table 5-1. See Appendix F Section B for the computations of the values seen on the table.

The result of average accuracy for the detection of illegal logging and forest fire in the web application is 93.33% and greater than 90.00% (as the standard percentage for accuracy), therefore the application can provide accurate alert on each sector depending on the forest condition detected by the prototype.

**For Mobile Application**

The values generated in this section are for the mobile application.

Table 5‑3 Accuracy Results for Mobile Application

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Sector** | **Forest Condition** | **Trial** | | | | | **Average Accuracy Per Condition** |
| **1** | **2** | **3** | **4** | **5** |
| **1** | Illegal Logging | **√** | **√** | **√** | **√** | **√** | **100.00** |
| Forest Fire | **√** | **√** | **√** | **√** | **√** | **100.00** |
| **2** | Illegal Logging | **√** | **√** | **√** | **√** | **√** | **100.00** |
| Forest Fire | **√** | **√** | **√** | **√** | **√** | **100.00** |
| **3** | Illegal Logging | **√** | **√** | **√** | **√** | **√** | **100.00** |
| Forest Fire | **√** | **X** | **√** | **√** | **√** | **80.00** |
| **AVERAGE ACCURACY** | | | | | | | **96.67** |

Table 5-1 shows the results that the mobile application provided on alerts on illegal logging and forest fire. The values are taken through the use of the prototype’s mechanism for illegal logging and simulating a smoke through sectors one (1) to three (3). The following shows the calculation of the values on Average Accuracy per Condition and Average Accuracy of Table 5-1. See Appendix F Section C for the computations of the values seen on the table.

The result of average accuracy for the detection of illegal logging and forest fire in the web application is 96.67% and greater than 90.00% (as the standard percentage for accuracy), therefore the application can provide accurate alert on each sector depending on the forest condition detected by the prototype.

**Functionality Test Result**

Table 5‑4 Functionality Test Results of the Different Cameras deployed on the Prototype

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Application** | **Camera Channels** | | | **Remarks** |
| Top View | Channel 2 | Channel 3 |
| Desktop | √ | √ | √ | OK |
| Web | √ | √ | √ | OK |
| Mobile | √ | √ | √ | OK |

As shown in Table 5-4, applications can access different channels for the real-time monitoring of the forest and got a remark of OK. This means that the functionality of the three different applications were successful.

### Evaluation Results

The designers have decided the possible end-users of the system which would be the respondents for the evaluation procedure. The fields defined in the evaluation form were based on specific objectives discussed on Chapter 1 (pp. 1). Figures 5.5, 5.6, 5.7, 5.8, 5.9 and 5.10 show the graphical representation of the results of the evaluation (refer to Appendix G) conducted by the designers.

As illustrated on Figure 5.5, six (6) out of ten (10) respondents evaluated the accuracy for the detection of illegal logging very satisfactory. The satisfactory and fair rating each got two (2) evaluations from the remaining respondents. The system can accurately detect if there is an illegal logging currently happening in a certain sector.

Figure 5.5 Evaluation Result for the Accuracy of the Detection of Illegal Logging

Figure 5.6 shows that 70% of the respondents were very satisfied with the system’s accuracy for the detection of forest fire. The remaining 30% evaluated it satisfactory. The applications provide accurate results in terms of the detection of forest fire.

Figure 5.6 Evaluation Result for the Accuracy of the Detection of Forest Fire

As shown in Figure 5.7, the results gathered from respondents ranked the functionality of cameras as very satisfactory. The viewing of the live feed through the applications is fully functional.

Figure 5.7 Evaluation Result for the Functionality of Cameras

As illustrated in Figure 5.8, the respondents find that the ease of using the desktop application is very satisfactory and meets the specific objectives discussed on Chapter 1.

Figure 5.8 Evaluation Result for the Ease of Using Desktop Application

Figure 5.9 shows that the 70% of the respondents find the web application easy to use and provides the needed functions for end-users. The other 30% ranked it satisfactory.

Figure 5.9 Evaluation Result for the Ease of Using Web Application

As illustrated on Figure 5.10, eight (8) out of ten (10) respondents ranked the ease of using mobile application very satisfactory and two (2) ranked very satisfactory. The application provides an easy way to receive alerts and information regarding the forest.

Figure 5.10 Evaluation Result for the Ease of Using Mobile Application

### Conclusion

Forest Activity Monitoring System helps the environment and on how to contribute for protecting landscapes and forests in the Philippines through the use of desktop, web and mobile applications. FAM was developed and designed to conform to coding techniques, image processing technology, engineering standards, and trade-offs based on multiple constraints. The main markets for the system are government agencies and departments that are inclined with the environment.

Three software designs were considered. The designs differed in the programming language to be used, server and database management system to be implemented. They were compared and calculated in Chapter 4 in terms of time, economic and performance constraint. After comparing and calculating, Java Programming Language for the back-end of the system, Raspberry Pi for the server and MySQL database were chosen to be the most practical design to use due to the highest score obtained. The chosen design followed specific engineering standards namely: WordPress Roles and Capabilities, Standards for Software Quality Assurance Plan and Ameritech Graphical User Interface and Design Guidelines.

Based on the results of testing as discussed in this chapter, the objectives to develop a system that monitors forest activities have been successfully achieved. Applications can receive and alert end-users with the activities of illegal logging and forest fires and at the same can access camera channels to view live feed of the forest and have been proven to be accurate and functional. It can now be said that the main and specific objectives have been successfully met.

# BUSINESS PLAN AND MODEL

## Business Plan

### Executive Summary

Forests are very useful to humans. It provides food, shelter, and medicine. However, the forests are becoming bare as a result of cutting down and burning all the trees. Incidents like illegal logging and forest fires happen because the forests are not protected and are not monitored periodically. This dilemma inspired the proponents to think of a positive solution on how to lessen and prevent such incidents to conserve the forests and the Mother Nature as well.

Adaptation of the modern technology made a possible solution for this problem. The Forest Activity Monitoring System came into realization. It is an automated system that monitors the activities in a forest specifically illegal logging and forest fires. It detects activities that trigger the three applications in web, mobile, and desktop. Providing 24/7 surveillance of the forest made this significant.

### General Company Description



Figure 6.1 Company Logo

Ionic Software Solutions Inc. is a proposed company that provides high quality technical and software engineering services its clients. It is a partnership, owned and operated in June 2014 by computer engineers namely Engr.Hannah Adsuara, Engr. Rene Aldea, Engr. Jazmine Balasa, Engr. Benedick Icban, Engr. Paul Sande, Engr. Justine Pregillano, Engr. Winselmo Reyes, and Engr. Lance Valdez. Ionic Software Solutions Inc. creates solutions to real-time problems.

