Home Water Tank Monitoring

Using LoRa technology

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Abstract— Home Water Tank Monitoring is a prototype that can send data to the receiver using LoRa technology. The prototype used LoRa technology because it is a long range and low-cost technology. It shows the communication between the sender and receiver of LoRa technology and notify the user if the water level in the tank is below than 100 litres. A single point water sensor has been placed in the water tank and it will be triggered if the water level is below it. It then sends data to the receiver. As the data received by the receiver, it then displays the data using the serial monitor. Based on the data collected, the data transmitted between sender and receiver need less than three level building. Besides, data can be transmitted 60 Metres with barrier. For future enhancements, the system should be able to notify the user via SMS and keep data in database for analysis. The prototype is using Arduino, LoRa shield and sensor as main components. As a conclusion, LoRa technology work well with Arduino to make this system successful.

Keywords—LoRa, Single Point Water Sensor

I. INTRODUCTION

This project is about home water tank monitoring that using LoRa Technology. LoRa Technology is long range transmission with low power consumption. It is a wireless Radio Frequency (RF) Technology or wireless data communication IoT technology with sensor for remotely measuring and monitoring water. LoRa also a low-cost technology which reduce up front infrastructure investments and operating costs, as well as end-node sensor costs.

Besides, Lora technologies have two parts, physical layer (LoRa) and upper layer (LoRaWAN). Both can be implemented in long range transmission. By implementing LoRa technology in water tank, it can monitor water level and user can be aware that water is getting low in their tank.

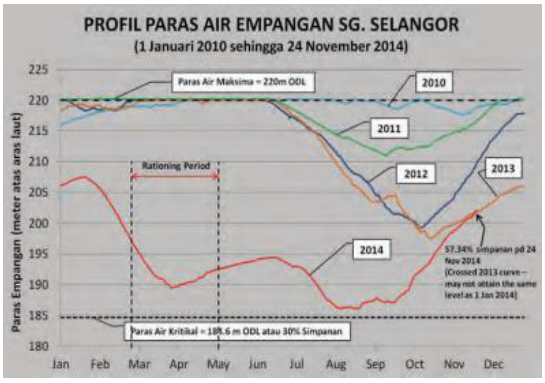
A. Objective

The objectives of the project are:

- To develop a prototype that will detect the level of water in water tank using LoRa technology.
- To monitor the water level of the tank using the sensor

B. Problem Statement

Nowadays, there are so many water issues in Malaysia. Selangor is one of the states in this nation to have the most issue related with the water supply disruption. The water supply problem in Selangor has burdened the people who were forced to carry buckets of water during the disruptions. Having a water tank at every house or resident is very effective way to reduce water issue. This is because Malaysian Water Association has been mentioned that during the water crisis, supply of water could not meet the full demand of water required. The figure 1 shows the water level of dam at Sg. Selangor from January 2010 until November 2014. On 2014 the water level of dam at Sg. Selangor is at critical level [7]. This means, to avoiding the water crisis people will need water tank at their house as water resources.



(Water Malaysia, 2015)

Figure 1: The level of dam at Sg. Selangor

C. *Project Scope*

The scope for this project is to focus on a sensor to detect the low water level in the tank. A single point float sensor is a type of water sensor is placed at a water tank at a low level. The tank that has less than 100 liters water is considered as a low level of water. The sensor sends a signal when water lowers the sensor and the user can monitor through the serial monitor and get notification thru the LED.

II. LITERATURE REVIEW

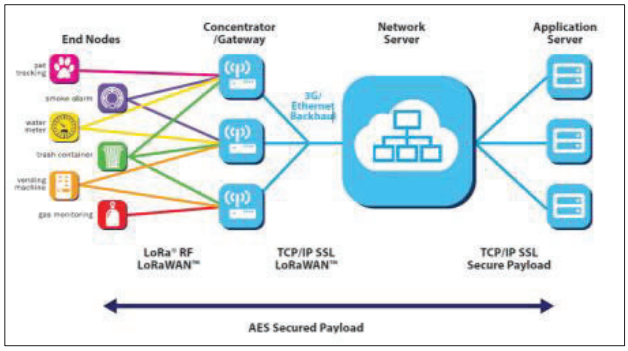
The data collections are being used as a reference for the researchers to gain information about the research that has been conducted. By reviewing the related project on how the project is conducted and the features added in order to make the project successfully running. In every related project, it recommends some future enhancement to improve the projects. Besides, this chapter also discusses the details of LoRa technology, including the definition, LoRa layers and LoRa features. It also includes the detail of single point water sensor.

