University of Namibia

Faculty of Science: School of Computing

CMP 3810: Research Project

Supervisor

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Title: A prototype of Water Level Monitoring System (WLMS) for farmers in Otjinene

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1. Background study

Water is the most important resources for human survival. According to (sciencedaily, 2015) the shortage of water affects around 2.8 billion people around the world at least one month out of every year. Water shortage can be defined as a lack of sufficient water, or not having access to safe water supplies (Paulson, 2015). Namibia is country where more than 1.5 million people rely on subsistence farming and the country is experiencing its worst drought in recent history, which has led to the Government declaration of a national drought emergency (Programme, 2016). Thus it is essential for Namibians to conserve water.

Water shortage is affecting the productivity of the agricultural sector in Namibia. This sector consumes about 75% of water in the country, with the commercial agricultural being the largest sub-sector and communal farmers being the least consumptive (Dirkx, Hager, Tadross, Bethune, & Curtis , 2008). It is difficult for staple crops such as wheat, mahangu and white maize to be grown as they require large volumes of water for growth. Resulting in household food security being compromised. This is because we depend on cereals as our staple food. According to (Kandjeke, 2013)Vision 2030 for the country emphasizes the need to increase agricultural productivity in order to achieve food security

Rainfall harvesting is a way of combating water shortages but, (Kerdiles E, 2015) argued that only 2% of Namibia's land receives sufficient rainfall to grow crops, most rivers flow only occasionally, hence the need for irrigation and other innovative technologies such as water level monitoring systems that can help with the efficient use of water.

2. Introduction

Storing water in water tank reduces the need for the Namibian government to construct new dams. People in the rural areas especially in the farming sector store water in tanks. Most water tanks can be seen at schools and hospitals in this areas. The water is used for cooking bathing and farming. Although people in this areas have water tanks, they do not get notified on the current status of the water level in the tanks and this results in water shortage for long period of time. The methods of

monitoring water levels in water storage tanks in rural areas are simple and cheap but not accurate or dependable.

The research is based on the current challenges that agriculture sector faces in terms of shortages of water in their water tanks, focused on providing an innovative technology that will help farmers manage their water resource .This will reduce or prevent water shortages on their farms. Farmers are more likely to motivated and active with their agricultural activities if they have water access, as they can see that this activities have a chance of succeeding.

The Water Level Monitoring System will monitor water levels on a regular basis and the data captured will be stored in a database to help farmers improve the way they manage their water resource. Farmers will be able to monitor the water levels from any location at any given time. The Prototype will measure water levels in real time and give feedback to the farmers, warning them on whether water levels are high, normal or low through a short message services (SMS).

2.1 Problem statement

Rainfall is very unpredictable in Namibia and for that reason every drop of water counts. When the number of livestock and people increases on a farm, the water level in the tank reduces drastically and within short period of time the water runs out (Johari, et al., 2011). Currently farmers monitor their water level in the tanks using a long stick as a measurement tool or by eye observation. Although these methods are cheap, they have low accuracy level, and lack capability for real-time data capture. Farmers tend to leave their water level unmonitored when they are away on holiday. They do not get alerted early enough about their water levels .This is due to the fact that they do not monitor the water levels on regular basis. Water shortage does happen at any given time when the tank is not properly monitored. Therefore, this is the problem that the researcher is trying to solve.

2.2 Objective

Water shortages results in farming activities being halted .The objective of this research is to solve the problem of water shortage on farms caused by unreliable and inaccurate ways of monitoring water levels in water storage tanks. This will be done by developing a prototype that will assist:

Main objective:

- How to develop a prototype that will monitor water levels on regular basis.

Sub Objective:

- Asses the effectiveness of alerting the user on the water level.
- To provide a platform for the user to monitor water level from any location at any given time.
- Analyze stored data in the database.

2.3 Motivation

According to the headlines by (Menges, 2017)Water crisis continues while dam levels rise. The Namibian, p.5. (Smith, 2016) N$24bn needed to solve water crisis. The Namibian sun, p.5. Namibia has a water crises and it is the headline in most Namibian newspaper. The people who are affected the most by this water crisis are the people in the rural areas. The motivation for this project is from the researcher's personal experience. The researcher found that it is difficult to find efficient, accurate cost effective ways to monitor water levels in rural areas. The researcher is also concluded that there are little to none effective ways of alerting the famers on their water levels. So water shortages are most likely to occur. The researcher searched for alternative ways of monitoring water levels and found that most of these methods where expensive and have low accuracy level. This has led to the development of Water Level Monitoring system (WLMS) prototype that is cost effective and accurate, alerting the farmer on water levels.