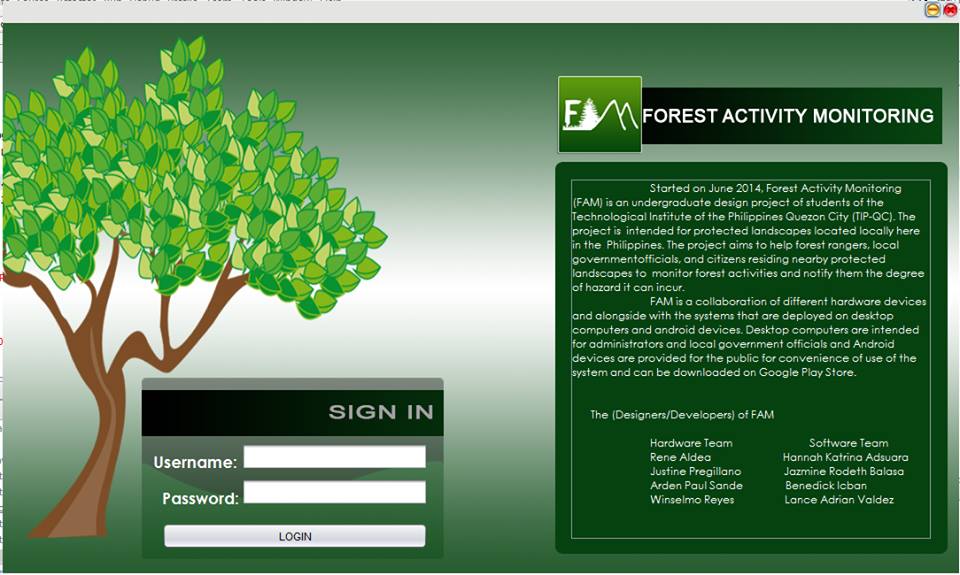
The partners graduated at Technological Institute of the Philippines, Quezon City. They specialized in computer engineering consulting to small and medium sized businesses. Ionic Software Solutions Inc seeks major contracts with medium sized firms.

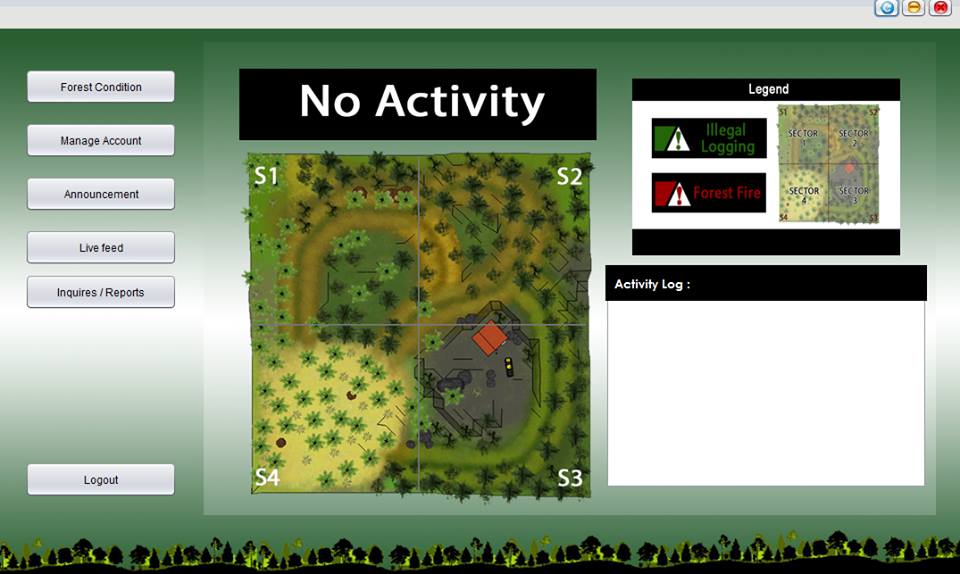
Ionic Software Solutions Inc. targets small to medium sized companies and government organizations within National Capital Region and surrounding areas. Those contracts are served with assistance of strategic alliances. This gives the company the flexibility it needs to successfully secure and complete projects.

### Products/Services Offered

Forest Activity Monitoring (FAM) System is an automated system that monitors the activities in a forest. The system uses image processing and web-based applications for mobile and desktop devices. It detects unwanted activities such as illegal logging and forest fires with the use of sound and vibration sensors, and Closed Circuit Television (CCTV) cameras. The main features of this system are: detects forest fire and illegal logging and displays it in web, mobile, and desktop application and it provides live video streaming of the actual forest condition.

**Desktop Application**





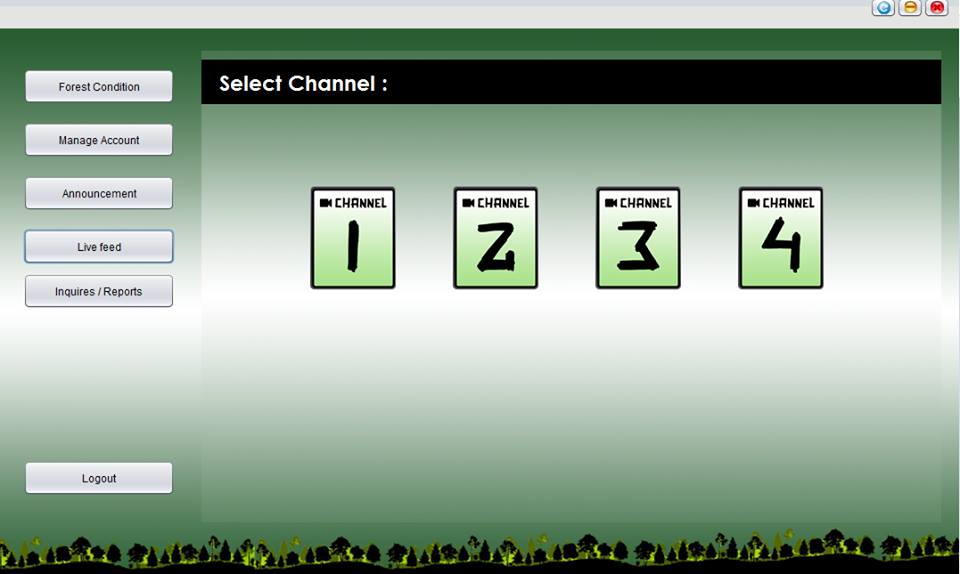
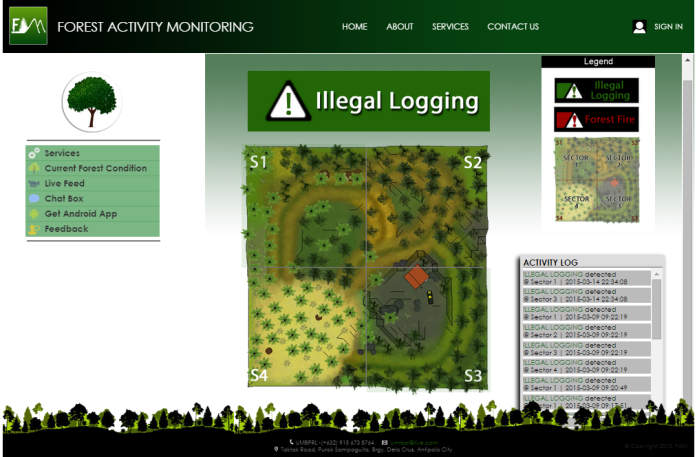


Figure 6.2 Graphical User Interface of Desktop Application

The desktop application is intended for the forest rangers and officials that manage a forest protection agency. It is the main frame of the system. Users of this application have the authority to manage the information displayed in all of the applications.

