International Journal of Research Studies in Management
2023 Volume 11 Number 3, 31-40

ISSN: 2243-7770
Online ISSN: 2243-7789

OPEN ACCESS

Automation of motorized water pump with LED and buzzer using Arduino

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Received: 30 April 2023 **Revised**: 1 June 2023 **Accepted**: 9 June 2023
Available Online: 9 June 2023 **DOI**: 10.5861/ijrsm.2023.1025

Abstract

One of the significant developments over the years in agriculture is the use of automation. This study focuses on the automation of motorized pumps with Led using Arduino. The researchers used an applied experimental design and the research process was fulfilled based on the procedures of this study in order to develop the product. Researchers carefully gathered all the information through observation experimentation and survey to determine the acceptability and effectiveness of the product. Based on the findings, there is a significant difference between the proposed product and the manual turning off of the water pump. Based on the result of observation, the number of times the farmers have to turn off the water pump manually within a day is slightly different with the use of an automated water pump. Researchers also found that the product would make the life of farmers easier. Thus, this system is useful both during the day and at night; the buzzer can be used in broad daylight, while the LED can be used in the evening as it may not be visible enough for farmers to see in broad daylight; with this, agricultural workers will be able to identify if the watering process is complete. Therefore, the researchers recommend using a Motorized Water pump and finding a Relay Module that has a high capacity of voltage that can be connected to the Motorized Water Pump in order for this product to be used in a larger area, in farms.

Keywords: Arduino, automation, LED, agriculture, motorized pumps

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1. Introduction

Society of National Geographic defined agriculture or farming as the process of soil cultivation, advancing crops, and nurturing livestock. Involves the preparation of plants and animals to be consumed by humans and dispensed in different marketplaces. Food and textiles are the ones that are superior in the production of Agriculture, as well as cottons, wool, and leather, producing other materials such as construction timber and paper goods. Philippines is one of the countries which acquire various work related to agriculture and farming, as stated by the Census of Agriculture (2012). Containing about 5.56 million farms and holds 7.19 million of hectares in total or an average of 1. 29 hectares per farm or holding. As the regular size of farms declined from 2.84 hectares in 1980 to 1.29 hectares in 2012. The number of farms from the year 1980 to the year 2012 has increased at a rate of 62.6 percent. The division of farms and holdings from one generation of agricultural owners/operators to their subsequent one may be responsible for this. With 518 thousand farms/holdings and a total area of 460.45 thousand hectares, Region VI - Western Visayas recorded the most farms/holdings overall. After that came Region V - Bicol, which had 486 thousand farms and holdings covering 765.82 thousand hectares. Third place went to Region II, which had 443 thousand farms and other properties totaling roughly 478.72 thousand hectares. With a total area of 20.27 thousand hectares, NCR has the fewest farms/holdings (Special Report - Highlights of the 2012 Census of Agriculture, 2012 CA).

However, with the large land used for agricultural work, a lot of problems also come with it. Major losses in productivity, increase in cost of production, and inadequate support from the government for the industry are the factors that contributed to the crisis that Philippine agriculture is suffering now. Rice as a product of agriculture is important in the Philippines Culture and its way of life. These troublesome Challenges are dealt with by Agriculturists. High-cost input as one of the major problems that made Filipino Farmers to be unable to increase their production because of the high prices of important inputs. According to a recent article in Manila Standard (Six (6) Challenges Faced by Rice Farmers in the Philippines, 2022), this is the reason of intensifying low palay prices that can be expected after harvesting. This leads farmer stuck in between of hardships, and in other cases, in considerable debt. It is not just about rice but also about all agricultural products.

As explained by Madayag and Estanislao (2021) in their study, they defined agriculture in the Philippines an important part of the Philippine economy. It employs around 40% of all Filipino workers and generates 20% of the nation's GDP on average. About 40% of Filipino workers and generate 20% of the national GDP on average are employed in the field of agriculture. 70% of all agricultural output comes from agribusiness, which is also the main source of this output. When it comes to rural areas, neglection of the agriculture sector and the distribution of resources in unequal manner made the poverty situation in this area worse (Madayag & Estanislao, 2021). Occidental Mindoro is an agricultural region dedicated to agricultural production as indicated by the Department of Agriculture. Watering of crops is one of the problems that the farmers of Occidental Mindoro are facing. Some Farms are near and have available irrigation but other municipalities in this region encounter problems with this issue.