2.4 Significance of the study

Water shortage in agriculture is one of the biggest challenges constraining the productivity of this sector. Therefore, this Prototype will not only reduce water shortages on farms but bridge the gap between agriculture and Technology. The study exploits the use of information communication technology (ICT) in agriculture as most rural farmers are not aware of the benefits of ICT. The study encourages other researchers to do further studies on this topic as water crises is not only a Namibian problem but a global issue.

2.5 Scope

The study focuses on how the water level monitoring system can help reduce the water shortages on farms and how this will improve productivity. The Research focuses on farmers in the Otjinene constituency.

3. Literature review

There are many water monitoring system that have been developed by researchers to solve the challenges of water. According to research carried out by (Faustine, et al., 2014) on Wireless Sensor Networks for Water Quality Monitoring. Their research was driven on the need for effective and efficient monitoring, evaluation and control of water quality in Lake Victor basin. The researchers observed that the current traditional methods people use for collecting water samples, testing and analyses in water laboratories are costly and lack capability for real-time data capture, analyses and that the information got from the testing are not sent to the relevant stakeholders on time for them to make informed decisions

The prototype monitors water temperature, dissolved oxygen, pH, and electrical conductivity in real-time and informs relevant stakeholders through web-based portal and mobile phone platforms (Faustine, et al., 2014).The prototype aims at solving the same issues as the Water level Monitoring System, both systems aim at informing relevant stakeholders about the current water status in very timely way so that the stakeholders can make decisions based on the information they received. The system has one limitation. It has no security features .The stakeholders can access the results with any cereals leaving there the information vulnerable to hackers.

Another contribution to the study on ways to reduce water shortage is the Tank Water Level Monitoring System using GSM Network research (Johari, et al., 2011). Their target population is students in hostels. The researchers observe that the student hostels received water from tank at the roof top of the building and that there where was no early warning system. Furthermore, the researchers (Johari, et al., 2011) conducted a research to monitor and alert the person-in-charge through Short Message Service (SMS). This study is one a many studies that explore the use of mobile phones as a way reduce water shortages. The limitation of their research is that their system only uses the SMS platform to alert the person in charge of monitoring the tank. Furthermore, their

system is not web based and as the result it unable to display the current water level in the tank in real-time.

The water crises is a global phenomenon and has led to two researchers from china (Eltaieb & Min, 2015) to also contribute to the research on ways technology can reduce water shortages .Their proposed system is an Automatic Water Level Control System. The motivation for research was to use computing techniques in creating a barrier to water wastage (Eltaieb & Min, 2015) .Their proposed system is cost effective, energy saving and also helps the environment water cycle .The goal for their research is save water for future generations. These researchers also used an Arduino microcontroller .Their System, has automatic control of the pump system .The system switches the pump on or off accordingly and displays the water status on an LCD screen. If the level inside the tank is low, the pump will automatically switch ON and this protects the motor from dry running. When the tank is low a beep sound is generated.

The common objectives of the above literatures done by different researchers from all corners of the globe is to alert stakeholders and people in charge of the current water Status. The researchers believe that alerting people in a more prompt and effective way will reduce the water shortages. They also considered the accuracy and how cost effective the systems are .The water level monitor system will overcome and improve the limitations on the traditional techniques that are used to monitor water level.

The researcher's Water level monitoring System has a security feature for Authentication. The benefits of this security feature is that it validate farmer's right to access the information .The water level monitoring system captures data in the database that can be accessed by the farmer at any given time or location .In future the system will be developed further in terms of having an mobile application for all mobile platforms.

4. Methodology

The aim of this research is develop a prototype that will monitor water levels in tanks for farmers in the Otjinene .The prototype will be developed using a Design Science Research Methodology approach (DSRM). DSRM is important in a discipline such as Information Technology to the creation of successful prototypes (Peffers k, 2007).

DSRM has six steps: problem identification and motivation, definition of the objectives for a solution, design and development, demonstration, evaluation, and communication as illustrated in figure 1.