**Web Application**

The web application is hosted with the use of a public domain. Every user can access the application with use of web browsers and that is connected to the Internet. In the home page it shows news from the DENR and other environmental issues that the country currently faces. It also provides weather forecasts coming from PAGASA. There is also a Login button where a user can login to their account and communicate with other users and talk about current news and happenings regarding the forest’s condition. Other features of web application are that it has announcements that can be viewed in the applications that are added and updated by administrators who are using the desktop application. Announcements show the events and issues regarding the environment and the target forest and, at the same time, show current condition and/or status of the forest. There is also the Contact Us button, a user can send some inquiries regarding the system and to report some problems and/or bugs. One of the main features of the web application is to show the condition of the forest by quadrant to know what the condition is namely: Illegal Logging, and Grass Fire. The web application also provides live feed coming from the cameras deployed in the forest and at the same time provide five (5) channels. Channel 0 gives the overall view of the forest; Channel 1, 2, 3 and 4 provides the view of Quadrant One (1), Two (2), Three (3) and Four (4) respectively. Users can also communicate with each other with the use of the chat box and can discuss any precautions and share knowledge in handling environmental disasters.



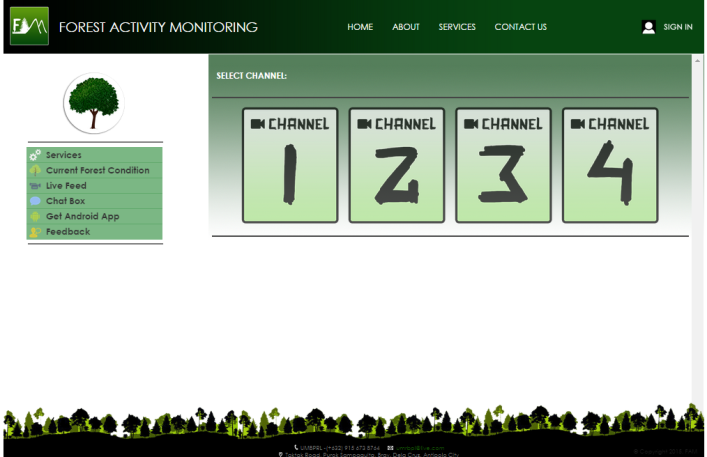
 

Figure 6.3 Graphical User Interface of Web Application

**Mobile Application**

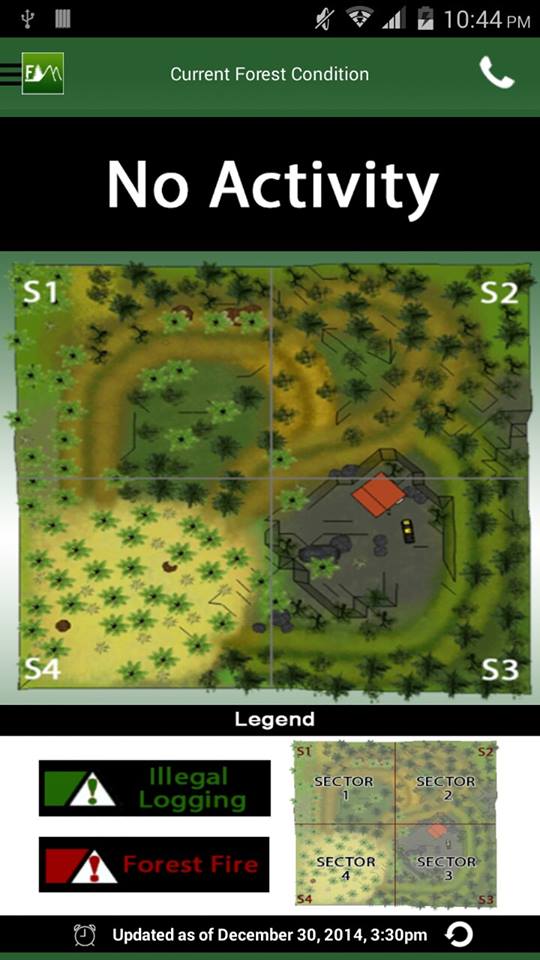
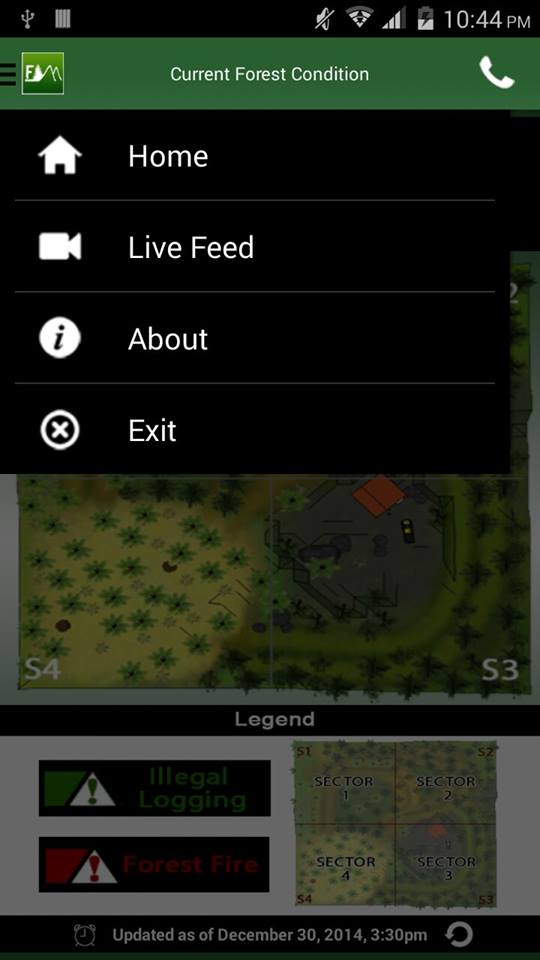
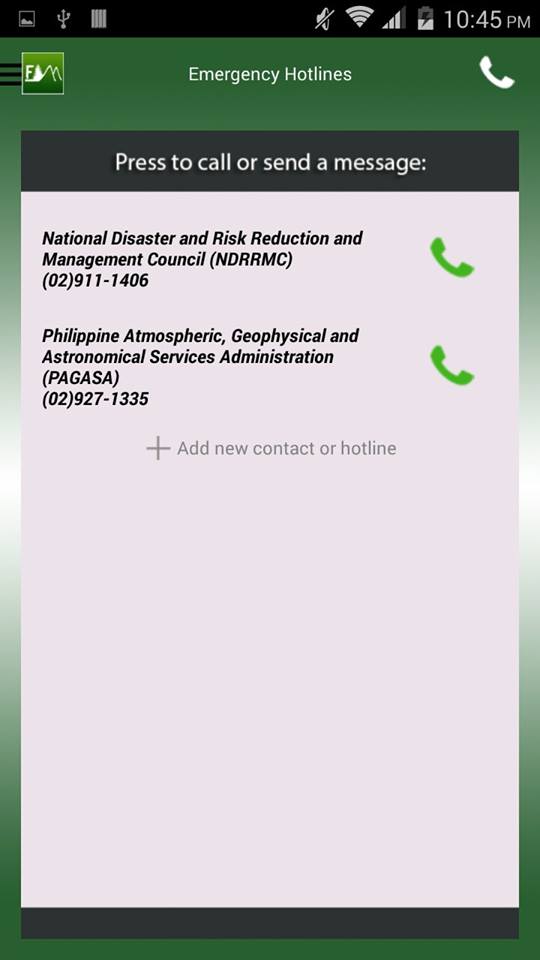
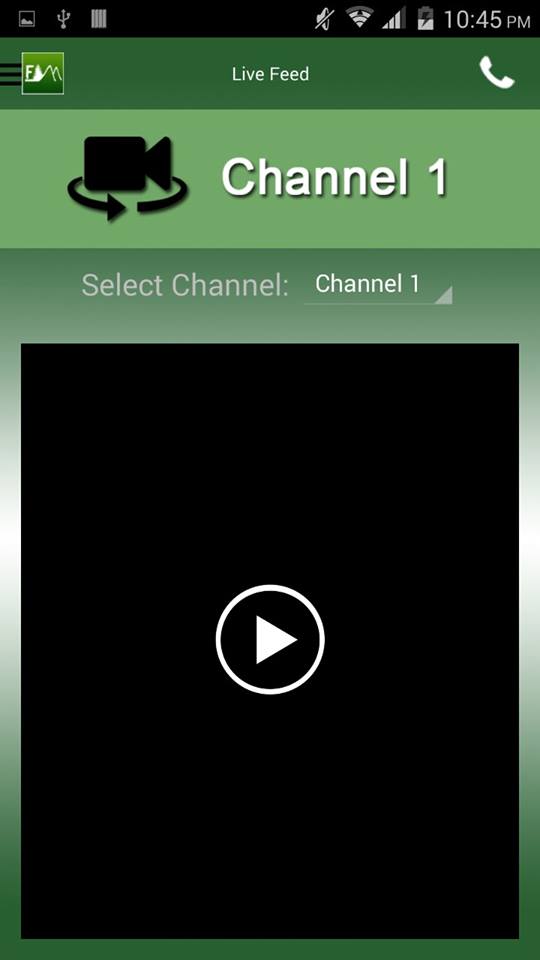
**  **