Unfortunately, some crops can`t get the water and minerals they need for them to grow with the use of needed nutrients. Seasonal typhoons are becoming more common and powerful as a result of climate change, as are dry seasons with previously unheard-of high temperatures. Both of these conditions are damaging to most farms' output. However, the negative consequences of climate change do not stop there. According to Peraka et al. (2020), climate change is expected to increase future food insecurity by raising food prices and decreasing food output. Food may become more expensive if energy prices rise in response to efforts to mitigate climate change. The amount of water required for food production may become scarcer as a result of drought and rising agricultural water demand. Competition for land may increase when some locations become climatically

unsuitable for production. Extreme weather events connected to climate change may also result in dramatic declines in agricultural productivity, resulting in sharp price increases. Farmers, according to Syngenta Global, must meet the expectations of a changing environment as well as regulators, customers, food processors, and merchants. Climate change, land erosion, biodiversity loss, changing consumer food tastes, and worries about food production all contribute to rising pressures. Furthermore, the plants, pests, and diseases that are a part of the natural world on which farming is based continue to pose challenges. While modern agriculture provides numerous options, the results are not always the same because each farm is unique due to its particular topography, soils, available technology, and prospective yields (The Future of Farming: Exploring Climate Smart Agriculture, n.d).

The ordinary Filipino worker makes less than half of what a farm laborer receives. Worse, a farm laborer produces only one-sixth the value of an industrial worker. Farm laborers account for two out of every three of our working poor, owing to lower earnings and even poorer productivity (Habito, 2018). Farmers who labor hard deserve a respite. Observing how farmers spend all day waiting for their plots to be watered, all of their time is spent solely on their crops. A watchman on a piggery or poultry farm, for example, must keep an eye on the animals. Given that agricultural workers, particularly farmers, work nonstop and have a lot of work to do, the researchers would like to reduce their workload by developing this system linked to Arduino that would allow them to detect if the motor had already stopped as it finally reached the water that the crops required. This technique can also be implemented in piggeries and poultry farms. This system is an eco-friendly gadget because it assists with water conservation.

The Automation of a Motorized Water Pump with a Led and Buzzer Using Arduino aims to provide agricultural staff with the necessary leisure while also making their job easier and less time-consuming. They can rest while their task is being done or do other things instead of waiting for the water to cease using this type of system. This gadget is programmed in the Arduino so that once the time and amount of water required are entered, the system will shut off the motor automatically. Spending less money and consuming less energy. Electricity is used in agriculture to control the environment and maintain the life of livestock, poultry, and plants; to prevent food spoilage; to avoid financial loss due to harvesting and sorting failures; and to provide security for the farm's capital investments, according to the University of Georgia Extension. This strategy will gradually help to reduce the electricity bill. Rest appears to be undervalued among agricultural workers, particularly farmers. The farmer can use this system to choose whether to rest or accomplish other things while their crops are being watered. Aside from lowering the power bill and saving money, it also decreases the risk of the motor overheating because it will shut down on its own after the task is completed. The proposed system would be extremely useful both during the day and at night; the buzzer can be used in the morning, while the LED light can be used in the evening because it may be visible enough in broad daylight for farmers to see. The buzzer and LED act in tandem when the watering process is completed. Using this type of equipment would considerably assist the workers in their various responsibilities; also, no water would be wasted because the pump would create only the amount required. No crops will be over or under-watered when water conservation is maintained.

Statement of the Problem - This study aimed to develop an automatic motorized water pump with LED and a buzzer using an Arduino that alerts the farmers and automatically turns off the water pump when the designated amount of water is reached. This may save water as well as the effort of the farmers. Specifically, it sought to answer the following questions: (1) What is the level of performance of the automation of a motorized water pump with LED and buzzer using Arduino in terms of; the ability to automatically shut off the water pump, ability to produce an accurate sound through the buzzer, ability to switch the LED on and off and ability to sense the moisture of the soil? (2) What is the level of effectiveness of the automation of a motorized water pump with LED and buzzer using Arduino? (3) How helpful is this motorized water pump to farmers and crops? (4) Is there any significant difference between the proposed product and the manual turning off of the water pump?