Figure 1. Illustrates the design science research methodology

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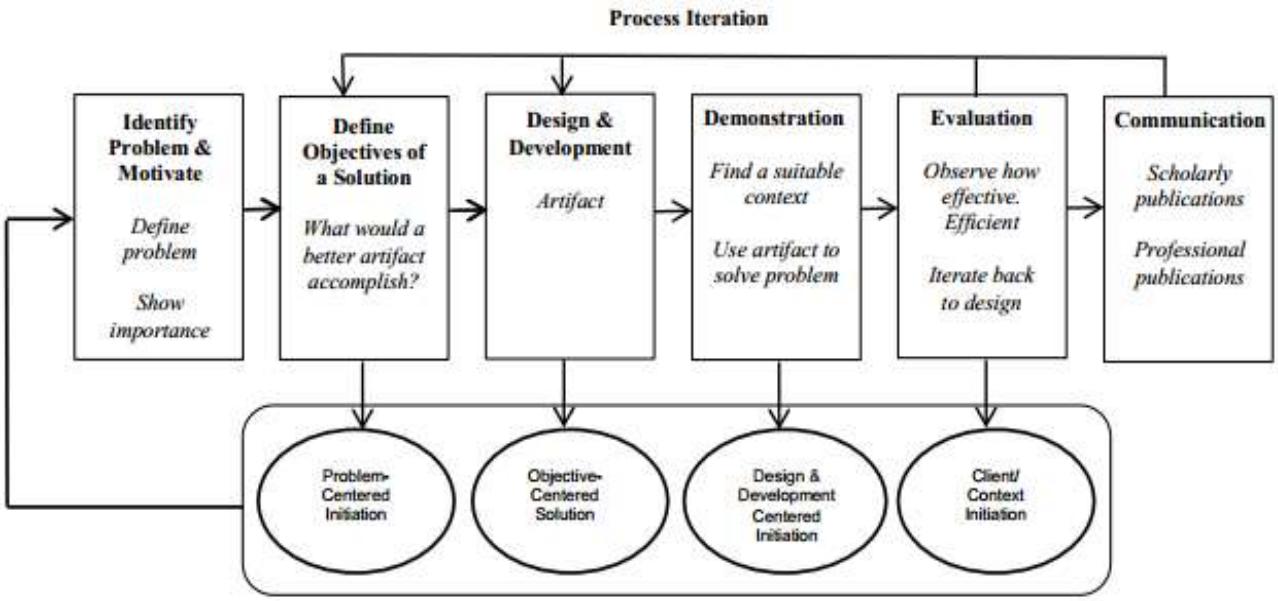


Step one. Identify problem and motivation:

The problem that the researcher observed is that there are water shortages on farms .The water shortages are general caused by farmers not being alerted early enough about their water level. Famers use traditional methods to monitor the water level which are inaccurate and not reliable. Thus, there is a need to develop a system that will reduces water shortages on farms

Step two. Define the objectives of a solutions:

The objective is that the researchers believes that the Water Level Monitoring System (WLMS) will reduce water shortages and increase productivity on farms. The WLMS will alert user early

enough for them to make informed decisions .WLMS will provide a platform for the famer to monitor the water status of the tank from any location. This implies that he does not have to be on the farm to monitor his water levels.

Step three. Design and Development:

The researcher at this step will commence on designing the prototype. It will start with a collecting project requirements, whereby farmers use the system, resulting in requirement documentation. This documentation will be used to design a detailed System architecture and determine the system functionality.

Step four. Demonstration

Through experimentation the researcher will then demonstrate the use of the prototype to solve the problems he identified. The prototype will be tested on a small water container .The test will measure the effectiveness, usability and accuracy of the prototype .The researcher will test the accuracy of the ultrasonic sensor. This test will ensure that the sensor does not give inaccurate results .The researcher will then commence testing the GSM shield to observe the time it takes to alert the farmer on his water level status.

Step five. Evaluation

The researcher will observe and monitor how efficient the prototype supports the solution to the problem. This means analyzing the objectives of a solution to actual observed results from use of the prototype in the demonstration. After evaluation process, the research will have to decide on whether to go back to step three and try to improve the effectiveness of the prototype or continue to the next step.

Step Six. Communication

After successfully completing all the other steps .The researcher should communicate the problem and the importance of the prototype to farmers and other researchers.

5. Design phase

The prototype is composed of three devices: Arduino Uno, Ultrasonic sensor and a GSM shield. The ultrasonic sensor sends ultrasonic waves to the water surface which reflects the waves back to

the sensing head, the time it takes to receive the waves provides it with the distance. The GSM Shield will have a MTC/TN number and will be responsible for alerting the farmer on the current water level .The GSM shield will also transmit the data over the internet, where it can be stored in a local database. Farmers will view their water storage tank water level status over the internet, where it will required for them to enter in their credentials .The information on the website will be easy to understand as it will only display relevant information such water level status. The database will capture the data. Data that can be retrieved anytime by the farmer.

