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ELECTRICAL SYSTEM IN ENABLED
PORTABLE IRRIGATION SYSTEM

MASTURAH BINTI HASSAN

Thesis submitted in fulfillment of the requirements
for the award of the degree of
Bachelor of Engineering Technology in Electrical

Faculty of Electrical & Electronics Engineering

UNIVERSITI MALAYSIA PAHANG

FEBRUARY 2022

ACKNOWLEDGEMENTS

I am grateful to ALLAH "S.W.T" for providing me with the insight, strength, patience, and support I needed to finish my job. The completion of this study would not have been possible if it hadn't been for His will and favour.

Without the advice and aid of various persons who contributed and extended their important assistance in the preparation and completion of this study, this dissertation would not have been feasible. I owe a great debt of gratitude to my supervisor, Dr Roshahliza binti M Ramli, for his patience, advice, constructive criticism, stimulating suggestions, and support throughout my research, thesis writing, and project work.

I'd also like to express my gratitude to the laboratory team for providing me with resources and technical support in order to complete the research. For their unwavering efforts in conducting experiments and trials for my senior design project, I am grateful for all of the guidance, commitment, and cooperation.

Moreover, I value having a strong working relationship with my groupmates, Afyq Rukaini bin Mohd Ruzaini ,Muhammad Hadi bin Zainal, Ahmad Nazmi bin Zakaria and Manirah binti Mohammad Maom during this project. I'd also like to thank them for their excellent effort in completing this job as a whole.

Last but not least, I want to express my gratitude to my entire family, especially my dear parents, Mr Hassan Ibrahim and Mrs Zainariah Sulaiman, for their unending prayers, unconditional love, counsel, and trust during my studies. The encouragement I received from them helped me to persevere in completing my research and thesis despite the obstacles. Not to mention all of my friends who are helping me finish my project and thesis in order to obtain a degree.

ABSTRAK

Sistem pengairan sedang dikuasakan oleh tenaga suria. Sistem pengairan pertanian tidak lagi berdaya maju kerana ia membuang masa dan memerlukan tenaga manusia. Menggunakan peranti solar atau fotovoltaik akan membantu anda menjimatkan wang dan tenaga (PV). Sedikit atau tiada pelepasan pencemaran, seperti karbon dioksida atau bahan cemar toksik lain, dijana oleh tenaga. Kami boleh mencapai tujuan utama projek ini adalah untuk membangunkan sistem pam air solar yang berkesan untuk petani. Dengan pelaksanaan sistem komunikasi hibrid untuk sistem pam air solar. Selain itu, kami boleh menganalisis dan menilai prestasi dan kebolehpercayaan sistem untuk dokumentasi dan penambahbaikan pada masa hadapan. Akhirnya, kita dapat mengurangkan tenaga kerja dan menjimatkan kos serta membantu seseorang yang ingin bercucuk tanam.

ABSTRACT

An irrigation system is being powered by solar energy. Irrigation systems of agriculture are no longer viable because they waste time and necessitate human labor. Using a solar or photovoltaic device will help you save money and energy (PV). Few or no pollution emissions, such as carbon dioxide or other toxic contaminants, are generated by energy. We can achieve the main purpose of this project is to develop an effective solar water pump system for farmers. By implementation of the hybrid communication system for solar water pump system. Other than that, we can analyze and evaluate the performance and reliability of the system for future documentation and improvement. Finally, we can reduce manpower and save costs as well as help someone who wants to cultivate.

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LIST OF SYMBOLS

m	meter
ft	Feet
km	Kilometre
cm	Centimetre
min	Minute
kg	Kilogram
L	Litre
W	Watt
v	Volt
kWp	Kilowatt-peak
kWh	Kilowatt-hour

LIST OF ABBREVIATIONS

SBPWM	Simple Boost Pulse Width Modulation
PVP	Photovoltaic Water Pumping
DC	Direct Current
AC	Alternating Current
PV	Photovoltaic

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CHAPTER 1

INTRODUCTION

1.1 Project Background

Electricity is a broad term that encompasses a wide range of phenomena caused by the presence and flow of electrical charge. Electricity is very important to us these days. Our everyday lives will be incomplete without energy. The energy tariff, on the other hand, has risen due to the rise in gas prices. So, alternative energy or clean energy is a good way for us to get energy and saving money. Wind, solar energy, nuclear power, hydroelectric, thermal energy, and many other sources of renewable energy exist. Solar energy, also known as photovoltaic energy, is a common renewable energy source nowadays (PV).

Photovoltaic (PV) power generation is a way of producing electricity by converting solar radiation into direct current electricity using photovoltaic semiconductors. Photovoltaic power generation makes use of solar panels, which are made up of a series of solar cells that hold a photovoltaic film. Thus, in this project, solar energy is being used to power an irrigation system. Irrigation systems are no longer very realistic because they waste time and require the use of human labour. There are many types of irrigation systems, including soil irrigation, drip irrigation, water sprinklers, sub-irrigation, and others. Many of these irrigation systems were regulated manually or automatically.

irrigation system is powered by electricity through this automated control. Electricity and resources can be saved by using a solar system or 2 photovoltaic system (PV). Furthermore, by using solar-powered passive irrigation, more time can be saved. There are several advantages of using green energy. One significant benefit of using green energy is that it is a clean supply that can never run out. In general, renewable energy facilities need fewer maintenance than conventional generators. Since their fuel is extracted from renewable and readily available materials, their operating costs are reduced. And more specifically, green energy generates few to no pollution emissions such as carbon dioxide or other toxic pollutants, resulting in a low environmental impact. Since most renewable energy facilities are situated outside of major urban centres and suburbs of capital cities, they can also provide economic benefits to many metropolitan regions. These economic benefits may result from increased use of local resources as well as tourism.

1.2 Problem Statement

Nowadays, basic commodities such as natural gas are becoming less expensive, yet the price of this natural gas is rising according to forces of supply and demand. This natural gas is critical for electricity production. Many Power Generation or Power Plants, for example, generate electricity using natural gas. So, in order to reduce our reliance on natural gas, we may employ alternate methods such as solar energy. Furthermore, this alternative energy has no negative impacts on the environment. The use of human labour in the irrigation system is widespread. As a result, labour and employee wage payments are excessively high. Users put a high priority on water. Water is used for a variety of purposes, including beverages, baths, and laundry. Aside from that, water is crucial for watering plants since it may provide nourishment to the plants. However, the watering technology that many people employ is inefficient. This is due to the fact that irrigation currently relies on human labour. Furthermore, a considerable amount of water has been squandered because of poor management irrigation system. As a result, this solar irrigation system may save a lot of time and water.