Significance of the Study - The findings of this experimental study will benefit the following; First, the local farmers, through this study, farmers will have the leverage to extend their ability to detect and comprehend the

difficulties in their water system. This would also help them enhance their farming methods without relying on their old conventional ways. The findings of the study would benefit local residents because it will give them leverage in terms of food consumption for there are chances that shortage will not occur because of the study's results. The study's result would benefit different economic establishments since this product is cost-effective. The findings of the study can also be their basis on upgrading their business. This study's results would be a good source of information for future researchers who will conduct a survey for further verification and understanding of the topic.

Scope and Delimitation of the Study - This study focused on creating a system that will automatically turn off if it reaches its desired amount of water with the help of Arduino. The researchers developed the product for agricultural purposes to be used on the farm by agricultural workers, especially farmers in Calintaan, the province of Occidental Mindoro. Its sole purpose is to find ways to help farmers lessen their work on the farm by creating something that is automatic that they can just program depending on how much is needed and would simply notify them when it would be turned off using the LED and buzzer attached to it. A soil moisture sensor is simply inserted in the soil to detect its wetness and dryness. This study is limited only to motorized water pumps and cannot be used in engines. This investigatory project would be conducted within this school year, 2022-2023.

2. Methodology

Research Design - To make this humble attempt accurate and successful, the researchers used experimental quantitative, as the researchers believed that this is the most suitable design for this research. Based on (https://www.scribbr.com/author/beccabevans/) for the purpose of studying a relationship between variables, experimental research aims to develop a series of steps. In the case where researchers aim to demonstrate how data have been gathered, experimental methods are a good choice because they enable them to make correct assessments of results. Although quantitative methods are the main components of quantitative approaches in which data collected through surveys, questionnaires, and polls is analyzed either statistically or quantitatively.

Research Process; Stage 1 Preparation and Gathering of Materials - For the purpose of creating a prototype model for an automatic water pump, the materials shall be as follows: Illustration of the materials:

Figure 1: Arduino UNO

Figure 2: Battery

Figure 3: Arduino IDE

Figure 4: Buzzer

Figure 5: Hose

Figure 6: Jumper Wires

Figure 7: LED

Figure 8: Plywood

Figure 9: Relay Module

Figure 10: Soil Moisture Sensor

Figure 11: Mini Water Pump

Arduino Integrated Development Environment (n.d.). Arduino.cc. https://docs.arduino.cc/software/ide-v1/tutorials/arduino-ide-v1-basics?fbclid=IwAR2vM40dVhIAjy5g36w6XPrAbaN5bm617_YuRl5JzbV90CVo7qZz-eL8o00

The researcher demonstrated the relationship between independent variables and how they can create an effect to be achieved. Researchers made a prototype version of an automated motorized water pump using LEDs and a Buzzer with Arduino. The researcher also used wood and materials found around the area where the system is being built, such as nails and wires, to secure the position of the other materials. The researcher did everything possible to find low-cost materials and make the automation as cost-effective as possible. When looking for the right materials, the researcher also seeks assistance. They purchased the other materials online, especially the ones that are not available in the physical stores in their area.

Stage 2: Construction and Development of the Product **-** To implement health protocols during the COVID-19 pandemic, an infrared thermometer using a PIR For the construction and development of the product first is to assemble the materials needed for the automation of the water pump. After that, make the code for the Arduino board and then program it. If the codes inputted are already done and working, attach the LED, Buzzer, Soil Moisture Sensor, and Relay Module to the board and connect the board to the battery for power supply. Organize the positions of the parts in a box. And lastly, observe how the system works.

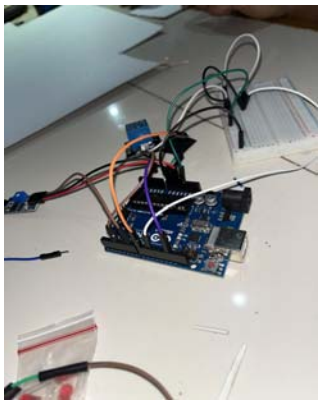

Figure 12. Actual product of motorized water pump with led and buzzer using Arduino

Stage 4: Experimental Stage, Observation, Recording and Data Gathering Procedure **-** The motorized water pump system is automated and placed in an agricultural environment to assist farmers and agricultural workers. The researchers also considered the place where it has: water, soil and crops (Palay) The researcher gathered and collected data through observation and experimentation. The system utilized and the data gathered by the researchers are credible and not subjective. The researchers completed the entire observation and data recording procedure and processed it correctly. Primary data- information obtained during the experimental stage. It is the information gathered by the researchers themselves. As a result, all data was derived directly from the methods themselves.