A. *LoRa Technology*

Lora is wireless technology that design for low power and long-range operation. The LoRa uses a chirp-spread-spectrum (CSS) modulation with different Spreading Factors (SF) and bandwidth to meet the range and data requirement [4]. LoRa technology is suitably used for Internet of Things (IoT), smart metering and home automation. Mostly, LoRa is used for IoT application to solve the problem [1]. For example, implementing LoRa technology in a system for transferring data. The advantages of LoRa technology are it can transmit and receive data for up to 15 km in suburban areas and 5 km in urban areas, consume very little power making it ideal for battery-powered devices and high network capacity [5]. Besides, LoRa provides the physical layer to communication [5].

B. *LoRa and LoRaWAN*

LoRa is a physical layer that enables the long-range communication while LoRaWAN is communication protocol and system architecture for the network [5]. The protocol and network architecture are very important to determine the battery lifetime, network capacity, the quality of service and security [5]. Figure 2 shows the network topology of the LoRa technology. The network topology used is star topology. The end-nodes forward the information of other nodes to increase the communication range and cell size of the network. The increase of communication range can cause the complexity, reduces network capacity and reduces battery lifetime.

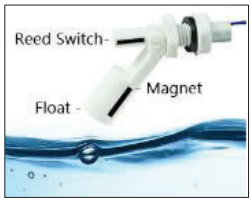


(LoRaWAN What is it?,2015)

Figure 2: Network topology

C. *Single Point Water Sensor*

Figure 3 shows a single point float sensor. Single point float sensor is a level sensor that detects the level of liquid within the tank. This sensor also can be used to control a pump, an alarm and to control other devices. Single point float sensor worked by opening and closing dry contacts to send electrical signals that set off a low water level alarm [6]. The figure 3 shows opening operation with reed switches can complete the circuit once the float reaches its lowest point in the water or when the storage tank is empty. The magnet would disconnect once the water reaches the high level as shown in figure 4 as a closing operation.



(How Do Float Switches Work,2017)
Figure 3: Opening operation

(How Do Float Switches Work,2017)
Figure 4: Closing operation

III. PROJECT DEVELOPMENT

A. *Flow Chart of the Home Water Tank Monitoring*

Figure 5 shows the workflow of home water tank monitoring in the form of a flowchart.

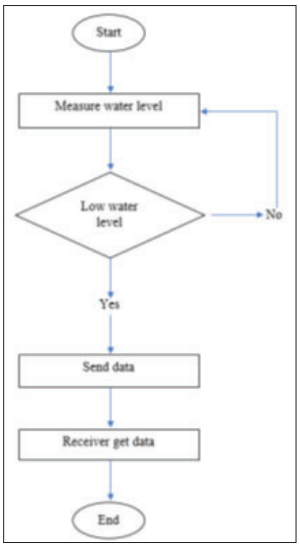


Figure 5: The workflow in the form of a flowchart

B. *Testing the communication of LoRa Technology*

The complete prototype testing to ensure the sender and receiver can communicate with each other via LoRa technology. Figure 6 shows a block diagram of the project flow. The block diagram consists of Arduino UNO, LoRa as a medium for communication, sensor and LED. Figure 7 and figure 8 show LoRa shield, Arduino UNO and a single point water sensor are connected as a sender. Figure 7 shows the sensor is closed when water is at a high level or over the sensor. When water is below the sensor or getting low the sensor will open. Figure 9 shows the schematic diagram of the sender.

