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Design and Development of Controlling System for Auto-Sludge Removal System for Highland Irrigation

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Water is a basic daily life resources, without water many house work cannot be done. Residents in the rural areas such as the aborigine uses natural uphill water as their main water sources. The reservoir had been constructed in uphill area which can cause sludge formation and the water will turn cloudy. It will cause energy and time to remove the sludge in the uphill area. Thus, this project is made to help the aborigine to remove the sludge automatically using the power from the solar energy. This control had been equipping by timer, relay, battery, solar charger controller, and solar panel. This device can operate automatically for about 20 minutes.

Keywords: Sludge, automatic, solar energy

INTRODUCTION

Irrigation system is known as a technology to supply water easily to the consumer. In rural areas, the irrigation system is important to supply clean water to the aborigine. Irrigation is an evolution so water can be supply for the use of agricultural or daily use. Residents should beware that water that irrigate from natural sources are not completely clean, as it at least has some bacteria that may contain regularly in rivers and streams. These bacteria cannot be prevented but the water can be clean from soil or any precipitate in the rivers and streams which can form sludge. In hydroponic systems and drip irrigation, growers can use poor microbiological quality water which avoid contact between the edible part of the crop and the irrigation water. Water quality can affect the crop growth and development. Similarly water quality, growth regulators and phloemic stress can regulates crop growth and development

(Moneruzzaman et al., 2010a; Khandaker et al., 2011). The ways that can be taken to prevent this sludge is by removing it by hand or create a new technology. The natural water resource is exposed to environment; so many other substances will enter the water source such as leaf, debris and rock. Thus, the natural water resources need to be filtered depends on how long the water been stored. Irrigation system for the aborigine is taken from the highland ground which it is the highland irrigation system. Irrigation in mountains is found in found in two distinct ecology zone such as valley bottom and highland slope which is the highland irrigation system. Along valley bottoms usually the communities construct flood control device to prevent rainy season inundation the community fields (Mitchell, 1976). Based on Murra (1960), it states that highland irrigation is not common usage, but it also can be source for watering the crop. Irrigation

systems may be more successful if based on an analysis of water deficit within different growth stages and in different regions (Zhao-fei et al., 2013). Therefore, highland irrigation system is developed to help the community in rural areas to easily get daily water supply from the highland water source. Highland irrigation system also provides water for crop cultivation (Mitchell 1991). The community in rural have a difficulty in finding clean water resource, thus they need the highland water source. The irrigation system helps the rural community to get the water easily. Highland irrigation is also important although it receive more rain. Highland irrigation is small and decentralized. Usually, it is transmitted through directly from the water source or indirectly via small reservoir. The water from highland ground usually collected from small streams, springs and the runoff. Highland irrigation is stated uphill and it is in open environment, where they are collected in a reservoir that does not have any closure, which will cause sludge to form in the reservoir. Sludge can be form when water flow down into reservoir bringing foreign materials such as leaves, twigs, moss and other things. The formation of sludge in the reservoir will cause the rural community to climb up the hill and clean up the sludge (Hudzari, 2015). If the community does not climb and clean the sludge, it will cause the sludge to be thicker and become harder to remove. This will waste the community energy and time. Based on Hofmann (1990), there is lack of experience to remove the sludge that is thickening in water thus resulting in sludge are hard to remove. According to Solar Energy Industries Association (SEIA), solar energy is the energy from the sun that is converted into thermal or electrical energy. Everybody knows that the sun is big and it have a ball-like shape with heat and light resulting from nuclear fusion at its core. The nuclear reaction exist will releases energy that travels outwards to the surface of the sun. The energy will transform to light energy on the way it gets to the surface of the sun. The sun will release two types of solar energy that reach the Earth which is heat and light. The light energy from the sun is converted to electrical energy for immediate use or stored for later use (Langley, 1983). Plants use the energy of light to convert carbon dioxide (CO₂) and water (H₂O) into carbohydrates during photosynthesis. Growth regulators can stimulate photosynthesis (Khandaker et al., 2013a) and flowering, fruit develop and accumulates of nutrients in crops correlates with photosynthesis (Moneruzzaman et

al., 2012; Khandaker et al., 2013b). The solar energy is renewable energy compare to gas and oil which is non-renewable (Bagnall, 2008). The solar energy also is free and it does not cause pollution to the environment. Like petrol and diesel energy, it will produce gases when it is use which can cause air pollution. This will destroy the environment. Solar energy can be used when it is converted to electrical energy in the form of photovoltaic array and the output will fed through an inverted and other control circuitry to form electric current (Langley, 1983). In this project, the solar energy is converted using a solar panel. The solar panel used in this project was polycrystalline and the maximum system voltage is 600 V and with maximum power of 87 watts. This solar panel are produced from several types of liquid crystals where it put into molds and frozen with CVD process chemical vapor deposition (Granqvist, 2004). When we looked at the outer layer with naked eyes, we can see it is consisting with substances like an abstract of broken glass crystal. The solar panel needed battery so it can store for further use (Shokeri, 2014). Thus, it also needed solar charger controller for automatically controlling the charging process where it able to cut off the excessive current if the battery has been fully charged (Hudzari, 2015).