Data collection is aided by observation and recording. The researcher automated and programmed the system with the help of an Arduino UNO. The alarm, LED, and buzzer are observed to see if they turn on and off at the appropriate times. The researcher also inspected the proper wiring to ensure that no issues or circuits occur during the passage of electricity. In this project, the researchers went to the selected fields and interviewed the farmers to

determine the acceptability of the product. The researchers used self-constructed questionnaires. Before this, the researchers asked for approval from their teachers and the farmers themselves if they would agree to participate in the study. Regarding this project, the researchers used purposive sampling, in which farmers served as respondents. In order to determine the accuracy and effectiveness of the system, the farmers are encouraged to observe how the system helped them to save time and if the water pump is automatically turned off if it reaches its water limit. The researchers distributed the questionnaires to the farmers in order to find out how effective the product would be.

Statistical Treatment of the Data - The researchers used T-test for statistical data analysis in conducting this study, to determine if there is any significant difference between the proposed product and the manual turning off of the water pump. They proved that the automation of a motorized water pump with LED and a buzzer using Arduino is helpful to save time and effort. By computing the weighted mean for the descriptive statistics, the researchers were able to know the respondents' perception of the automation of motorized water pump with LED and buzzer using Arduino.

3. Results and Discussions

Table 1

Level of Performance of the Automation of Motorized Water Pump with LED and Buzzer using Arduino

Questions	Frequency of Rank				Overall		Rank
	4	3	2	1	Weighted Mean	Descriptive equivalent (D.E)	
Arduino IDE and Arduino UNO accurately send signal /program to the water pump.	10	5	0	0	3.67	Strongly Agree	4.5
A soil moisture sensor detects the dryness and wetness of the soil.	11	4	0	0	3.73	Strongly Agree	2.5
Water pump automatically turns off when it receives the signal/program from the Arduino and Soil moisture sensor.	10	5	0	0	3.67	Strongly Agree	4.5
The Buzzer emits a high-volume alarm	11	3	1	0	3.67	Strongly Agree	4.5
Once the water pump is turned off, the buzzer sounds an alarm.	14	1	0	0	3.87	Strongly Agree	1
The LED emits a high level of brightness.	4	1	10	0	2.6	Disagree	7
Once the Water pump is turned off, the LED lights up.	11	4	0	0	3.73	Strongly Agree	2.5
Overall Weighted Mean					3.56	Strongly Agree	

Table 1 presents the first part of the survey, comprising the evaluation of the respondent`s views on the functions of the different components of an Automated Motorized Water Pump with LED and Buzzer using Arduino. The highest weighted mean gathered is 3.87 from the item of once the water pump is turned off, the buzzer sounds an alarm. While the lowest was about the emitted brightness of the LED with a weighted mean of 2.6. With a weighted mean of 3.67, the respondents strongly agree that Arduino can accurately send signal/program to the water pump. With a weighted mean of 3.67, the respondents strongly agree with the success of the water pump to automatically turn off when it receives the program from Arduino IDE and Arduino UNO. With a weighted mean of 3.67, the Buzzer emits a high level of volume, and with a weighted mean of 3.67, the LED emits a high level of brightness. A 3.73 weighted mean that the soil moisture detects the moistness of the soil, and An LED for accurate work when sending alarms with a weighted mean of 3.73.

For the accurate work of the Buzzer for sending an alarm with a weighted mean of 3.87. With an overall weighted mean of 3.56, the respondents strongly agree that the Automation of a Motorized Water Pump with LED and Buzzer using Arduino has a high level of performance that would be really helpful on the farm. According to Howcroft & Taylor (2022), it shows how automation helps in farmers` health, in the case of dairy research, see to it that the material world of farm safety is also socially embedded, and these societal considerations are themselves implicated in specific environments and technological practices. The interaction of these domains, ostensibly distinct in their respective specialties, indicates that climate change raises multiple

health and safety problems. Additionally, agriculture has become a mandatory practice all over the world. A major food issue will emerge during the next two decades. As a result, agricultural improvement and progress are critical. Agriculture in the world is partially automated now thanks to emerging technologies, and farmers mostly rely on conventional ways, resulting in a lack of rainfall and a scarcity of water. There are numerous strategies available to automate agricultural processes and thereby boost their efficiency, resulting in higher crop output. Agriculture automation allows for a reduction in human participation (Jha et al., 2019).