5.1 System architecture

The water level monitoring system will have a simple system architecture as shown in Figure 2 it is composed of the water tank where the ultrasonic sensor and GSM shield will be placed, webserver that will store the captured data, internet and cellphone that will receive the captured data.

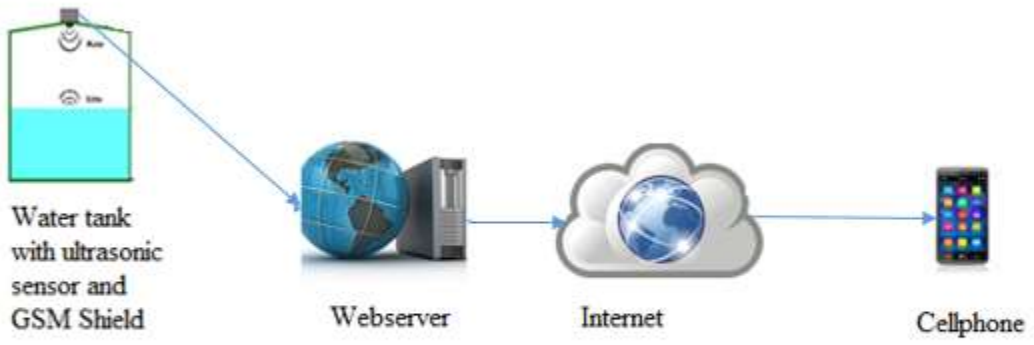
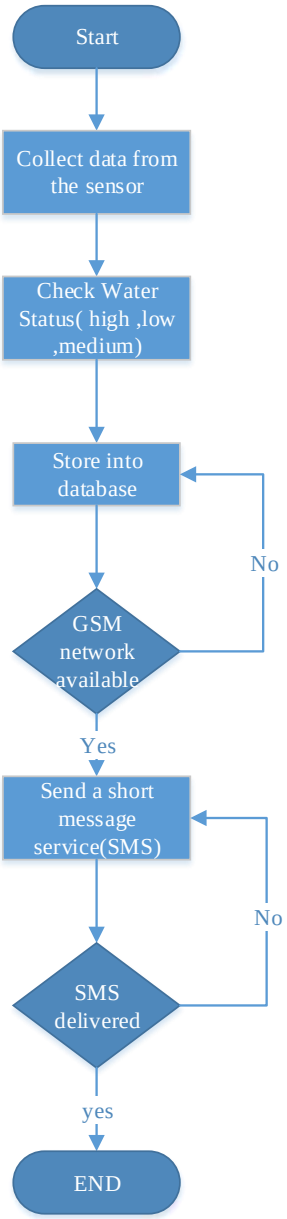