In this project, the gate that helps to clean the sludge is the solenoid valve. Solenoid valve is the best choice to make an automatic control gate for the sludge to flow out. Solenoid valve is consisted with an electromagnetic coil that capsulated in yoke. In the center of the electromagnetic coil, there is a longitudinal hole and in the hole there is a cylindrical plunger guide connects with it. The solenoid valve can be open and close when there is a current flow to the electromagnetic coil. When there is a current flow, the plunger moves the end plate. This is because by the electromagnetic force that cause by the flow of current. There is a prove that solenoid is use for water supply control in recent years, such as a privates washing devices (Kazuo, 1997). The solenoid valve that is use in this prototype for the auto-sludge removal is 12V solenoid valve with size $\frac{3}{4}$ inches. The coil DC resistance is powers approximately for 39 ohms. The current is about 300mA at 12VDC, and it can work continuously without overheating (Cytron Technologies).

The aborigine needed clean water resources for their agricultural usage and for daily use. Water quality also affects the plant growth and development. Uptake of water by plant parts regulated by temperature (Moneruzzaman et al.,

2010b). However, due to the topography that is hilly and steep slopes and bad weather conditions often causes the quality of the natural water resources become less favorable. Most of irrigated agriculture is heavily dependent on lower water quality and less desirable sources (FAO, 1985; Islam et al., 2004). At the earlier decay, water quality concerns have often been neglected because good quality water supplies have been plentiful and readily available (Dhirendra et al., 2009; Megersa et al., 2009). The water will turn cloudy due to the sludge that precipitates in the reservoir. Their rural areas at remote sites make it difficult to get water and supply electricity. The irrigation system that has proper management will produce better quality of water. However, the open reservoir system causes much garbage from the environment to precipitate on bottom of the reservoir which will cause bad water quality. The result from the sludge formed, it will cause the water supply from the villagers to become less favorable and can causes sickness to the villager. When the sludge has causes the cloudy water, the aborigine need to climb up the hill to clean it which will cause danger due to the wildlife and it will be time

consuming. It will become worst when it turns to rainy season where the hill area will be slippery and can cause unwanted incident to the aborigine. The used of solar system can cause high costing during the early installation. The solar system requires maintenance when it is unable to collect sunlight energy well. This system also requires some basic things which some is in high cost such as solar panel, solar charger controller, inverter and battery. In order, to operate this system, a knowledgeable operator and a skillful operator are needed. The objectives of this study is to create a prototype of controlling system for automatic sludge removal and to apply the effective use of solar energy.

MATERIALS AND METHODS

The materials needed for this experiment are: Solar Panel, Solar Charger controller, Battery, Plastic box, Timer, Fuse, Connector Block and Sludge Removal. The controller box need to be installed with the solar panel, battery and the solar charger controller to make a complete circuit for the controlling system for the automatic sludge removal.