Figure 6.4 Graphical User Interface of Mobile Application

A mobile application is developed for the convenience of users. It provides the same features as the web application discussed above. Another factor that is considered is the portability of an android device. Therefore, it can be easily accessed just by installing the application and connecting to the server of the system.

The forest is divided into four quadrants and shows the condition of each quadrant with a specific legend. The conditions in which the user can see are as follows: Illegal Logging, and Forest Fires. Mobile application provides live feed coming from the cameras deployed within the forest. The user can choose from 5 different channels to surveillance all parts of the forest. Channel 0 gives the overall view of the forest; Channel 1, 2, 3 and 4 provides the view of Quadrant One (1), Two (2), Three (3) and Four (4) respectively. Also the user can view some of the emergency hotlines that can be called in case of unwanted accidents and emergencies.

### Marketing Plan

Forest Activity Monitoring system with Android Technology develops to protect the welfare of the environment specially a protected landscape. This marketing plan illustrates our market segments and the strategies to get customers and a solid revenue stream. This project emerged from the said actual scenario. In which, the group came into a realization that we need to help local agencies on preserving the environment. Adapting modern technology such as Android in real time monitoring of forest vicinities made the idea a plausible solution that would reap considerable benefits.

**Target Market**

Our ideal customers are the agencies and organizations that protect and manage protected landscapes. In 2013 statistics of Department of Environment and National Resources (DENR), the Philippines has an aggregate land area of 30 million hectares. This is made up of certified alienable and disposable land (47.3%) and forestland (52.7%). Our system design covers the medium to large organizations that are looking for creative promotional methods for their services.

## Business Model

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **FOREST ACTIVITY MONITORING (FAM) System Business Model** | | | | |
| **Partner Network**  **Institutional Partners:**  -Technological Institute of the Philippines Quezon City  -College of Engineering and Architecture  -Computer Engineering Department  **Other Partners:**  -Engr. Ronnie M. Dysangco (Adviser)  -Engr. Maria Cecilia A. Venal (Department Chair) | **Key Activities**  -Detection of Illegal Logging and Forest Fires  -24/7 Monitoring of the Forest | **Value Proposition**  -Automated forest activity monitoring  -Alerts on illegal logging and forest fires  -Real-time video feeds of the target forest  Applications available to customers:  -Desktop  -Web  -Mobile (Android)  Time constraint by offering an easy and efficient way for forest rangers in monitoring the forest | **Customer Relationship**  -Annual updates of the sensors and cameras deployed on the forest  -Annual updates of the applications being used by the end-users | **Customer Segments**  -Government Agencies protecting our Environment (DENR)  -Groups and Organizations that affects the welfare of the environment  **-Upper Marikina Basin Protected Landscape (PENRO)** |
| **Key Resources**  -Sound and Vibration Sensors  -Closed-Circuit Television Camera  -Router  -Hardware and Software Knowledge | **Channels**  -Project Design Exhibits and Colloquium  -Client Visit  -Email and Updates on the System |
| **Cost Structure**  FACILITIES/INFRASTRUCTURE – (FIXED COST, ENERGY COST)  Industrialized Sound and Vibration Sensors, Highly-Specialized Cameras for Monitoring | | | **Revenue Streams**  Fully Automated High Quality Forest Monitoring Activity System with the use of sensors and cameras  Installation fees, Maintenance of the equipment including the applications (desktop, web and mobile) | |