1.3 Project Objective

Our main objectives for these projects are to improve an existing Portable Solar Irrigation System within system, capacity solar battery storage and water pump pressure. This can be achieved through the following objectives:

1. To develop hybrid communication systems using GSM and Wi-Fi system.
2. To increase the pressure by upgrade voltage and wattage water pump.
3. To integrate the purposed method with mobile and web applications.
4. To test performance of the developed system on actual environment.

1.4 Research Scope

The scope of study for this project focuses on the electrical and electronic part of the water pump. In addition, the research scope also focuses on using the application on to operate the water pump.

a) Communication System

I. GSM

II. Wi-Fi

b) Electrics and Electronics

I. Water pump

II. Soil moisture sensor

III. Humidity sensor

IV. Rain sensor

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

With the inescapable depletion of fossil fuel resources, a substantial growth in global energy use, and the severe issue of climate change, it is more important than ever to use renewable energy resources efficiently. In recent years, solar energy has been widely used to generate electric power as one of the key sources of inexpensive, accessible, abundant, non-polluting, sustainable, and safe energy supplies. Solar power is generated by converting radiation into electrical energy using photovoltaic (PV) cells, which turn sunlight into direct current (DC) electricity directly. Solar cells' semiconducting materials are subsequently stacked to form solar-panel arrays. Solar arrays bring solar energy's benefits to new or underdeveloped fields of application, such as tiny satellites, interplanetary or military applications.

Solar technology is gaining popularity around the world, although it only accounts for a small fraction of North America's electricity production. Despite the many benefits of solar technology, there are certain technological restrictions to harnessing this abundant source of energy. PV panels have a low conversion efficiency, and innovative production technologies are required to improve PV materials' capabilities. Furthermore, the efficiency of a PV system is influenced by environmental factors such as solar radiation, ambient temperature, wind speed, and solar panel positioning. Another concern with solar panel uses in local households is the PV system's bulkiness and transportation convenience. With other energy sources on the decline, the amount of solar electricity produced has climbed dramatically in recent years and will continue to rise as the need for clean energy grows. The solar system's efficiency can be increased if the panels track the sun. Due to the movement of the sun during the day, and in order to maximize the PV system's power production, the panels should be mobile, allowing them to shift to the best position dependent on the radiation angle. Solar tracking is a technique for improving a PV system's energy harvesting efficiency by maximising the amount of time it is exposed to the sun.

2.3 Electrical System

Because of its simplicity and environmental friendliness, solar energy is widely used in a variety of applications. Water pumping or field irrigation using PV (photovoltaic system) solar panels is one of the most appropriate and straightforward uses of photovoltaic electricity. Multiple solar cell arrays make up a solar panel. PV panels' solar cells are made of semiconductor materials, which are abundant. When light strikes a solar cell, it absorbs it and produces an electron hole pair. Electrodes gather the produced electrons, causing electrical current to flow. Figure 2.6 depicts a basic current flow diagram for a solar panel.

In today's rural areas, solar-powered water pumping systems are widely employed in crop or field irrigation. The main benefit of this water pumping system is its simplicity and lower total cost due to the lack of fossil fuels. This technology is dependable, affordable, and capable of increasing agricultural productivity. Solar-powered water pumps provide not only cost-effective solutions, but also electricity in remote areas.

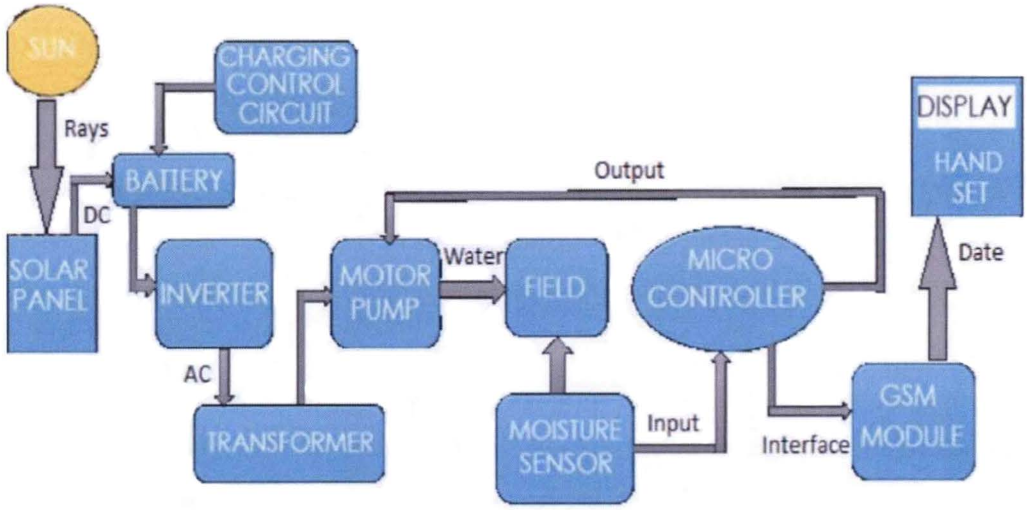

Figure 2.1: Block diagram of the proposed system (A. Waleed et al,2019)

Water pumping systems powered by PV can be divided into two types: battery coupled and direct coupled. In our study, we suggest a battery-coupled pumping system, which provides a cost-effective solution by storing surplus energy in the batteries. Battery-coupled PV water pumping systems are chosen because they may be used at any time of day or night without experiencing a power outage. PV panels, charge control regulator, batteries, inverter, humidity sensors, GSM module, tank, and water pump are all part of our PV pumping system. The PV panels oversee generating electricity and charging the batteries. The pump is powered by batteries, and it pumps water from underground to the surface.

The humidity sensors and GSM module are deployed in the crop fields for automation and wireless control in this project. The humidity sensor collects data on the soil's humidity level and transmits it to the control room via a GSM module. The microprocessor automatically turns on or off the pump based on sensor data. The GSM modules also convey information to the farmer, keeping him up to date on the current situation. Figure 2.7 shows a schematic block diagram of the entire system.

