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Hybrid Self-Powered Water Regulation for Residential Area

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Abstract: Water is one of the greatest necessities for humans. The lack of water resources can affect the daily activities of people. Therefore, it is important that we as consumers should have a thrifty attitude without any waste of water. Water shortage also can be caused by the damage of the old water pipelines. This is due to the pressure of water flow in the pipeline. The higher the demand the pressure will increase and cause the pipeline to leak. Therefore, this study has been conducted to create a water distribution system according to the capacity that has been set for an individual which is 160 litres per person per day. Water will regulate the same amount of water into the residential houses. This system uses mini hydroelectric energy where it will generate electricity by itself through the flow of water in the pipeline. This electrical energy will also turn on the solenoid valve that functions as an open and closed for the water to flow to the tank. The water tank for each house is measured by the capacity of the occupants of a house. The volume of water is measured using a water detection device to measure the water in the house tank. The water level will also be measured using an ultrasonic sensor to detect the distance and to give a signal to the solenoid valve to close the water pipe.

Keywords: Water shortage, Water pipelines, Solenoid valve, Ultrasonic sensor

1. Introduction

Water is a priceless natural precious need of living things. Almost 3/4th of the earth's surface is waterlogged [1]. Among it 3% is of consumable water by the human beings. Human body contains 70% of the water. Studies show that they can live more than a week without food but only a few days without water. This illustrates how important water is in our lives [2]. It is also reported that this audible water quantity is reducing day to day and will finish by 2050 [3]. If it is not conserved in a proper way, it will be very difficult for human being to live. In October 2016, water treatment plants located in Langat and Cheras were shut down due to the foul-smelling pollution suspected to originated from Sungai Semantan in Pahang [4]. October 9, 2018, four districts of Selangor faced water disturbance for a maximum period of 72 hours. It was due to the facilitate equipment replacement works at the Sungai Semenyih Water Treatment Plant (WTP) [5]. Many more are reports of leaking and burst of main pipelines [6]. The cause of it can be due to the decay of life

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and/or pressure increase with respect to the demand. Water issue has become more worse in the Selangor area due to the impact of infrastructure and the population of residents [7].

The UN has set a water requirement of 160 litres per person per day [7]. While Malaysians use an average of 201 litres of water per person per day, equivalent to 134 bottles (for the capacity of 1.5 litres each). This can be one of the causes to damage the old pipelines [8] due to same pipeline but increase of supply to fulfil the demand. The proposed developed self-powered water distribution and monitoring system will supply the limited water to the consumers according to their demand (as per number of residents) @ 160 litres per person per day.

2. Materials and Methods

In Figure 1, the microcontroller will receive the data from the ultrasonic sensor which will detect the water level in the water tank. The water flow sensor and solenoid valve were designed by using the Arduino Uno controller where the programming to stop the water flow will be coded in the Arduino IDE software.

The sensor and solenoid valve both will receive a signal from the microcontroller and at the same time, the water flow sensor will measure the amount of the water that flows through the pipe. The relay module connects to the solenoid valve to turn on and off as the microcontroller is only 5V, but the solenoid valve is operating at 12V. For purchasing components such as Arduino Uno and sensors are available at the electronic shops and online shops such as Cyctron, Aubotic, RS Components, and Mybotic.