Figure 2

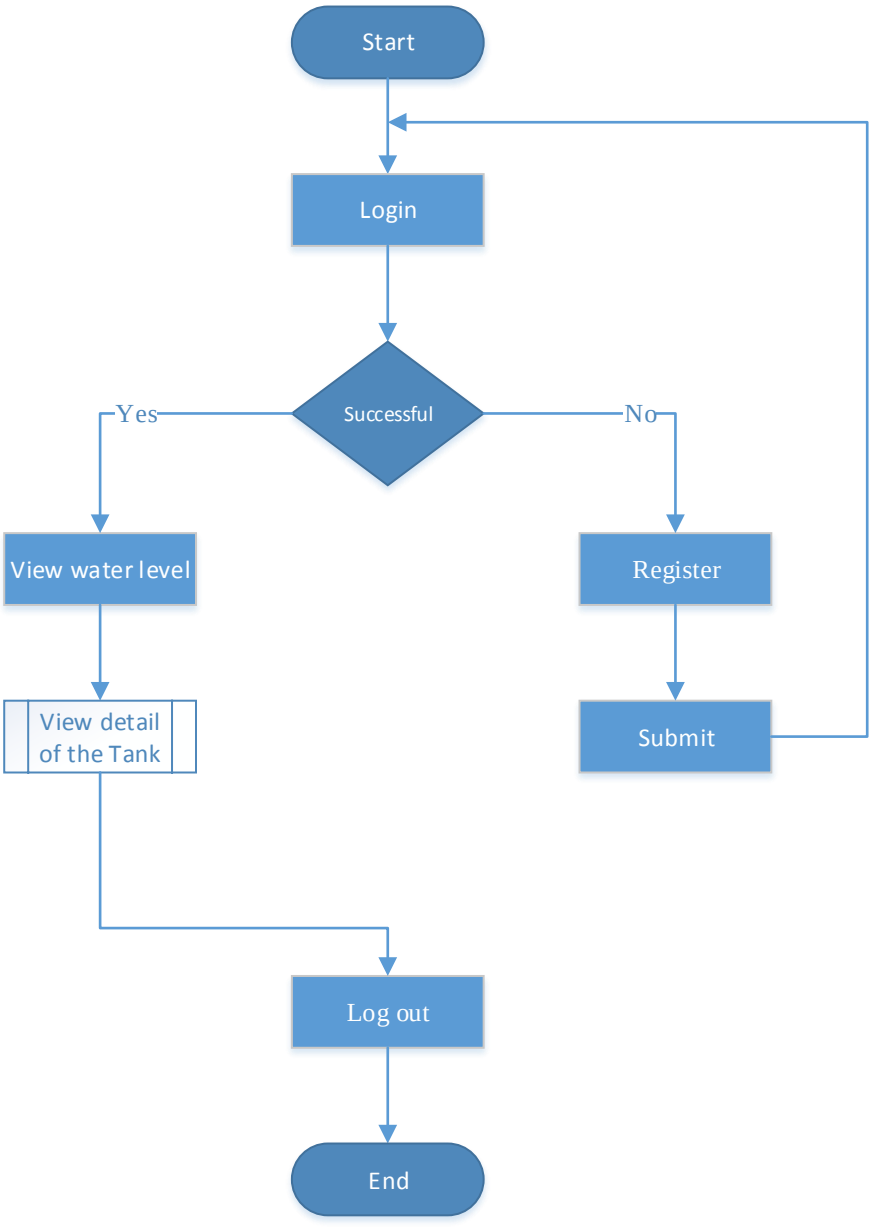
5.2 Flow chart

The illustration in figure 3(a) shows the flow diagram of how the microcontroller will work. The system will collect data from the Ultrasonic sensor on top of the tank .The data collected determines the water level status .The data will then be captured in the database .When there is a GSM network available it will send a short message to the end user.



(a)

The illustration in figure 3(b) How the end user interacts with the prototype. The user login with their credentials assuming that the user has an account already. Then the user can View the water level status. Then if the user can view the saved water level detail. If the user does not have an account. They will be required to register.



(B)

5.3 Use case

Below is an use case diagram that will identify, clarify the organized system requirements .The use case will illustrate the user's interaction with the system