2.3.1 Type of Water Pump

Pumping water and irrigating fields is an essential component of farming, but it comes at a hefty expense due to fossil fuel-powered water pumps. PV-powered water pumps may be the best alternative to fossil fuel-powered pumps. Solar-powered water pumps can be used for a variety of purposes, including crop irrigation and home consumption. This type of PV system is more dependable and requires less upkeep. PV water pumping systems can be expensive to build, but they require significantly less maintenance and labour after that.

PV-powered water pumping has been extensively tested and found to be cost-effective around the world. By lowering electricity and energy costs on a wide scale, these dependable systems have enhanced agricultural output on a global scale. Solar systems can also be built in isolated regions, which helps to minimize reliance on fossil fuels and grid electricity. Such self-contained systems are gaining traction around the world and may be a perfect contender for future farming. There are two types of solar pumping systems, as described in the previous discussion: There are two types of battery-coupled systems: 1) battery-coupled and 2) direct-coupled. The pumping systems in our study are battery coupled, including solar panels, charge controllers, batteries, pressure vessels, and DC pumps as part of the pumping system. During the day, the solar module (PV module) charges the battery, and the battery powers the pump when water must be pumped from underground.

2.3.1.1 Electric Water Pump

According to a 2011 survey done by the Bureau of Electrical Energy in India, over 18 million pump sets and 0.5 million new connections with an average of 5HP capacity are added each year for agricultural purposes (R. Kumar Harishankar.; 2014) . Solar PV technology for water pumping systems is based on solar energy being converted into electrical energy by solar panels and then used to power a water pump (T. J. Kardos.; 2010). Because of the lack of electricity and the high cost of diesel, solar energy for water pumping is a possible alternative to traditional electricity and diesel-based pumping systems. Photovoltaic (PV) technology turns solar energy into electrical energy, which is used to power a DC or AC motor-driven water pump. The study's main goal is to provide a complete evaluation of solar pumping technology, assess its economic viability, and identify research gaps and hurdles to the widespread adoption of solar water pumping systems and technologies. Water pumping is largely reliant on conventional energy or diesel-generated electricity around the world.

Solar water pumping reduces reliance on electricity generated by diesel, gas, or coal. Water pumping systems based on diesel or propane consume not only expensive fuels, but also produce noise and pollutants. A diesel pump has a 2–4 times higher initial cost, operation and maintenance costs, and replacement costs than a solar photovoltaic (PV) pump. Solar pumping systems are environmentally benign, low-maintenance, and require no fuel (Foster.; 2014). PV pumping is one of the most promising applications of solar energy, given the lack of grid electricity in rural and remote areas in most parts of the world. The technology is like any other traditional water pumping system, with the exception that it is powered by solar energy. PV water pumping has grown in popularity in recent years because of the lack of electricity and the rise in diesel prices. Pumped water flow rates are determined by incident solar radiation and the size of the PV array.

When compared to traditional pumping systems, a properly designed PV system results in significant long-term cost savings. Tanks can also be used to store water instead of batteries, which are needed for electricity storage (Thureau & Bhave, 1988). Agricultural production in developing countries is heavily reliant on rains, and lack of water during the summer months has a negative impact. Summers, on the other hand, have the most solar radiation, so more water can be pumped to meet increased water demands. The use of electricity to pump water in cities is also reliant on the use of electricity. PV pumping systems for water supply have a wide range of applications in rural, urban, community, industry surface mounted/submersible/floating motor pump set, and electronics make up an SPV water pumping system. The PV array is installed on a suitable structure and can be tracked manually or automatically. Water is pumped during the day and stored in tanks for use at night, during the day, or when the weather is cloudy. The water tank serves as storage, and batteries are not typically used to store PV electricity; however, they can be used for specific, reliable requirements. The components used in a PV water pumping system should meet national or international specifications, depending on which is applicable in each country. PV water pumping systems have advanced significantly in the last ten years.

The first generation of PV pumping systems relied on centrifugal pumps, which were typically driven by DC and variable frequency alternating current (AC) motors and had a long track record of long-term reliability and hydraulic efficiency ranging from 25% to 35%. Positive displacement pumps, progressing cavity pumps, and diaphragm pumps are used in second-generation PV pumping systems, which are characterized by low PV input power requirements, low capital costs, and high hydraulic efficiencies of up to 70%. (Protogeropoulos & Pearce, 2000). The current solar pumping technology employs electronic systems, which have improved the system's output power, performance, and overall efficiency. The controller accepts inputs for monitoring storage tank levels, controlling pump speed, and optimizing water using maximum power point tracking technology.

The tracking mechanism of PV arrays has progressed from manual to dual axis automatic tracking systems thanks to microcontroller programming. Tracking the sun reduces the amount of PV panel area required for a given output, increasing power yield, system efficiency, and return on investment. Solar water pumping uses photovoltaic (PV) technology to convert sunlight into electricity, which is then used to pump water. The PV panels are connected to a motor (DC or 25 AC) that converts the electrical energy from the PV panels into mechanical energy, which the pump then converts to hydraulic energy. The capacity of a solar pumping system to pump water is determined by three factors: pressure, flow, and pump power. Pressure can be thought of as the work done by a pump to lift a certain amount of water up to the storage tank for design purposes. The amount of work a pump must do is determined by the elevation difference between the water source and the storage tank. Figure 2.7 shows a schematic of a typical direct-coupled DC solar photovoltaic water pumping system with MPPT.