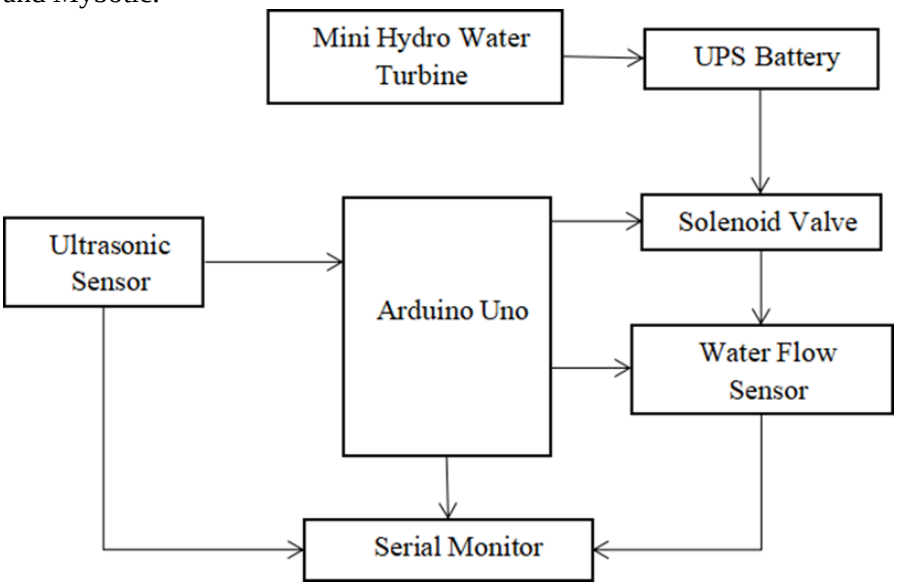

Figure 1: Block diagram of system project

Figure 2 is the hardware connection. There are several essential components used to develop the hardware monitoring system of this project. Firstly, the Arduino Uno board is used as the main component for the monitoring system. All the coding for each sensor related to this project will be uploaded to the Arduino Uno board. Secondly, the part of sensors will connect to a digital pin in the Arduino Uno board. There are a few sensors that is used in this monitoring system such as an ultrasonic sensor, water flow meter and solenoid valve. An ultrasonic sensor is used to measure the water level in the water tank while the water flow meter will be used to measure the flow rate of water. The solenoid valve will act as a switch where it will open and close once the water tank is full or empty.

After the connection, operate the Arduino Uno board to get the reading of each sensor. Lastly, the UPS battery will replace the power supply 12V to activate the solenoid valve but at the same time, it will be connected to the voltage regulator to step down the voltage to 5V to supply the microcontroller and ultrasonic sensor. By using this UPS battery, it can be recharged again by using the current that will be given from the water mini hydroelectric generator.

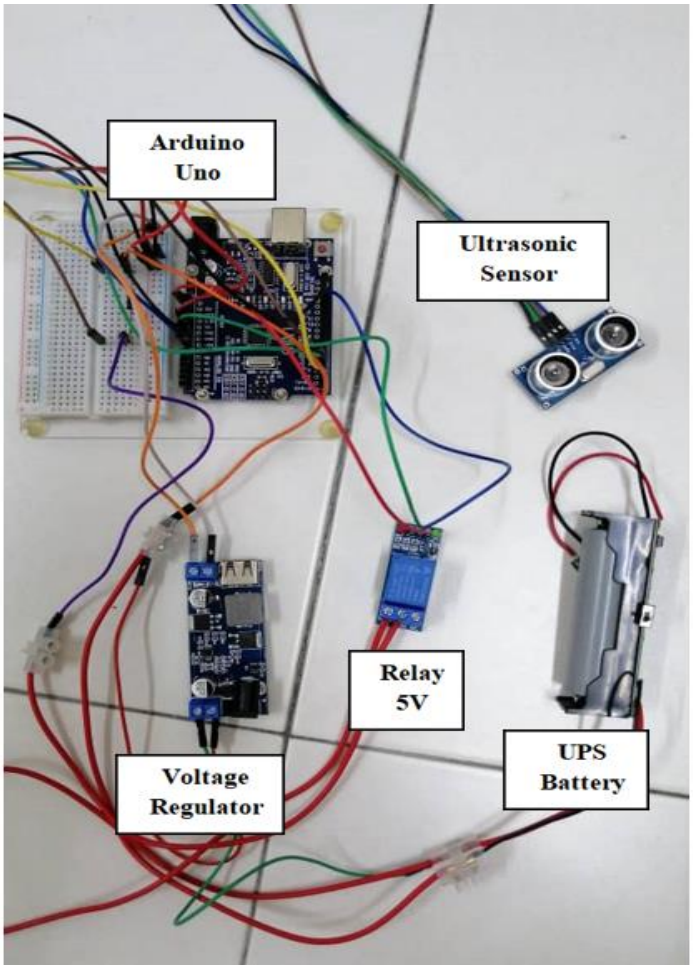

Figure 2: Hardware connection

Input terminal of UPS battery in Figure 3 is connected with the mini hydroelectric generator to store the energy that generate from the water flow through the pipelines. It then gives the 12V output to the solenoid valve to open or close the water pipeline. Switch is to turn on or turn off the battery.