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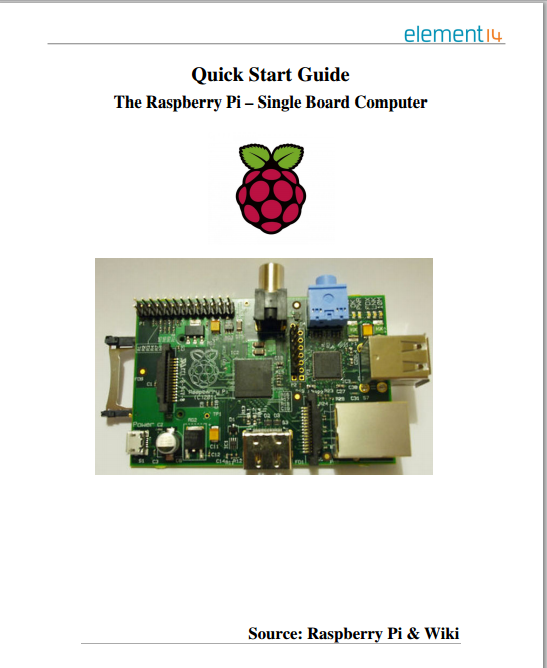
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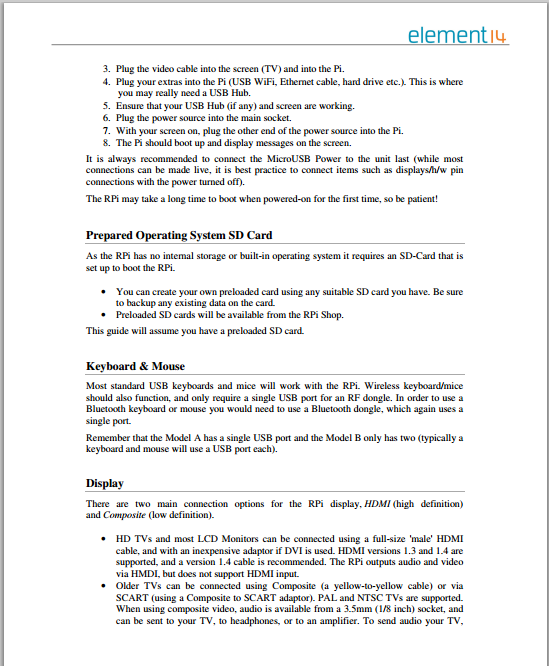
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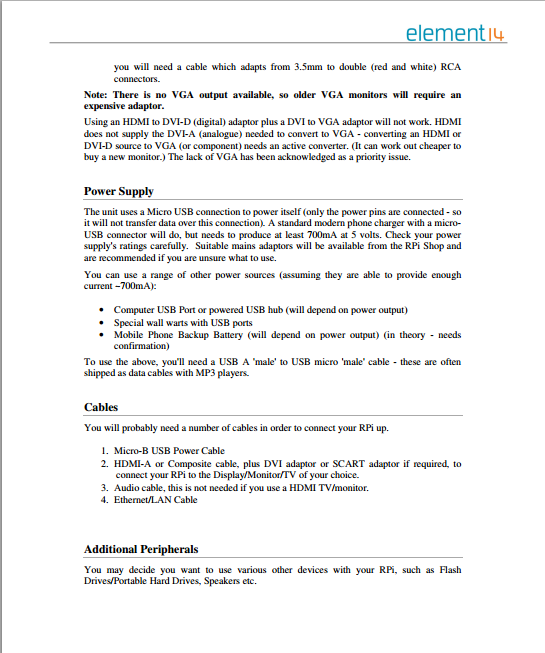
# APPENDICES