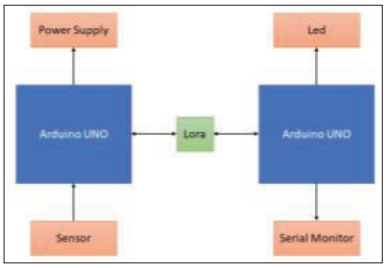


Figure 6: Block diagram of the prototype

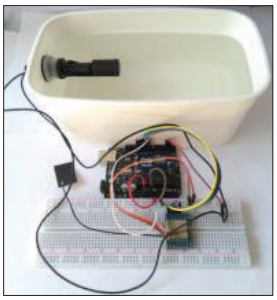


Figure 7: Sensor is closed

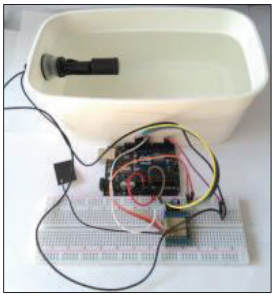


Figure 8: Sensor is open

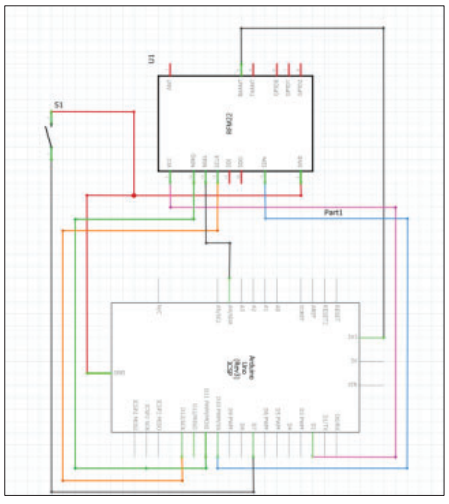


Figure 9: Schematic diagram of the sender

While figure 10 and figure 11 show LoRa shield, Arduino UNO and LED are connected as a receiver. Figure 7 shows when sensor is the closed, the LED is light off as shown in figure 10 and figure 8 shows when the sensor is open, the LED is light up as shown in figure 11. The LCD display cannot be in the prototype because it needs to use 6 digital pins of Arduino UNO while LoRa shield has been used 5 digital pins at the Arduino UNO board. The LED has been used in the prototype as a notification purpose. Figure 12 shows the schematic diagram of the receiver.

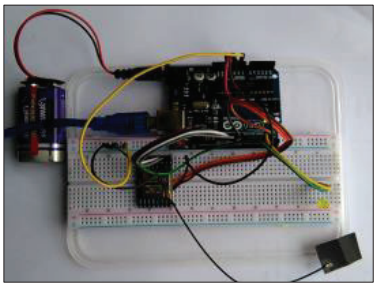


Figure 10: LED is light off

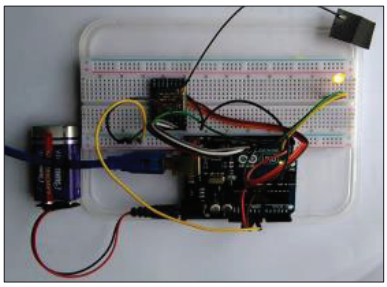


Figure 11: LED is light up

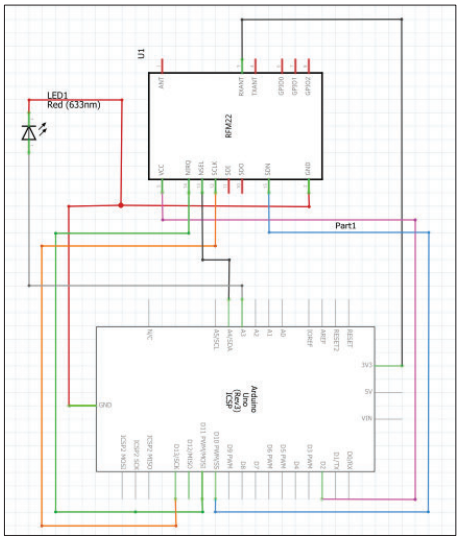


Figure 12: Schematic diagram of the receiver

C. *Results*

The results have been collected by the testing and graph analysis is plotted. Figure 14 shows the graph of connectivity based on the distance of sender and receiver. The sender and receiver are placed at the same floor of the Plaza Rah condominium as shown in figure 13. From the graph, it shows at 5 meters the LoRa can communicate with each other. The graph also shows that data can be transmitted 60 meters with barriers.