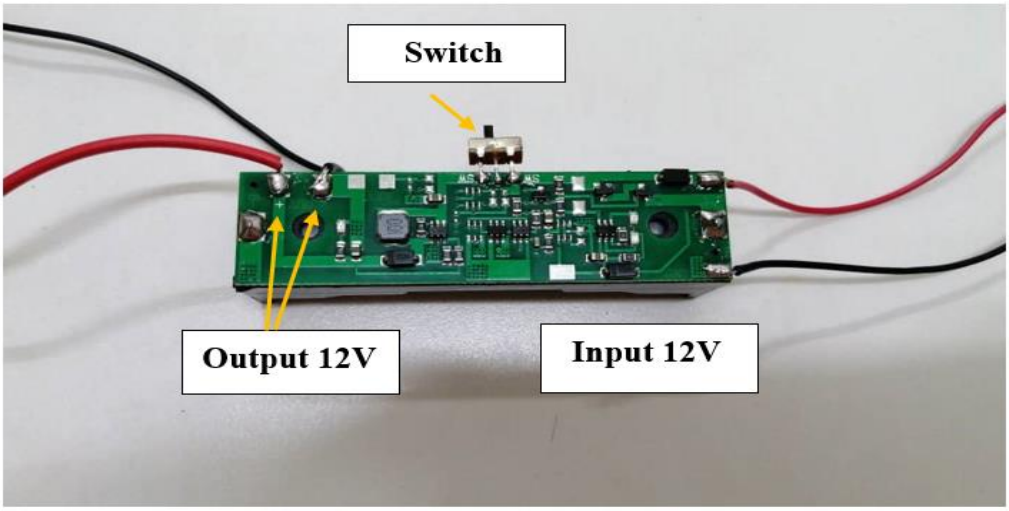

Figure 3: UPS 12V battery

Figure 4 shows the whole prototype of hybrid self-powered water regulation. There is an ultrasonic sensor attached to the water tank. There is also a water flow meter on the left side, a solenoid valve on the middle side, and a mini hydroelectric generator on the right side.

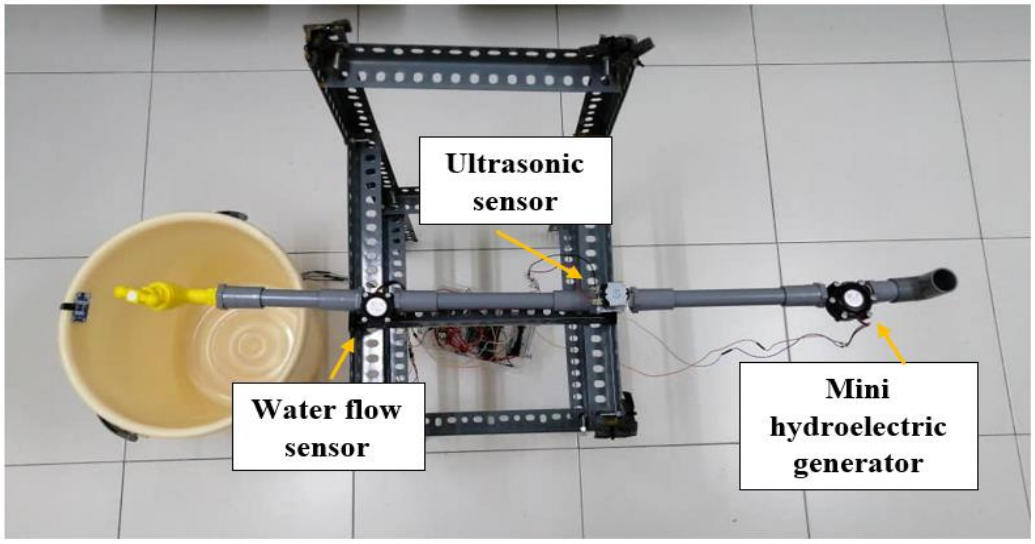

Figure 4: Hardware prototype

3. Results and Discussion

This system is directly connected to the monitoring system by using the serial monitor of Arduino IDE. The data was recorded based on the ultrasonic sensor detection and water flow meter performance. The maximum distance of the water tank is 33cm. The water tank used to measure the distance is shown in Figure 5.

Figure 5: Water tank

A. Water Level Data Collected

From Figure 6, results for ultrasonic sensor detection of the water level have been recorded from the serial monitor of Arduino IDE. The percentage started with 10% of water fill and the distance of the water surface and ultrasonic sensor is 28 cm. During the 50% of water fill, water volume is keep rising and the distance between water surface and ultrasonic sensor is 16cm. When the percentage reached 100% and the distance value set is 2 cm to turn off the solenoid valve. The solenoid valve will automatically stop after receiving a signal from the ultrasonic sensor.