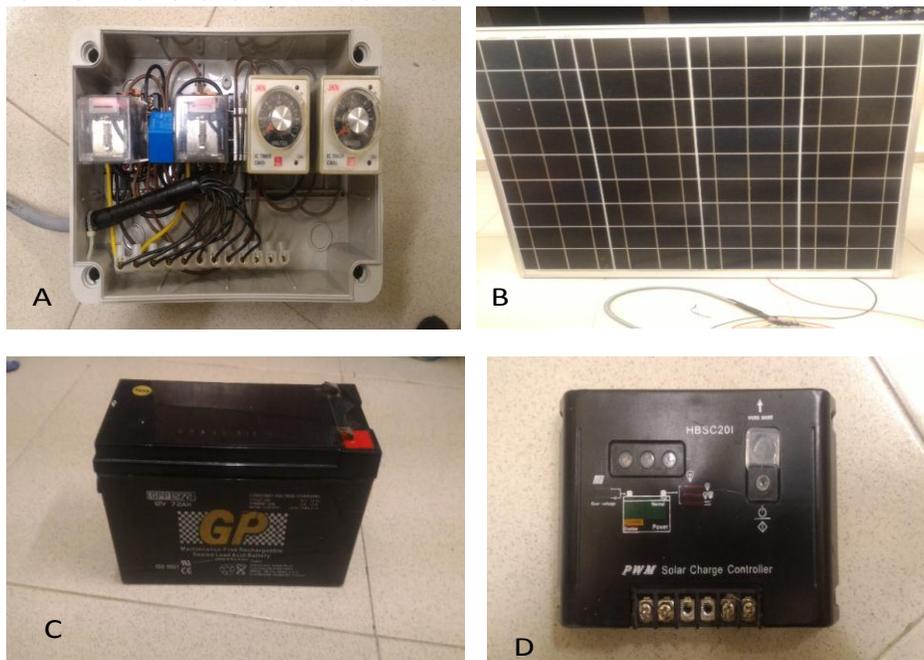


Figure 1. A: Complete circuit of controller box. B: Solar panel. C: 12V capacity battery. D: Solar charge controller

Methods

In this project, the starting point was to design a rough sketch of the electronic control circuit.

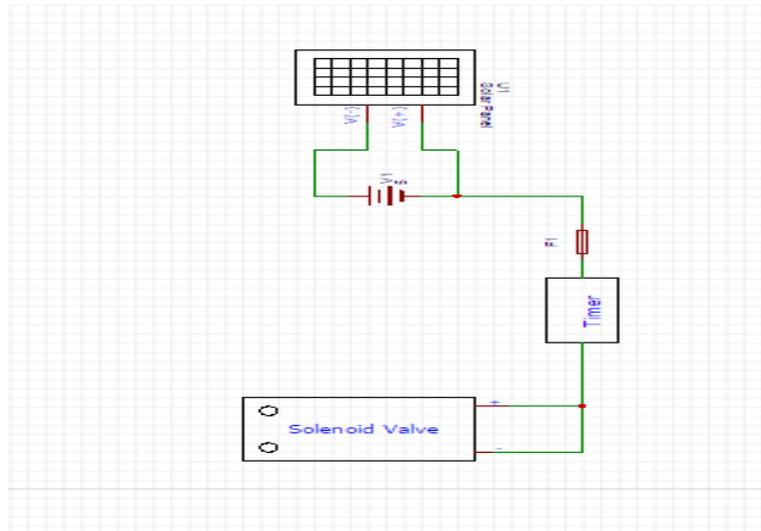


Figure 2. Sketch of electronic control circuit

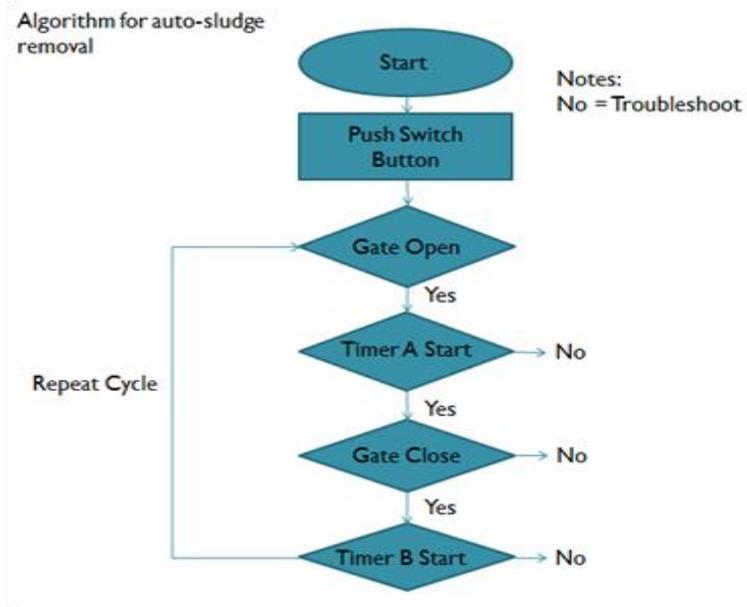


Figure 3. Algorithm for auto-sludge removal.