Table 2

Level of effectiveness of the Automation of a Motorized Water Pump with LED and Buzzer using Arduino

Questions	Frequency of Rank				Overall		Percentile Rank
	4	3	2	1	Weighted Mean	Descriptive equivalent (D.E)	
The overall system is functioning according to its purpose.	13	2	0	0	3.87	Strongly Agree	3
The system is helpful to save time and effort.	7	8	0	0	3.47	Agree	4
It helps to increase the productivity of the user.	3	10	2	0	3.07	Agree	6
It gives alertness once there`s no water coming out from the water pump.	14	1	0	0	3.93	Strongly Agree	2
It is useful for agricultural purposes.	15	0	0	0	4	Strongly Agree	1
The system lessens the work of the user.	5	10	0	0	3.33	Agree	5
	Overall Weighted Mean				3.62	Strongly Agree	

Table 2 below shows the second part of the survey, which consists of six questions regarding their perceptions of the product and its practicality. It has an overall weighted mean of 3.62, from which we can infer that the respondents are strongly agreeable to the matters provided, such as the overall system's functioning according to the purpose, and if our product helps to increase the productivity of the user, whether this product is applicable for agricultural purposes, and if it really does help to lessen the work of agricultural workers, and whether they would recommend this system to be used in an agricultural area. According to Micle et al. (2021), the farm's workload would be reduced by automation and remote work and farmers must be made aware of the advantages of using these emerging technologies. The question with the highest weighted mean of 4 was the question that indicates that it is useful for agricultural purposes and the question with the lowest weighted mean of 3.07 was it helps to increase the productivity of the user. Because our product is a prototype version of the bigger system we had in mind, as of now, we are not able to provide the estimated price of the product. However, the promoted product would lessen the money spent in terms of labor and help our environment in terms of water conservation.

Table 3

Perceptions of the respondents on how helpful the automation of motorized water pump with led and buzzer

Questions	Frequency of Rank				Overall		Percentile Rank
	4	3	2	1	Weighted Mean	Descriptive equivalent (D.E)	
Automated motorized water pump is helpful when it comes to water conservation	15	0	0	0	4	Strongly Agree	1
This motorized water pump can help farmers to lessen their work	5	6	4	0	3.07	Agree	3.5
Using this motorized water pump can prevent the rotting of the crops.	4	8	3	0	3.07	Agree	3.5
It is very effective and easy to use	5	9	1	0	3.27	Agree	2
It is applicable to the farm	2	11	2	0	3	Agree	5
	Overall Weighted Mean				3.28	Strongly Agree	

Table 3 shows the third part of the survey, which consists of 5 questions and shows the respondent's insights about the system. It has an overall weighted mean of 3.28, which means the respondents strongly agree with the questions provided, such as the help of the system to conserve water. The respondents prefer to use the automated motorized water pump over the manual pump since they won't have to turn off the pump anymore. The question with the highest weighted mean of 4 indicates that the automated motorized water pump is helpful in conserving water. While the lowest weighted mean of 3 indicates that the automated motorized water pump is applicable in a farm. Out of all the questions given, the respondents find it most helpful in terms of water conservation. Furthermore, a study conducted by Megalingam and Gedela (2017), proposed that an automated water pumping system powered by solar energy can be utilized in many villages as an alternative to those that use fossil fuels. The automatic system only activates the water pumps when the soil moisture content falls below a specific level, as measured by the moisture sensors positioned across the fields. The analysis demonstrates that, if implemented, the suggested automated solar-based water pumping system would be beneficial to the communities in terms of cost and profit. In addition, this system is effective in conserving water based on the experiment of the researchers.