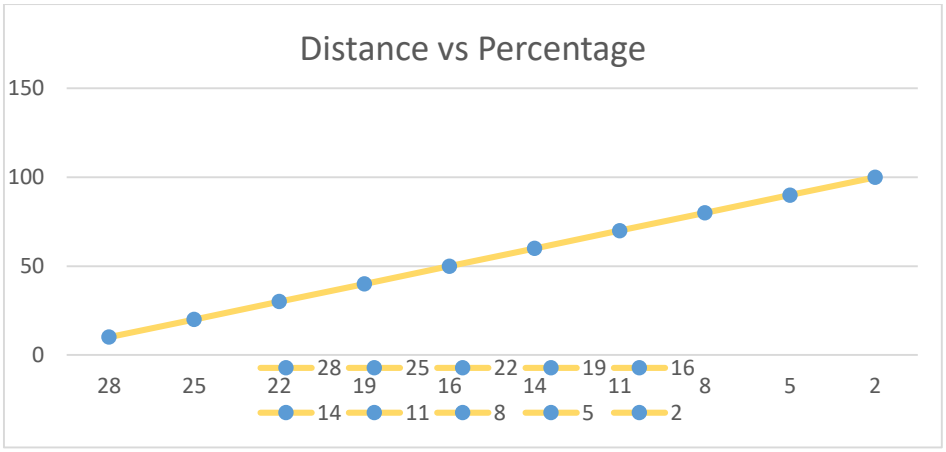

Figure 6: Distance and percentage of Ultrasonic Sensor

Figure 7 shows the distance of water surface to the ultrasonic sensor is 25 cm and the percentage of water fill is 20%. The solenoid valve is open.

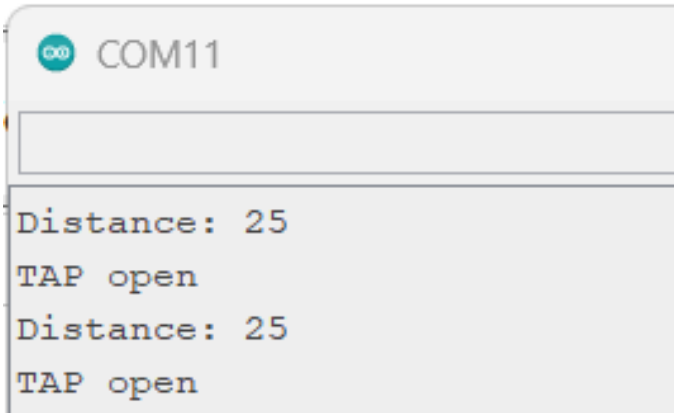

Figure 7: 25 cm distance from water

Figure 8 shows the distance of water to the ultrasonic sensor is 2 cm and the percentage of water fill is 100%. The water tank is full, and the solenoid valve is closed. Water will stop flowing.

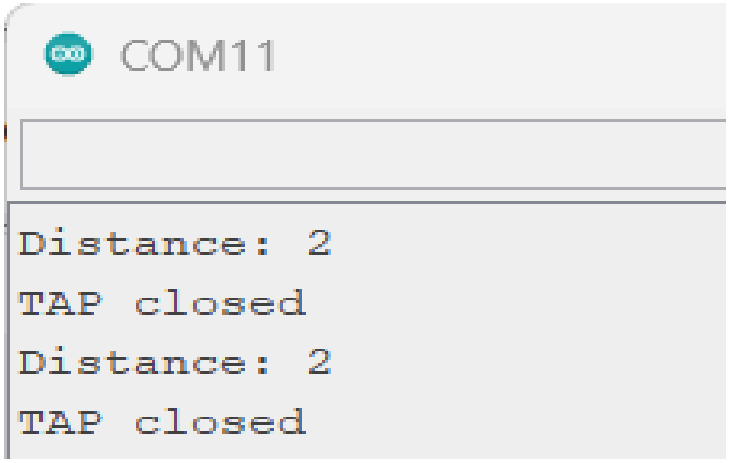

Figure 8: 2 cm distance from water

B. Volume of Water Tank Data Collected

Figure 9 shows the graph a time vs volume of water flow in the pipeline to the water tank. The first minute for the water flow sensor measured volume is 13L. After 2 minutes, the water flow sensor measured volume is 24L. After 3 minutes, the volume of water measured increases to 33L and lastly after 4 minutes, the water measured is 38L and remain constant.