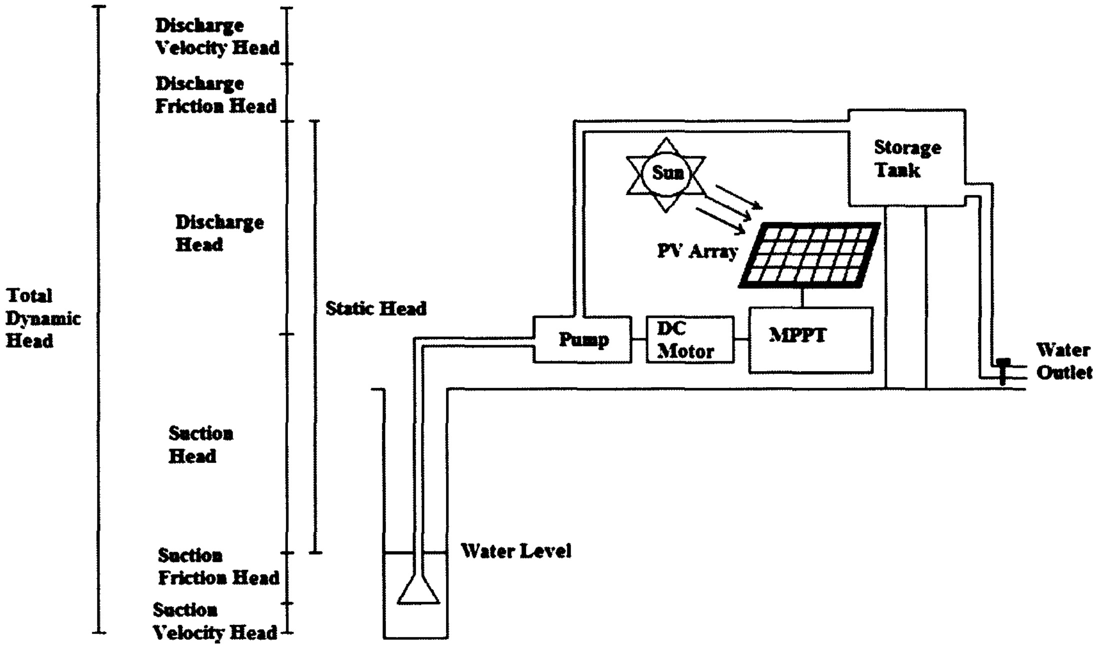

Figure 2.2: Schematic of a direct coupled solar photovoltaic water pumping system

2.3.1.2 Diesel Water Pump

When Photovoltaic and PWR are unable to meet demand, Diesel Generation is activated. When used independently, it can regulate frequency and voltage and improve system reliability. When determining the size of the DG, some parameters must be considered, including but not limited to the fuel usage vs output power equation and the maximum demand. (Bukar et al., 2019). The power shortage in the usage case predicted in this paper must be met by both PWR and DG in the most cost-effective and technically feasible manner. The amount of fuel consumed by DG is primarily determined by its rated power and output power. Using the manufacturer's DG fuel consumption curve is the best way to calculate DG fuel consumption at any load. (Siddaiah&Saini,2016).

In addition, for a variety of reasons, installing diesel generators in these remote areas is prohibited. The most significant factors preventing the economic deployment of diesel generators are the cost of fuel throughout the year, as well as the operation and maintenance of these generators. Water authorities and private farmers in Jordan's remote and rural areas with no access to grid power must rely on diesel engines and photovoltaic systems to pump water from wells. (Bakelli et al., 2011). Due to their low capital cost compared to RE technologies, diesel generator systems are usually the first choice for supplying load demand in grid-isolated systems. However, the negative consequences of diesel systems (such as harmful GHGE, noise pollution, high O&M costs, and high fuel costs) necessitate more restrictions on their use. RESs, on the other hand, are environmentally friendly, have low operating and maintenance costs, and provide inexhaustible resources. RE resources, on the other hand, are only available on a regular basis.

As a result, their output capacity is unreliable and unpredictable. Energy storage may be able to solve this problem, but it is expected to be economically unfeasible. As a result, combining different energy sources as part of a hybrid system may be able to solve previous technical, economic, and environmental issues. In the first, the system diesel generator runs at full capacity to meet the load demand and provide the required operating reserve. While the surplus power is used to power the deferrable load and, if applicable, the electrolyser, as well as charge the battery storage until it reaches the set point state of charge. In the second strategy, the system diesel generator's main priority is to generate only enough power to meet the load demand at the time, and it is not required to provide any surplus power for other purposes. (Elkadeem et al., 2019)

2.3.2 Types of Battery

Batteries are manufactured in a variety of ways and are classified into multiple varieties based on the qualities and requirements that are suited for different uses. The charging unit and the amount of energy allowed to be charged in the unit are the most important factors in solar systems that efficiently use PV as an ultimate energy receptor. Because of their low cost, variety of sizes, and appealing performance, lead acid batteries are the best choice for these energetic systems. One of the most fundamental obstacles that must be overcome is the manufacture of perfect batteries. Nickel cadmium cells are commonly used in low-temperature environments. However, the high initial cost of such compounds made them unsuitable for use in photovoltaic systems. As a result, it is possible to conclude that there is no such thing as an ideal battery. Furthermore, designers' difficulties begin at this point in determining which battery is appropriate for each application. Electrical storage batteries are commonly used.

Primary and secondary batteries are the most common types of electrical storage batteries. Primary batteries are carbon-zinc and lithium batteries used in electrical devices that can store and deliver energy but are not rechargeable. As a result, primary batteries are incompatible with PV systems. Secondary batteries, on the other hand, can store, transfer, and recharge by applying current in the opposite direction of the discharging current. As a result, primary types of lead acid batteries are widely employed in automobiles and photovoltaic systems. There are many different varieties of lead acid batteries based on their properties, performance, and design. Furthermore, there are several changes in the design parameters and performance of lead acid battery cells, which can be divided into three groups [1]. To begin, most automotive starters are powered by starting lighting and ignition (SLI) batteries. The maximum discharge depth for these batteries is between 40 and 60 percent. Second, motive power or traction batteries are designed for use in long discharge cycle applications such as electrically operated vehicles, resulting in thicker and more robust batteries than SLI batteries. Finally, stationary batteries are commonly used in uninterruptible power supply (UPS), which provide backup power for computers, telephone stations, and other sensitive equipment.

Lead acid batteries are a low-cost, dependable power workhorse that are commonly utilised in heavy-duty applications. They're normally quite big, and because of their size and weight, they're only utilised in non-portable applications like solar-panel energy storage, vehicle ignition and lighting, backup power, and load levelling in power generation and distribution. The lead-acid battery is the most ancient type of rechargeable battery, and it is still highly relevant and significant today. Lead acid batteries have low energy-to-volume and energy-to-weight ratios, but a high power-to-weight ratio, allowing them to deliver massive surge current when needed. These characteristics, together with their low cost, make these batteries appealing for use in a variety of high current applications, such as starting automobiles and storing power in backup power systems.