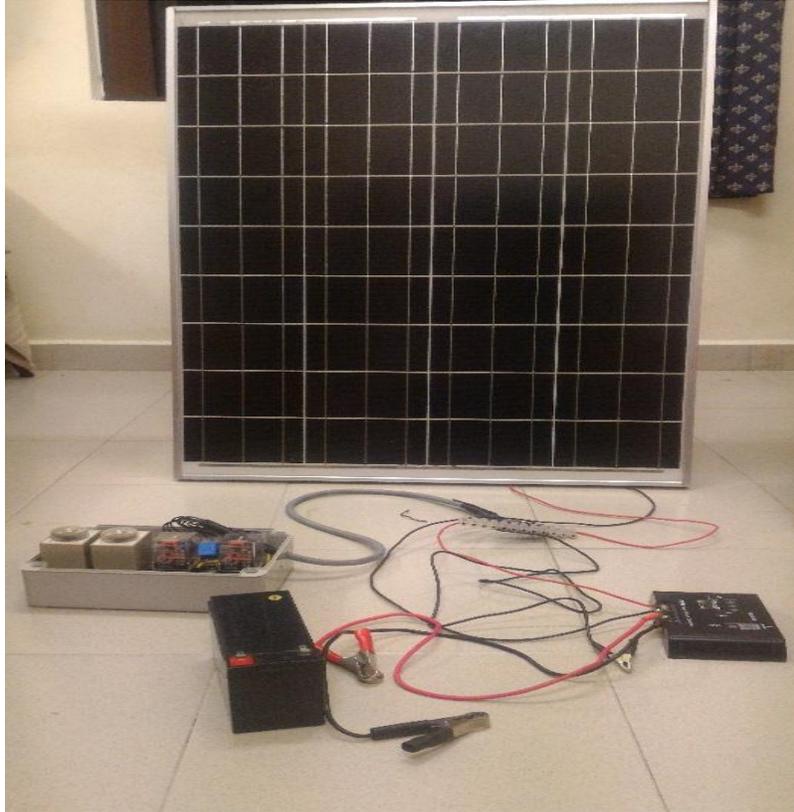


Figure 4. Complete circuit of controlling system for automatic sludge removal

RESULTS AND DISCUSSION

This project objective is to create a prototype of controlling system automatic sludge removal and measuring the effectiveness of solar panel. To measure the effectiveness of solar panel, it can be measured by testing time of solar panel charge the battery and discharge the power to the solenoid valve for 20, 40, 60, 80, 100 and 120 minutes of charging. This project is to helping the aborigine that have problem getting clean water from highland irrigation water system. The water will turn cloudy cause by the sludge that form in the reservoir uphill. The factor of emphasis of this project was the solar panel and the adjusted time to supply power.

Solar Panel

The solar panels used in this project were Polycrystalline which have maximum system voltage of 600V and a maximum power of 87 watts. This solar panel is produced from combining several types of liquid crystal where it pours into molds and froze using CVD process (chemical vapor deposition). As we can see the

solar panel is like the combination of a broken glass (Figure 3.3). The solar panel is function as converting solar energy into direct current (DC) and this DC is then stored into battery, which 12V-capacity batteries type were used in this project (Figure 3.4). Therefore, to avoid excessive energy that supply into the battery we use the solar charger controller (Figure 3.5) to for automatically controlling the charging process. This project also tested the effectiveness of the solar panel which can be determine by testing time of charge and the time of discharge (Table 4.1)

Table 1: Time of charge VS time of discharge

Time of Charge (min)	Time of Discharge(min)
20	30
40	60
60	100
80	120
100	145
120	183

Adjusted time

To adjust the time in this project we use timer in minutes. The adjusted times are 5, 10, 15, 20, 25 and 30 minutes. This adjusted time was to determine how many minutes were taken to remove the sludge completely from the prototype reservoir. The results of this test are as follows:

Table 2: The results for automatic sludge removal

Time (min)	Description
5	1) The solenoid valve works properly without any problems. 2) The sludge slightly remove
10	1) The solenoid valve works properly without any problems. 2) The half amount of the sludge have been remove
15	1) The solenoid valve works properly without any problems. 2) Almost all sludge have been remove
20	1) The solenoid valve works properly 2) All sludge have been remove.
25	1) The solenoid valve starts to increase in temperature. 2) All sludge have been remove.
30	1) The solenoid valve temperature too high and loss of power. 2) All sludge have been remove.

CONCLUSION

As for conclusion, water source from uphill open reservoir will turn cloudy causes by the sludge that had been collected in the floor of the reservoir. This will make the aborigine to climb uphill to clean the sludge that had been collected in the reservoir which will cause time and energy. So, this controlling system can help to aborigine by automatically controlling the automatic sludge removal to remove the sludge which the optimum time to operate this automatic controlling system is at 20 minutes for the power to run to completely remove the sludge. This project will be using the solar panel which will not cause pollution to the environment. The solar panel need at least only 1 hour to completely charge the battery.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

MAA performed the experiment and MHR designed the project. TLD wrote the paper. MHS and AM reviewed and edited the manuscript. MMK supervised the project student, edit and approved the final version of the manuscript.

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