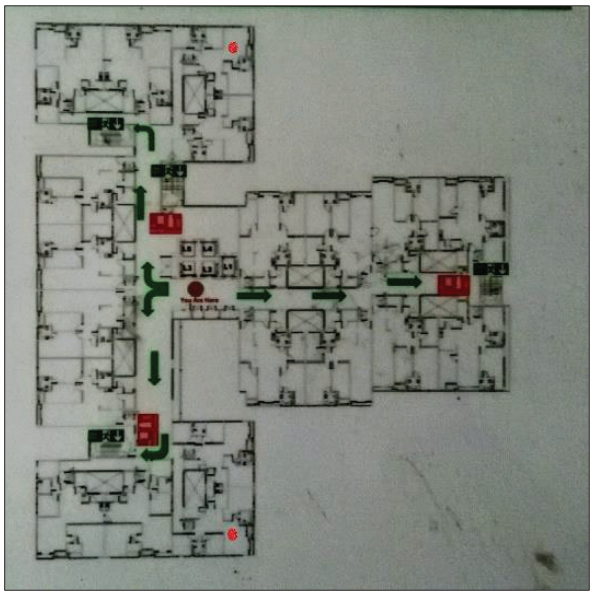


Figure 13: Floor plan of Plaza Rah Condominium

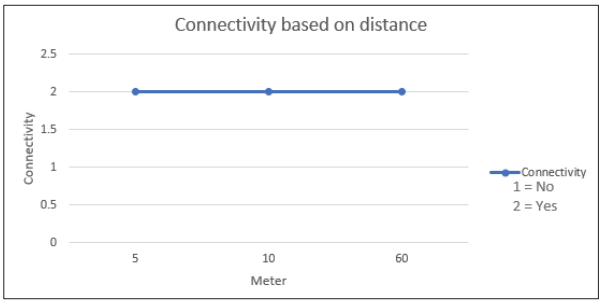


Figure 14: Graph of connectivity based on distance

Next, figure 15 shows the graph of signal strength or RSSI of the LoRa connection between sender and receiver. At 5 meters, the signal strength is -31 dBm while at 60 meters the signal strength is -252 dBm. For RSSI measurement, when signal close to 0 dBm is the better signal. If the signal is -30 dBm it considers as amazing signal strength. When the signal is -80 dBm and below, the signal strength is not good. It is minimum signal strength for basic connectivity.

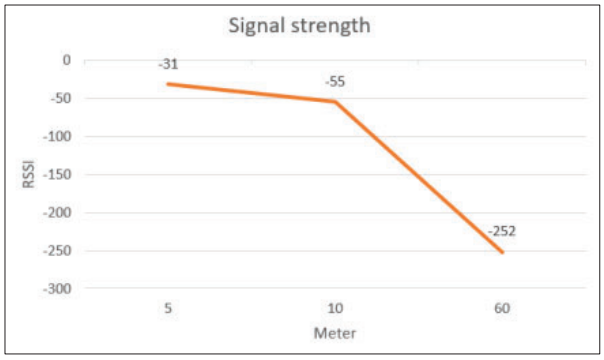


Figure 15: Graph of signal strength

Besides, based on the data collected, the data transmitted between sender and receiver need less than three floor building as shown in figure 17. At floor 4, the communication between sender and receiver is totally lost. It is because the distance is too far away and have many obstacles such as a concrete wall. The testing has been made at UniKL MIIT and figure 16 shows the floor plan of the building.