2.2 Solar Irrigation System

A solar-powered irrigation system includes a solar panel that generates electricity, a pump, and some sort of water distribution system. Figure 2.1 depicts a typical block diagram of a solar water pumping system. The charge controller receives the high voltage electricity generated by the solar panel, half of which is transmitted to the buck converter, which lowers it down to low voltage, while the other half is stored in the battery for backup. The buck converter is connected to the relay board, which acts as a switch to electronically open and close circuits. The major component is the "myRIO," which is a portable reconfigurable I/O device for designing and controlling mechatronics systems and mounting information. The "myRIO" is connected to soil fertility and soil moisture sensors, and sends a signal to the controller, which uses a relay board to drive the pump. The water is drawn from the subsurface water level and stored in the storage tank by the pump.

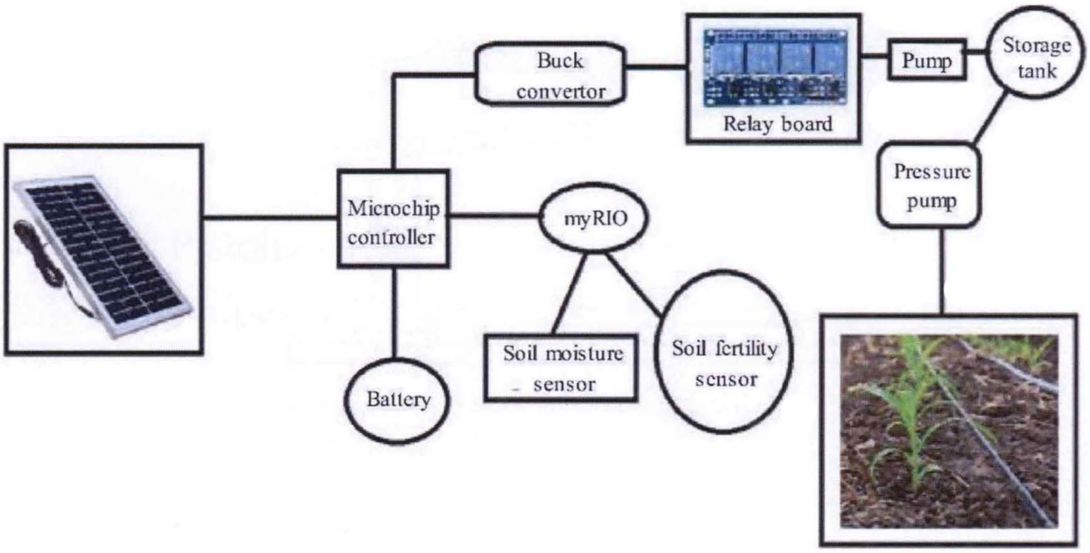

Figure 2.3 A typical block diagram of solar photovoltaic pumping system(Singh et al., 2020)

As indicated in Fig. 2.2, Chigerweet et al.(Chigerwe et al., 2004) attempted to employ low head drip irrigation kits and treadle pumps for small holder farmers. The majority of smallholder farmers rely on rain-fed agriculture, and they frequently experience dry spells that reduce their agricultural productivity. In situations where there is a dearth of water or other energy inputs, low head drip irrigation and treadle pumps may be a viable alternative. Four treadle pumps and eight drip kits are studied in a case study to analyse the most efficient irrigation method. To study these four treadle pumps, a few metrics were computed, including discharge rate, pump input power, pump output power, mechanical advantage, total dynamic head, and efficiency. While the regularity of water delivery is the most crucial feature for evaluation in drip irrigation kits, they are less expensive. Different laboratory methods and criteria were used to investigate these treadle pumps and drip irrigation kits. If the treadle pump and drip kits are carefully chosen, it is possible to irrigate drip irrigation gardens up to a size of 1000 m2.

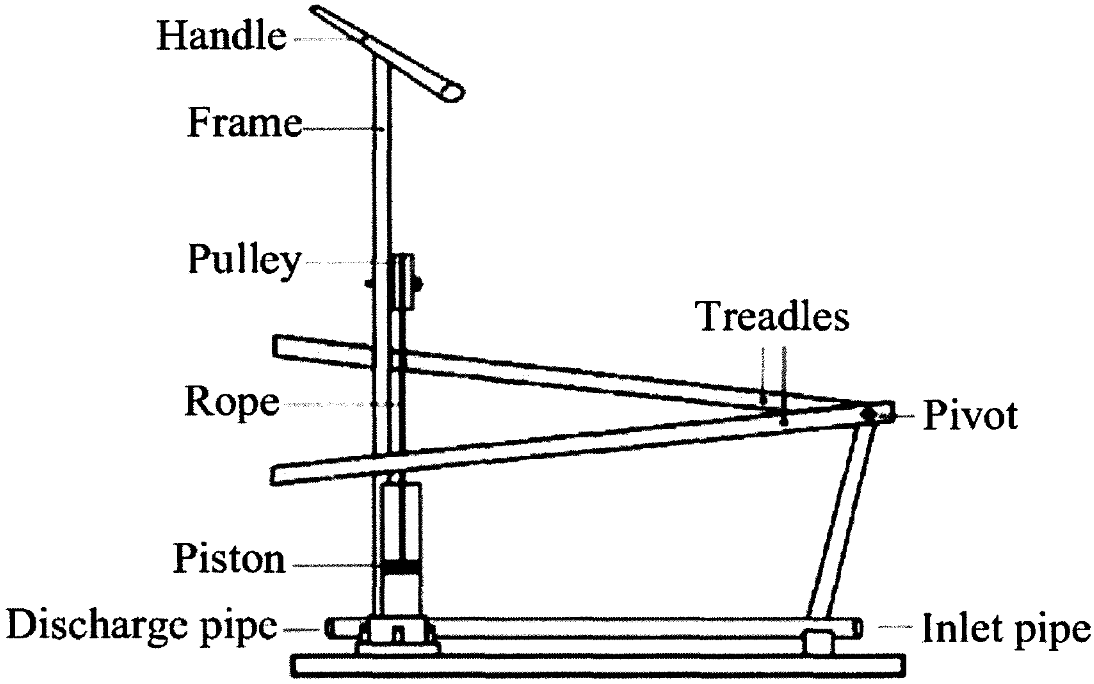

Figure 2.4 Block diagram of treadle pump (Chigerwe et al., 2004)