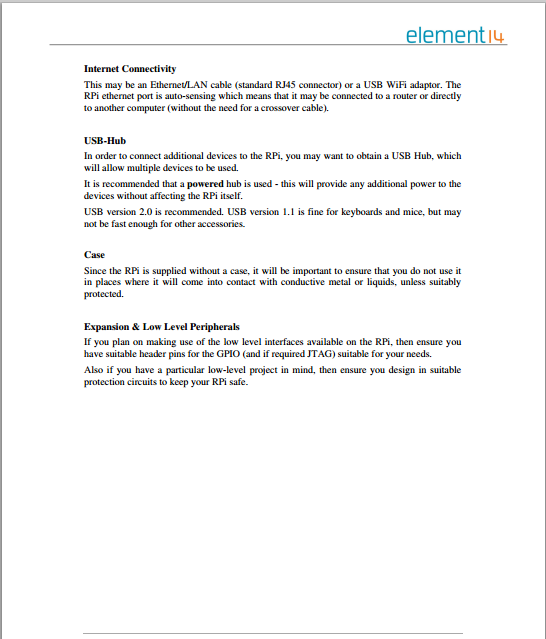
# APPENDIX A Raspberry Pi Datasheet



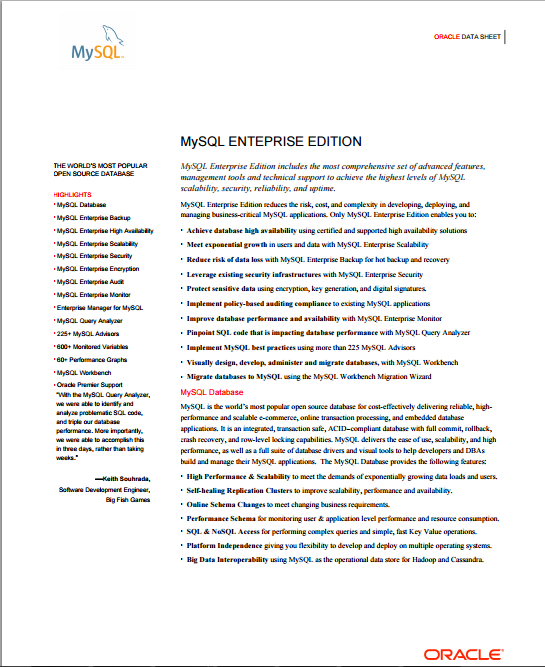


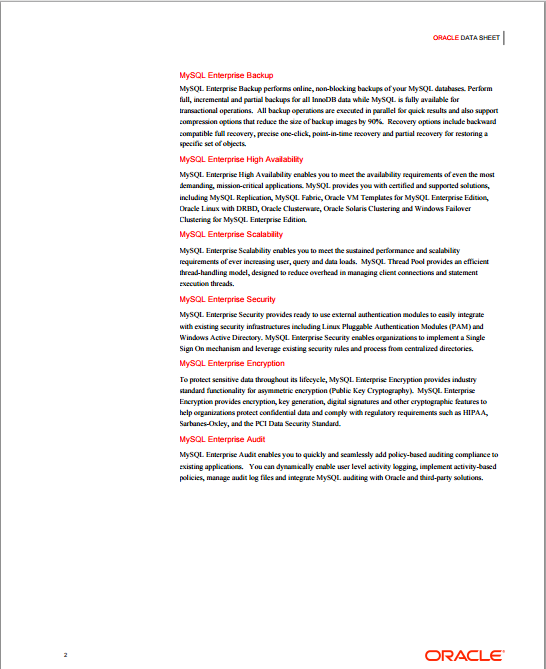


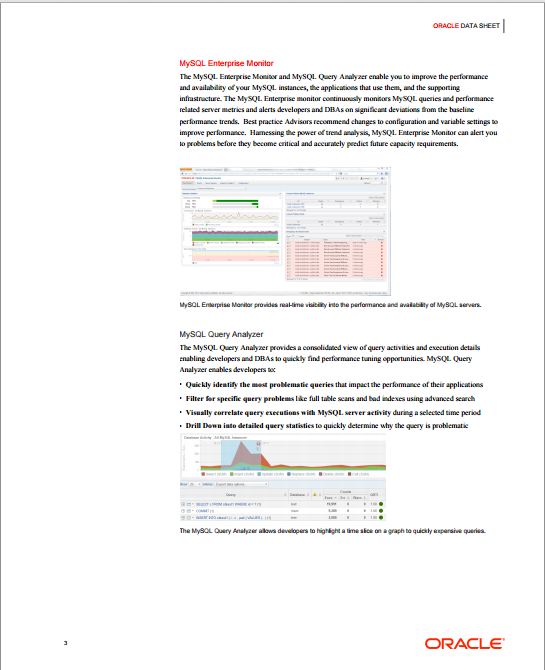


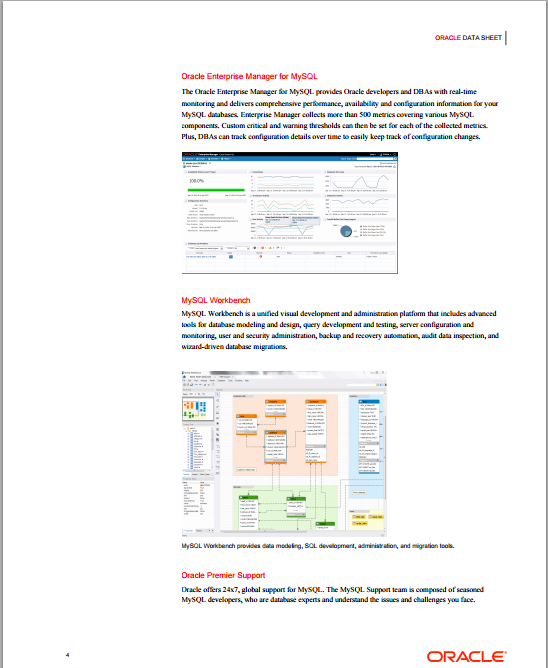


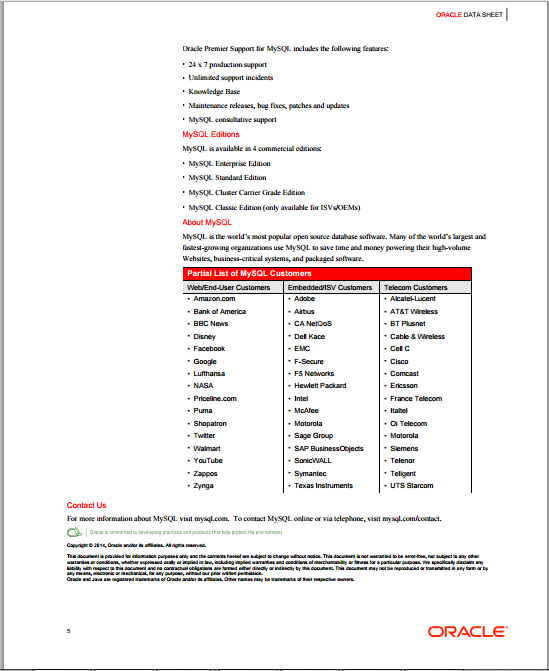