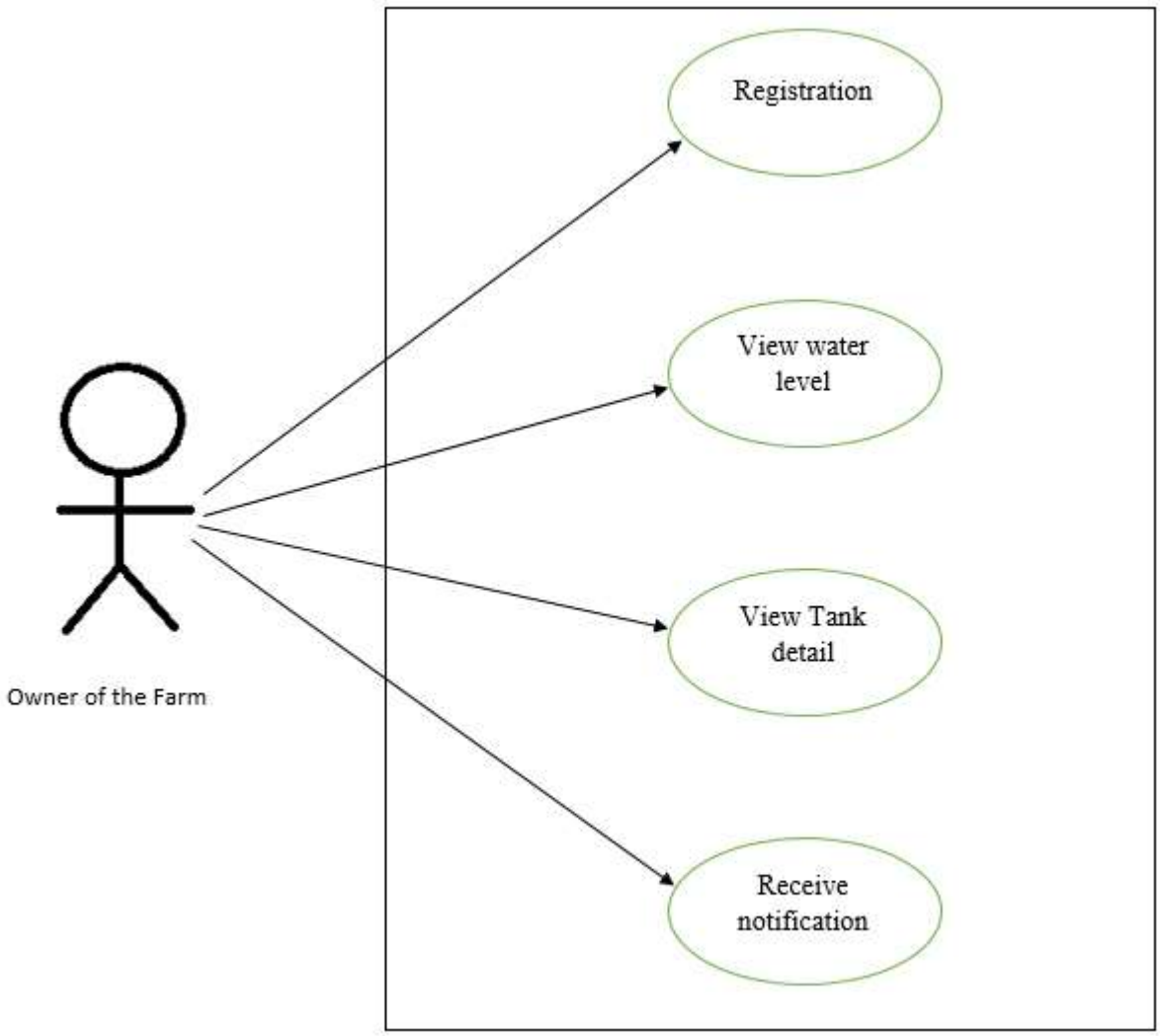


Figure 4

1. Registration

Actor	Farmer
Goal	To Register his tank and himself
Description	The farmer shall register himself and his tank, in order to get credentials to access his data on the web platform

2. View water level

Actor	Farmer
Goal	Display water status
Description	The farmer should be able to view his current water level

3. View details of the tank

Actors	Farmer
Goal	Access the database
Description	The farmer should be able to access the database to view water level data

4. Receive notifications

Actors	Farmer
Goal	Alert the farmer
Description	The farmer should be alerted through short message services on his water status

6. Proposed Schedule

The project is run the whole year, from March to October 2017.The researcher used the Gannt chart .The chart below is visual representation of the project Schedule

Task Name	Duration	Start	Finish
Supervisor assigned	1 day	Thu 02-03-17	Thu 02-03-17
Project Documentation	**160 days**	**Fri 03-03-17**	**Thu 12-10-17**
Topic approval	4 days	Fri 03-03-17	Wed 08-03-17
Proposal Submission	14 days	Tue 04-04-17	Fri 21-04-17
Design	15 days	Mon 24-04-17	Fri 12-05-17
Methodology	13 days	Mon 15-05-17	Wed 31-05-17
Implementation	59 days	Thu 01-06-17	Tue 22-08-17
Testing	9 days	Wed 23-08-17	Mon 04-09-17
Final Presentation	3 days	Tue 10-10-17	Thu 12-10-17

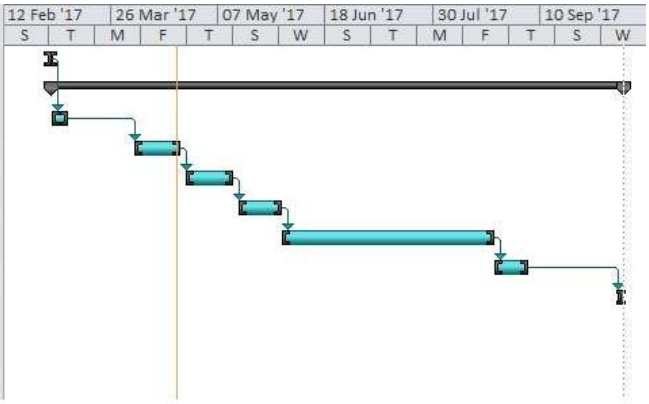


Figure 5

7. Project requirements

This last section will discuss the hardware and software necessary for the successful completion of this prototype

Software Requirements

- Arduino (IDE)
- MySQL server.

Hardware

- Ultrasonic Distance Measuring Sensor HC - SR04
- GSM shield for Arduino
- Cellphone.

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