Glasnovic and Margeta (Glasnovic & Margeta, 2007) described the methods for analysing the most effective suited design of solar irrigation water pumping system based on hydraulic energy demand that could be satisfied by the system using alternative energy. The work took a comprehensive approach to the problem, examining the system's features as well as its features, including the local climate, PV water pumping system, boreholes, crops, irrigation method, and soil. As a result, throughout the study, a novel methodology was created, and the water pumping system was studied using mathematical modelling and simulation with the goal of optimising the model for optimal PV irrigation. For optimization, the author used dynamic programming, while the simulation model was used to specify the restrictions. The model was evaluated in two locations in Croatia, and it was discovered that it successfully took into account all of the characteristic values and their relationships within the integrated system. The optimal nominal electric power of a PV generator obtained in the manner described was significantly lower than when the same old approach of sizing was used. The strategy for resolving the problem provided opened the way for the eventual model for optimal sizing of all stand-alone PV systems with some reasonable energy storage.

Abdolizadeh and Ameri(Abdolzadeh & Ameri, 2009) looked into whether spraying water on the front of PV cells increases the PVWPS' performance. The results are compared to the standard results. When the temperature of the PV array rises, the efficiency decreases. A PVWPS of 225 W can be seen here. The spraying of water over the PV cells improves the efficiency of the system and subsystems significantly. For a 16 m head, medial PV cell efficiency increased by 3.26 percent, subsystem efficiency increased by 1.40 percent, and total efficiency increased by 1.35 percent. The medial flow rate obtained while water was sprayed on the PV cells was 644L/h, whereas the mean flow rate obtained without the water spray was 479L/h at 16 m head. The water sprinkling improved the optical performance by 1.8 percent, according to measurements of the module's short circuit current (which is nearly temperature independent). The influence of the water head on the performance of a PVWPS (photovoltaic water pumping system) was investigated by Abdolzadeh et al. (Abdolzadeh et al.; 2009) As illustrated in Fig. 2.3, the authors used an experimental setup consisting of three PV modules and one water pump. The PV modules had a 12.5 percent efficiency. The PV modules were connected in a series of parallel connections. 6 m, 10 m, 16 m, and 20 m operating heads were chosen. The 20-meter head had the highest array efficiency, which was attained about noon. A plot of power against head for the highest speed of the pump was drawn to see why the array efficiency reduced for lower heads, and it was discovered that the efficiency reduced if the PV panels' output power was greater than the highest power corresponding to the water head. The motor pump used all of the array power for a 20 m head at noon, resulting in a high array efficiency. The flow rates for the lower heads were likewise found to be higher in the mornings. The flow rates of high heads were low, despite their high efficiency. In a second experiment, the authors employed two distinct PV array arrangements: three PV array and two PV array. The efficiency of the two PV array designs was found to be higher when a water head of 6 m was used. For efficient functioning, the PV array arrangement should be chosen based on the highest power corresponding to the needed head. The flow rate was also measured, and it was discovered that the three PV array designs had a higher flow rate despite their lower efficiency. The same experiment was carried out with a 16 m head, and in three PV array configurations, declining array efficiency was observed. The water head of 16 m, on the other hand, had a slower rate of efficiency reduction. In comparison to the 6 m head, the total efficiencies of both arrangements are high at 16 m head, indicating that an optimal array configuration must be chosen for optimal performance and lower installation costs.

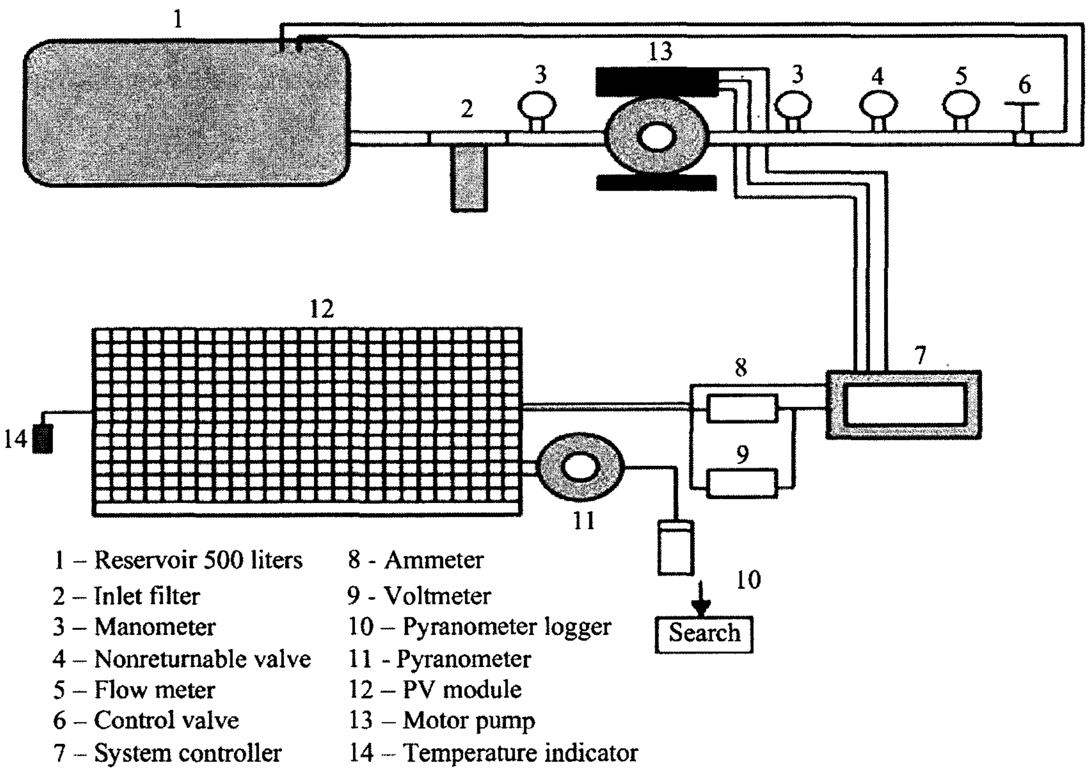

Figure 2.5 : Layout of pumping system test stand with spraying systems.((Abdolzadeh & Ameri, 2009)