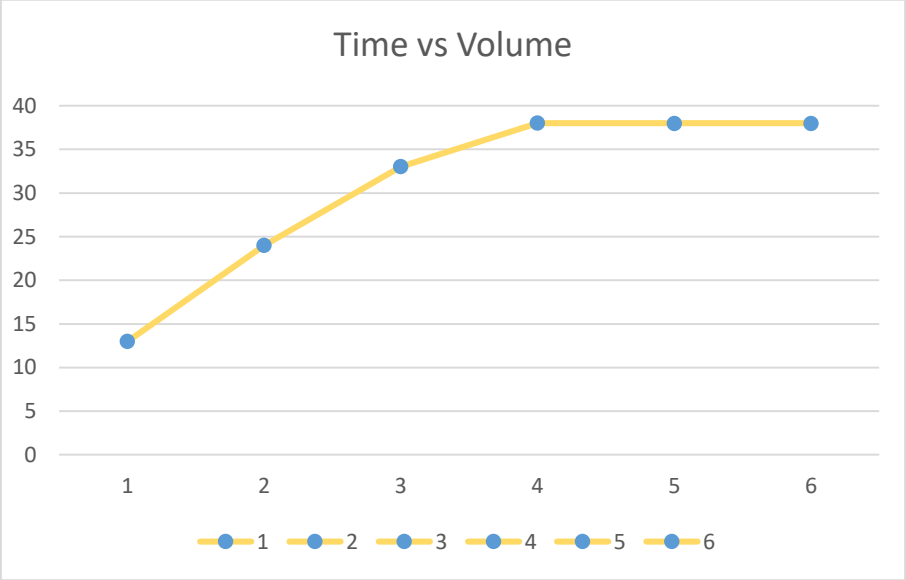

Figure 9: Volume of water tank

Figure 10 is the first minute of water flow sensor measured the volume of water flow. The water quantity is 13553 mL or 13L.

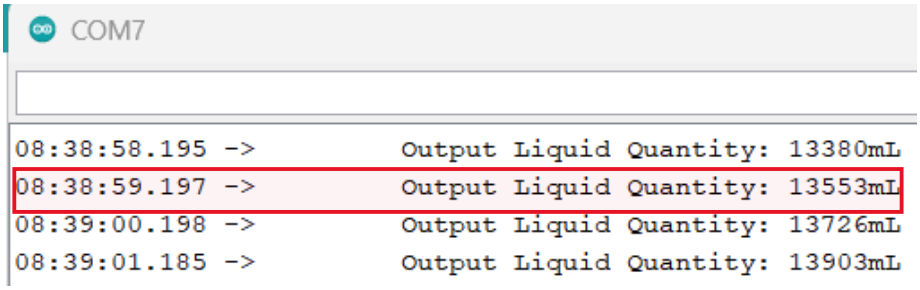

Figure 10: Water measured is 13553mL

Figure 11 is the fourth minute of water flow sensor measured the volume of water flow. The water quantity is 38144mL or 38L. This shows that the water tank is full and solenoid valve is closed. No water flows in the pipeline and the measure value remains constant.

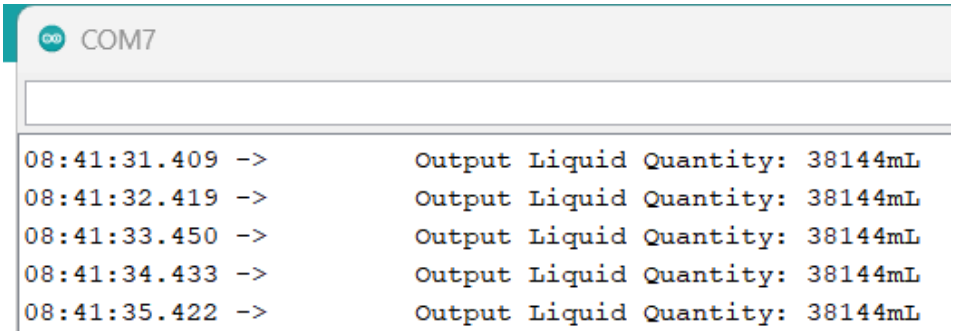

Figure 11: Water measured is 38144mL

4. Conclusion

In conclusion, the development of the prototype for Hybrid Self-Powered Water Regulation succeeded. This project's objective is also successfully achieved. The system has been successfully created where the amount of water and the measurement of tank water can be measured using a water flow meter. Other than that, a mini hydroelectric generator also can generate power through a water pipeline when the water flows into the tank. The UPS 12V battery will restore the energy and at the same time will give a supply to the solenoid valve to operate. This shows that the first objective of the project succeeded. For the second objective, to regulate the same amount of water in the water tank, a calculation is provided in the results. The coding will be coded into the Arduino Uno to enable the water flow sensor to calculate the right amount of water needed by the residents.

Acknowledgement

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