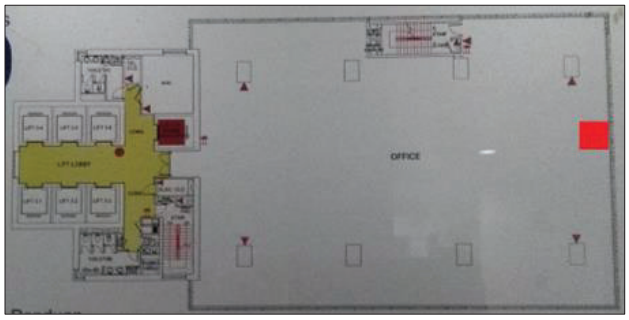


Figure 16: Floor plan of UniKL MIIT

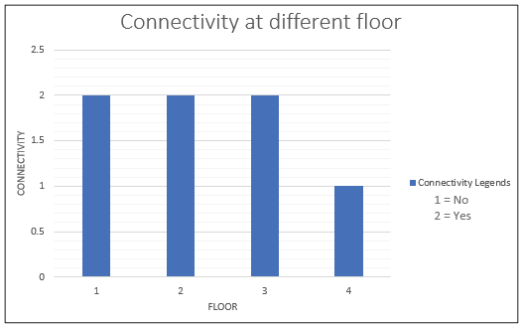


Figure 17: Graph of connectivity at different floor

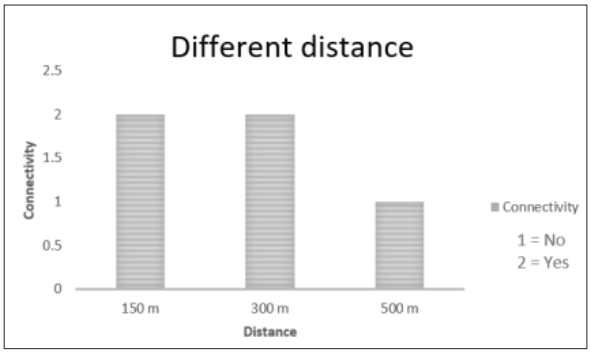


Figure 18: Graph of connectivity at different distance

Based on the graph shown in figure 18, data can be transmitted at 300 meters during the outdoor testing. The communication already lost when distance reach at 500 meters. From the graph, at 500 meters the system cannot connected each other during outdoor testing because block by obstacle such as cars, motorcycles and trees. Besides, the project has been compared with the previous related projects as shown in table 1.

Title	Toward Intelligent Agriculture Service Platform with LoRa-based Wireless Sensor Network [1]	Water Tank Monitoring and Visualization System Using Smart-Phones [2]	A Study on real-time Flood Monitoring System based on Sensors using Flood Damage Insurance Map [3]	Home water tank monitoring using LoRa
Purpose	To develop an intelligent agriculture service platform	To design a smart-phone application that can analyzes data	To design a linkage system	To monitor water level in tank
Method	Using LoRa technology	-Database -Web page	-Using LoRa technology -NB- IoT	Using LoRa technology
Type of Sensor	-Environmental -Humidity -Light -Carbon dioxide	-Data	-Acceleration -Tilt -Level	-Water
Testing	Mean error of temperature and humidity	SQLite for monitoring system	Use tilt sensor for minimize power consume	Distance
Result	Sensor 2 -The lower mean error of temperature and highest in humidity	Not suitable for external database	Need to add ON/OFF function	Only can communicate at 3 level building

Table 1: Comparison with related projects

IV. FUTURE RECOMMENDATION

For future recommendation, there a few aspects of the project that can be improved. The Home water tank monitoring system should be able to notify the user via SMS. By notifying the user via SMS, user can be able to be at 10 km away from their house. A suggestion to keep data such as bandwidth, signal strength and battery consumption in the database for analysis purpose. Besides, the Home water tank monitoring using LoRa technology can apply at another place such as a farm. For future enhancement, the system should have multiple types of sensor

V. CONCLUSION

As a conclusion, LoRa shield SX1278 able to function as wireless technology and work properly for the project. The developed prototype has fulfilled the objective to develop a prototype that detects the level of water in the water tank using LoRa technology. The sensor triggered when water is below it and send data to the receiver via wireless communication. Besides, the results show the Home water tank monitoring using LoRa technology provide an advantage to the user which is the user can monitor the water tank at long distance. User no need to be worried to use the water in the tank during the water disruptions. The prototype is easy to use and easy to set up at the real water tank. In conclusion, the Home water tank monitoring helped user know the volume of water in the tank.

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