Bakelli et al.(Bakelli et al., 2011) used the water tank storage to investigate an optimal sizing model to achieve the best capacity sizes of different components of PVWPS (photovoltaic water pumping system). Because solar radiation and water are readily available, this PVWPS is an excellent choice for application. They optimised the size of the PVWPS based on two essential factors: the loss of power supply probability (LPSP) and the life cycle cost (LCC) principles. In order to test the sizing standards, the LPSP approach is used. There is a risk of insufficient power supply if the PVWPS is unable to meet the load requirement. When a renewable energy source is unavailable for a length of time, a water storage tank is sized to fulfil the load demand. The system's reliability may be explained in terms of LPSP, which is directly related to load demand in this study. In order to study the photovoltaic water pumping system project, which is designed to deliver drinking water in remote areas, several levels of water head were studied using a graph known as the curve of autonomy of the system, which aids in the analysis of the entire system. Following the case study, they recommend the best technical sub-model for system dependability built using the LPSP approach, as well as the best economic sub-model built using the LCC idea. Following the case study, they10 recommend the best technical sub-model for system dependability built using the LPSP approach, as well as the best economic sub-model built using the LCC idea.

Campana et al. (Campana et al., 2014) developed a novel PVWPS(photovoltaic water pumping system) control system to address large systems, boost water savings, and improve energy efficiency. Because the traditional control system does not maximise the water supply, water is lost during the non-irrigation season when the demand for water is low and solar irradiation is low. A unique control system introduces a control setup in the system that interacts with the water excess and demand based on data input in the system, releasing water in the field based on crop requirement, which can be on a daily or monthly basis data in the system, and acting based on the water existing at the ground level. When the groundwater level drops below a specific depth, the speed of water irrigating the field slows down, and when the need is met, the water pump stops, resulting in water conservation and energy optimization as the power supplied to the pump returns to the power grid once the duty of field irrigation is accomplished. Photovoltaic cells, which are utilised in photovoltaic water pumping systems, are the focus of D. Baskar's (Baskar, 2014) research. Due to temperature, the PV cell has some limitations. The efficiency of the solar cell decreases when the temperature rises above the permitted temperature limit. The author attempted to improve the PVWPS's performance. If the temperature exceeded a particular threshold, water was sprayed over the PV cell to cool it down, and the spraying mechanism was controlled automatically by a microcontroller and solenoid. The author used an experimental strategy to improve efficiency in this study.

Tabaei and Ameri (Tabaei & Ameri, 2015) investigated how a PVWPS may be made more effective by coating the PV array surface with a flowing water layer and utilising booster reflectors. Three PV modules (3 45 W) were used in the experiment, together with an aluminium foil booster reflector. As indicated in Fig. 2.4, the PV panels were positioned east– west with a 30° inclination to the horizontal. An experiment was undertaken to find the best inclination for the booster reflectors, and it was discovered that a 45° inclination angle with regard to the horizontal plane generated the most power.

It's worth noting that the writers aren't claiming that this is the greatest option for the entire year. Two of the three panels were employed as a power source to assess the effect of booster reflectors and water film on performance. Without booster reflectors, with water film, with booster reflectors, and with booster reflectors plus water film were all considered. It was decided to go with a 16-metre head. A continuous film of water flowed over the cells, fed by the pump to a pipe with holes. The PV cells were placed on top of the pipe. It was discovered that when both booster reflection and water films were utilised, output power was at its peak. The amount of water gained was 48 percent more than with standard panels, with a 50 percent increase in power generation. For a 35° C ambient temperature, the principal temperatures of the PV array were 59° C, 36° C,71° C, and 39° C without booster reflector, with water film, with booster reflectors, and with both booster reflector and water film conditions, respectively. The PV cells' optical transmittance was improved by the intervening layer of water. A 6-metre-head was used in the same experiment. The effect of the booster reflector and water film is greater in higher heads than in lower heads. The authors feel that this is primarily due to the system's design, which prevents the output from being increased after the pump's speed reaches its limit. This speed corresponds to a specific input power value, and the pump will not operate at a higher input power.

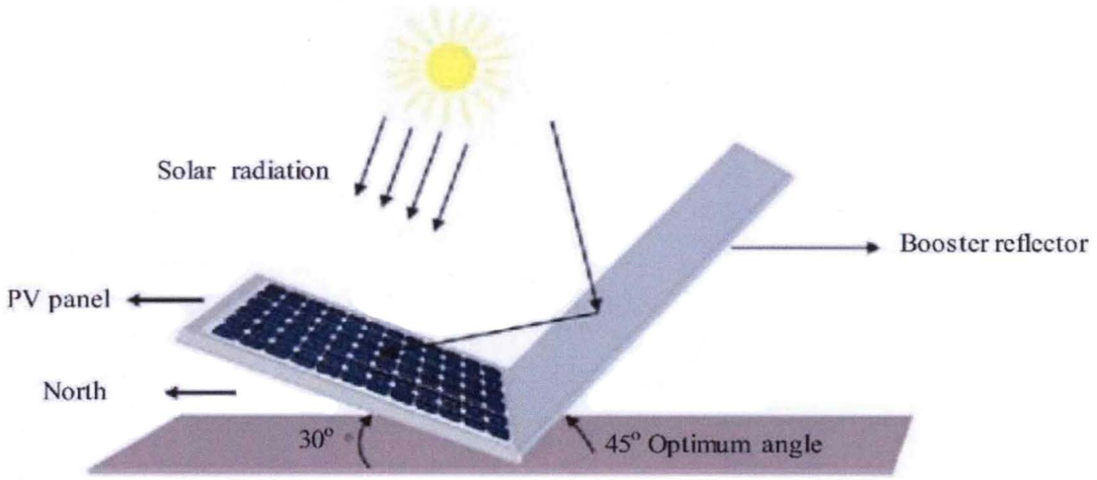

Figure 2.6: Schematic diagram of the PV panels with solar reflector.(Tabaei & Ameri, 2015)

Campana et al. (Campana et al., 2015) investigated the feasibility of the PVWPS and the wind power water pumping system (WPWPS), separating the two systems based on the technical and economic conditions that were ideal for the system. They designed both the PVWP and WPWP systems in this investigation, as illustrated in Fig. 2.5. To begin, they used a low cost for both system components and discovered that WPWP will only compete with PVPWS when the speed is high and the sun irradiation is low. Then, after a dynamic study, it was determined that PVWPS outperformed WPWPS across all parameters, implying that dynamic results are necessary for scientific and lucrative selection.