Table 4

T-Test Results between the Proposed Product and the Manual Turning Off of the Water Pump

	X- Automated motorized water pump	Y- Manual water pump
The number of times the farmers have to turn off the water pump within a day		
1:00 AM	0	0
3:00 AM	0	0
6:00 AM	0	0
9:00 AM	0	1
12:00 PM	0	0
3:00 PM	0	1
6:00 PM	0	0
9:00 PM	0	0
12:00 AM	0	0
3:00 AM	0	0
6:00 AM	0	0
9:00 AM	0	0
12:00 PM	0	1

Legend: 0 = on; 1 = off

Table 4 below shows the number of times the farmers have to turn off the water pump within a day. Based on the result, by using the automated motorized water pump, the farmer does not need to go back to the water pump to turn it off as it would automatically shut off once the moisture soil sensor detects that the soil has already enough water needed. When using a manual water pump, the farmer needs to return to where the water pump is placed to turn it off every 9 AM, 3 PM, and 12 PM.

Table 5 shows the data using T-test variance model computation for Table 4 which allows the researchers to postulate that there is a significant difference between the automated and manual water pump. With the result of 2.39>2.23 which means if Tcomp>Tcrit and the p-value (0.04) turns out to be smaller than the alpha level of 0.05, then it indicates that the hypothesis was rejected. In this scenario, since the alternative hypothesis will be true and accepted, the data are significant. According to the study by Choi & Lee (2017) the automation timeline finally began to have a significant impact on people's lives since the 19th century began. Based on the findings, the proposed product and manual turning off of the water pump has a significant difference which results in an automated water pump being more efficient to use. The proposed product is more helpful to farmers to save their time and be productive.

Table 5

T-test Results Comparing the Performance of the Automated and Manual Water Pump

t-Test: Two-Sample Assuming Unequal Variances	Variable 1	Variable 2
Mean	1	0.636363636
Variance	0	0.254545455
Observations	11	11
Hypothesized Mean Difference	0	
df	10	
t Stat	2.390457219	
P(T<=t) one-tail	0.018964486	
t Critical one-tail	1.812461123	
P(T<=t) two-tail	0.037928971	
t Critical two-tail	2.228138852	

4. Conclusions and Recommendation

Based on the findings of this experiment, the following conclusions were made: The pump is working properly. Only automatically turns off when the sensor detects that there is enough amount of water in the soil. The buzzer emits a high level of sound/volume and will surely alert the farmers. Like the buzzer, the LED is also functioning well. It also automatically turns on and off. But the LED emits a low level of brightness according to the respondents. The moisture sensor is working according to its purpose. It can sense if the amount of water is enough so that it can alert the buzzer and LED to notify the farmers. The automated water pump with buzzer and LED using Arduino is useful for agricultural purposes, however, it depends on the size of the system. The elements and the overall system are working effectively based on what the researchers programmed them to do. The researchers built this system called Automated Motorized Water Pump with LED and Buzzer using Arduino to let farmers have some rest and save time while working. It is proven to be effective in reducing the work of the farmers and also gives them alerts. The system is effective in reducing the rotting of crops. There is a significant difference between the Automation of a Motorized Water Pump with LED and Buzzer using Arduino and the manual turning off of the water pump. This system can be used as an effective substitute for the manual water pump.

This research study showed the usefulness and effectiveness of the “Automation of Motorized Water Pump with LED and Buzzer using Arduino” (prototype). Thus, the following recommendations are offered based on the work accomplished during this research and on the conclusions of this experiment; The researchers recommend using a Motorized Water Wump and finding a Relay Module that has a high capacity of voltage that can be connected to the Motorized Water Pump in order for this product to be used in a larger area, in farms. If the user wishes to replace the LED with a light bulb for a much higher level of brightness, they may do so by replacing it with a bulb that has an equal voltage as the battery. Researchers recommend using a battery with a larger milliampere-hour (mAh) so it will take a long time for the battery to run and need a recharge. The researchers advise inserting the Moisture Soil Sensor properly in the soil and then adjust the on-board potentiometer to adjust its sensitivity as it will be the one to detect the wetness and dryness of the soil that will send a signal to the relay module to either open or close an electrical circuit that will operate the automation of the water pump. The Automation of a Motorized Water Pump with LED and Buzzer using Arduino should be implemented at the farm to lessen the work of the farmers. Instead of using a battery to power on the water pump, use a larger wire and connect it to the power outlet. For future researchers, this system is also recommended to be used in gardens to water plants as it is more suitable to be placed in there because of the smaller area.

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