# APPENDIX B MySQL Datasheet





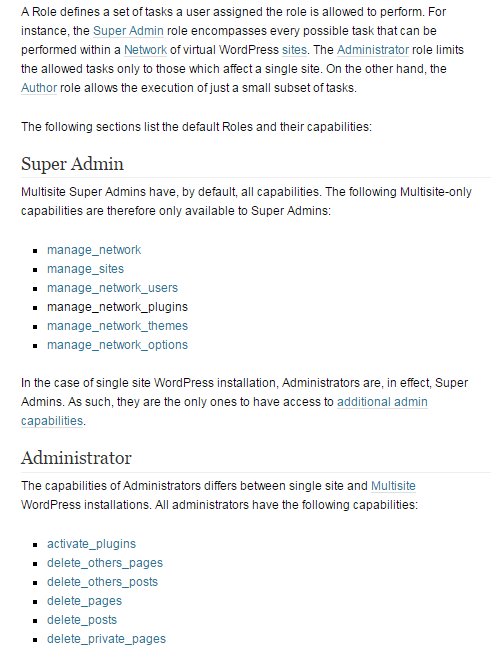


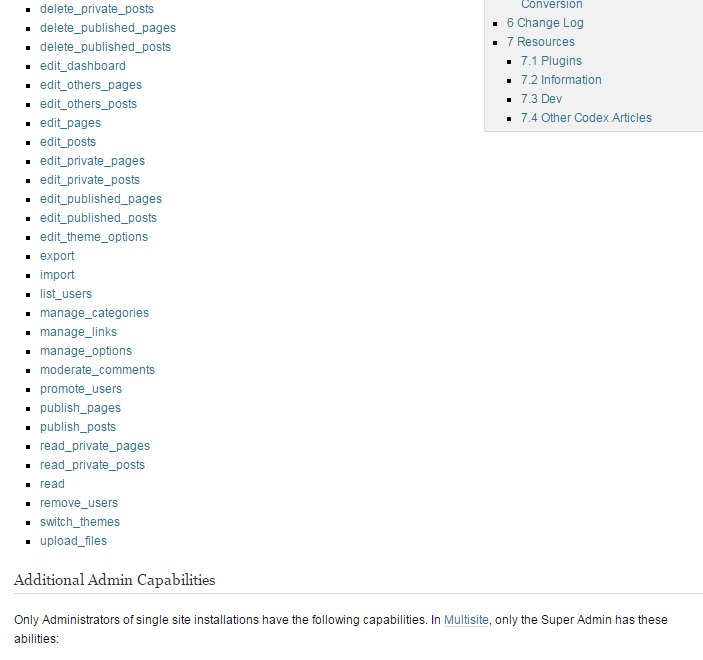


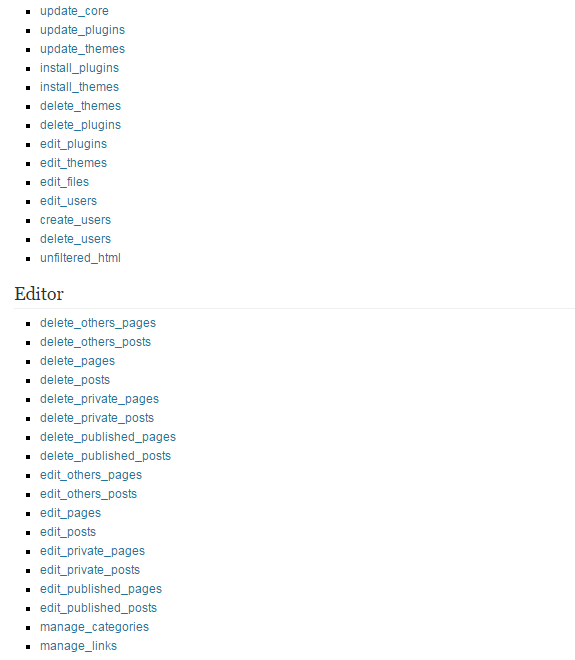


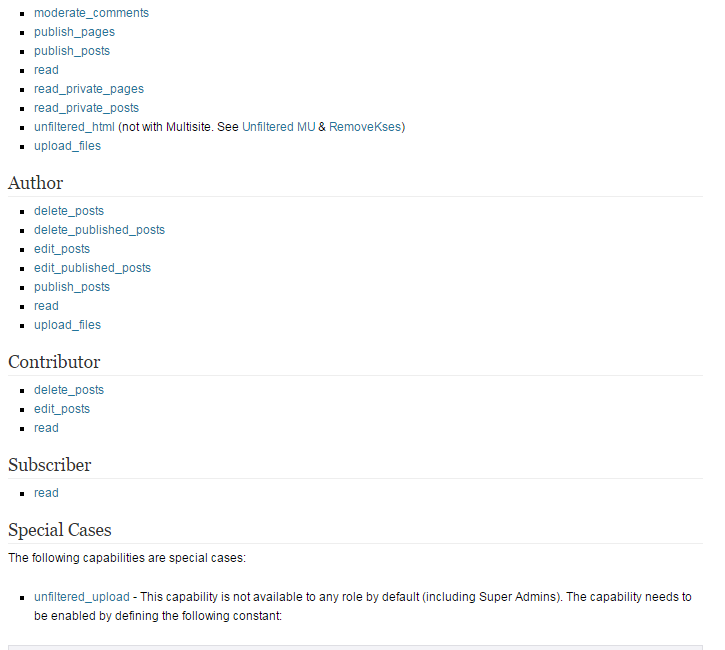
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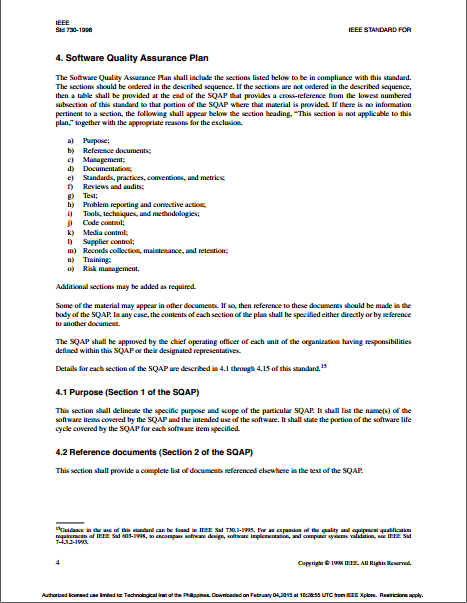


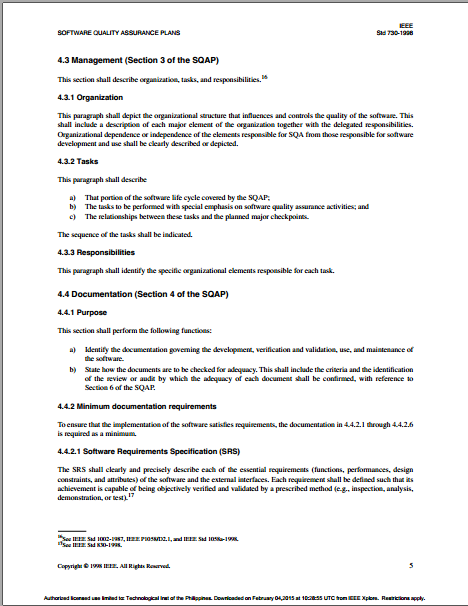


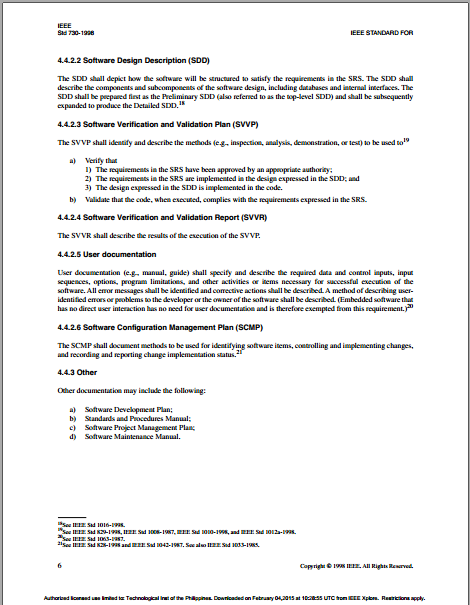


# APPENDIX D IEEE 730-1998 Standard for Software Quality Assurance Plans

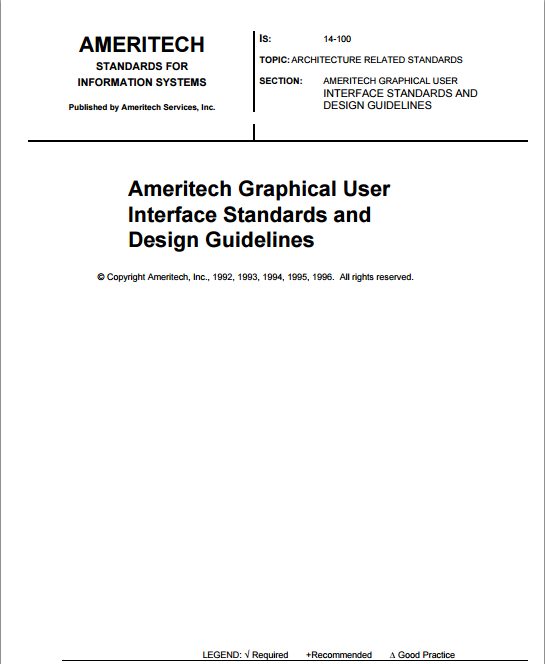


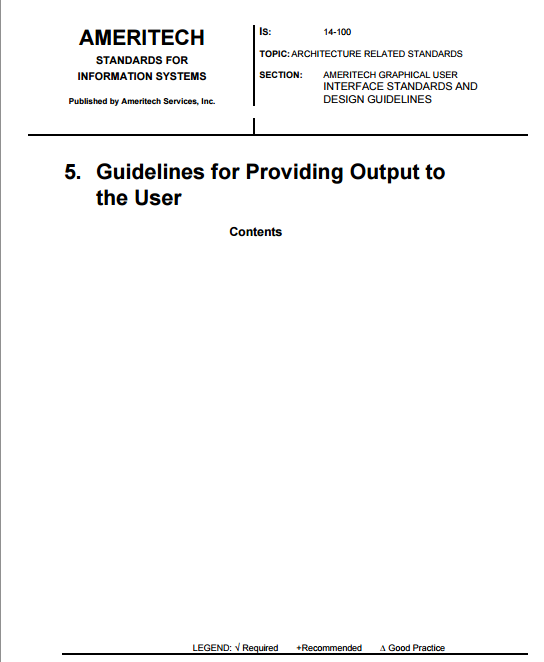


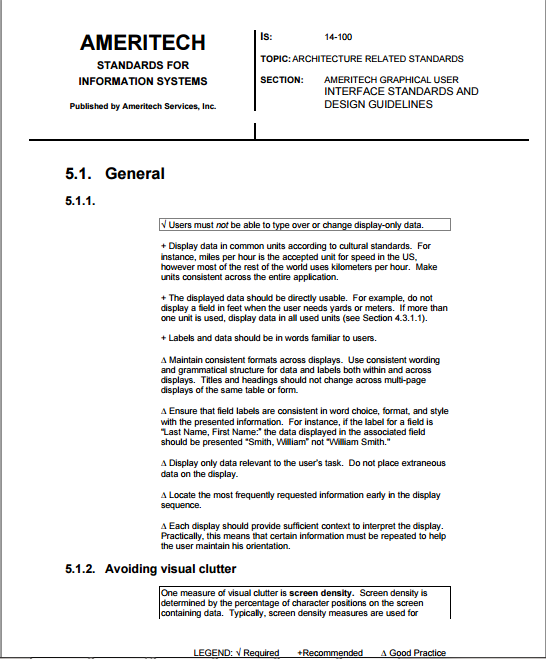


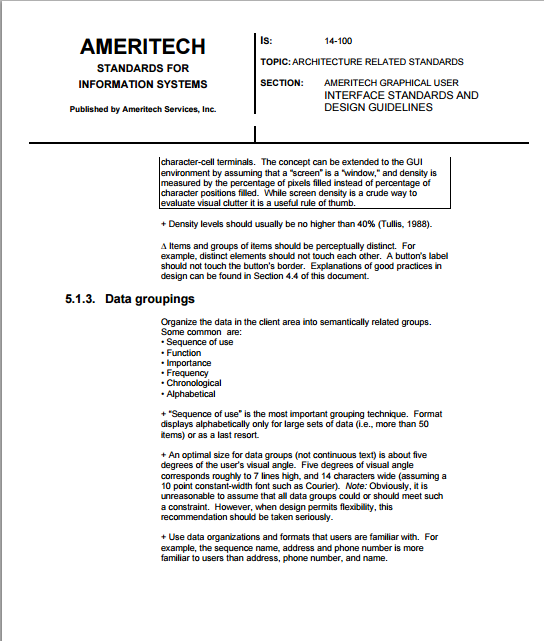


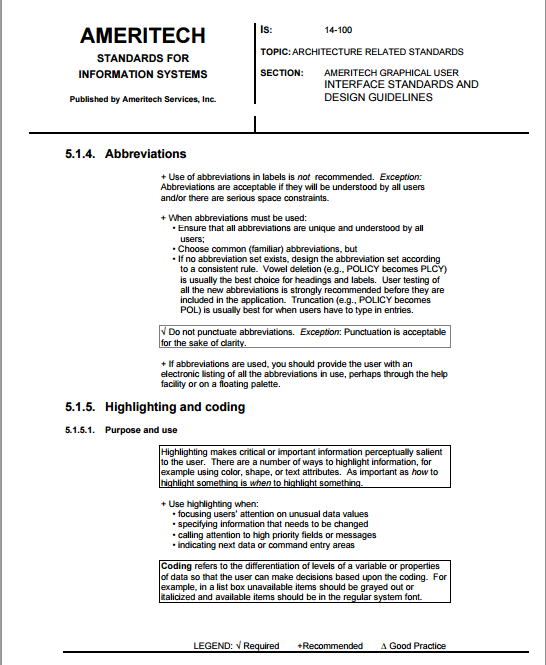
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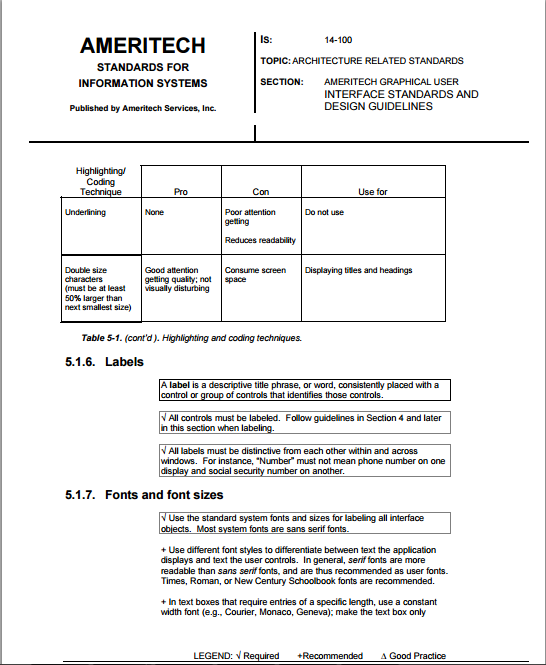


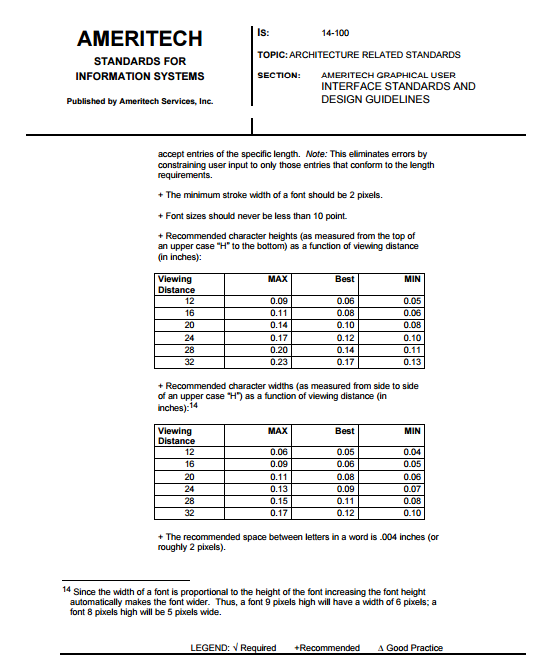












# APPENDIX F Computations for the Accuracy Results

**Section A**

For Sector 1

Detection of Illegal Logging:

Detection of Forest Fire:

For Sector 2

Detection of Illegal Logging:

Detection of Forest Fire:

For Sector 3

Detection of Illegal Logging:

Detection of Forest Fire:

**For Average Accuracy**

**Section B**

For Sector 1

Detection of Illegal Logging:

Detection of Forest Fire:

For Sector 2

Detection of Illegal Logging:

Detection of Forest Fire:

For Sector 3

Detection of Illegal Logging:

Detection of Forest Fire:

**For Average Accuracy**

**Section C**

For Sector 1

Detection of Illegal Logging:

Detection of Forest Fire:

For Sector 2

Detection of Illegal Logging:

Detection of Forest Fire:

For Sector 3

Detection of Illegal Logging:

Detection of Forest Fire:

**For Average Accuracy**

# APPENDIX G Clients’ Evaluation Form