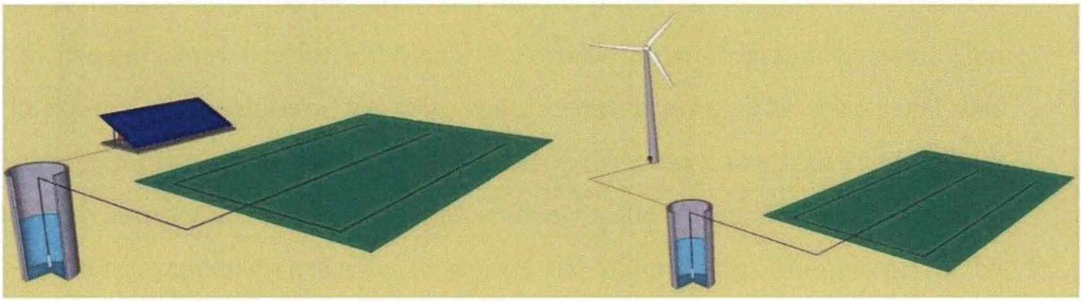

Figure 2.7: PVWP and WPWP system for micro-drip irrigation (Campana et al., 2015)

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter will cover the research methodology of this project. It will briefly be described on the process of the methods used for this project and the materials that are suitable to use as a modifier for IoT-Enabled Portable Solar Irrigation System. This system in figure 3.1 explain how the solar water pump working. The solar panel will generate energy for the system using solar to power up the water pump with a smartphone as the device controller and to supply the information of the surrounding condition. The system will use an application device to control the water pump. The pump will be pumping water from the reservoir when the water pump ON.

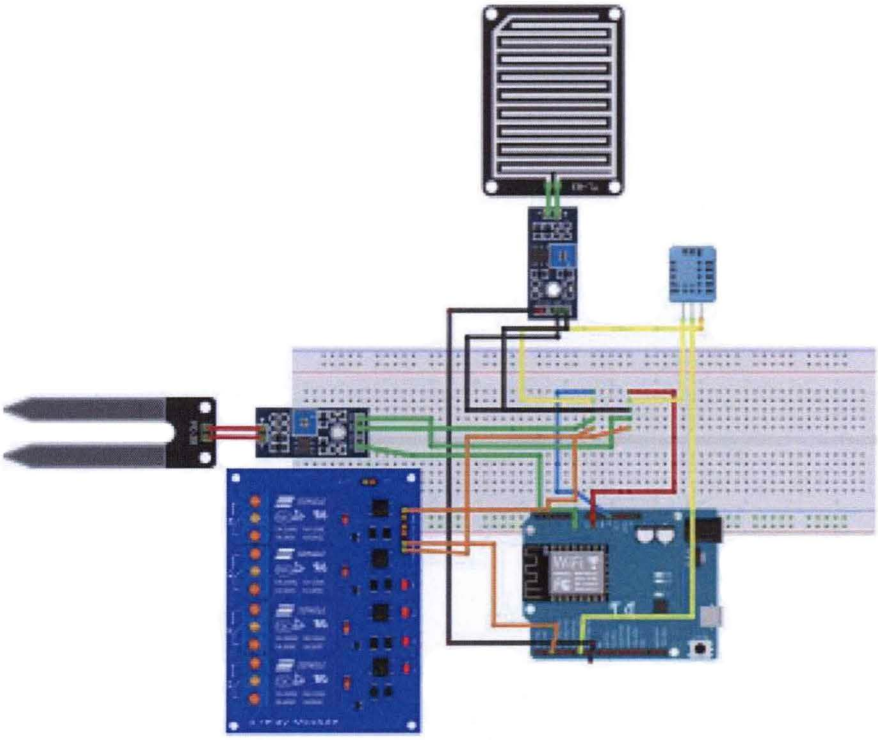

Figure 3.1 : Circuit Diagram

3.2 Type of Sensor

The sensor is an electronic device that measures physical attributes such as temperature, pressure, distance, speed, torque, acceleration, etc., from equipment, appliances, machines, and any other systems. The sensor produces an electrical signal/optical signal using multiple technologies proportional to the inputs. These Signals are either interpreted into a readable format or passed on to the next stage for further processing. Sensors are broadly grouped into analog and digital sensors. Analog sensors measure the exact value of physical variables, whereas digital sensors measure the status. Applications classify sensors, Property sensed, Technology used and Systems where they are deployed.

3.2.1 Moisture Sensor

The volumetric water content in soil is measured by soil moisture sensors in figure 3.2.1. Since direct gravimeter measurement of free-soil moisture necessitates the removal, drying, and weighing of a sample, soil moisture sensors indirectly calculate the volumetric water
content by using another property of the soil as a reference for the moisture content, such as electrical resistance, dielectric constant, or neutron interaction. The relationship between the measured property and soil moisture must be balanced, and it can change depending on environmental factors including soil type, temperature, and electric conductivity.

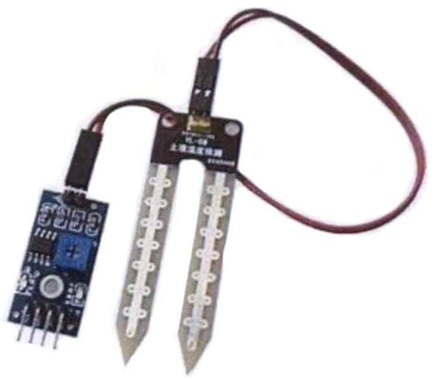

Figure 3.2.1 : Moisture Sensor

3.2.2 Rain Sensor

The sensor uses a high-quality double-sided FR-04 material, the large area of 5.0 * 4.0CM, nickel-plated surface and has antioxidant, conductivity, superior performance and lifetime aspects. The module directly with power relays, direct load control and adjust the sensitivity of digital distribution, control at different moisture control open relays. When connected to power, the power indicator light, the sensor board does not drop, the relay does not operate, switching lights off, drop a drop of water, the relay start related equipment, switch indicator light, Wipe off water droplets above, and restored to the original state. Figure 3.2.2 below show the rain sensor.

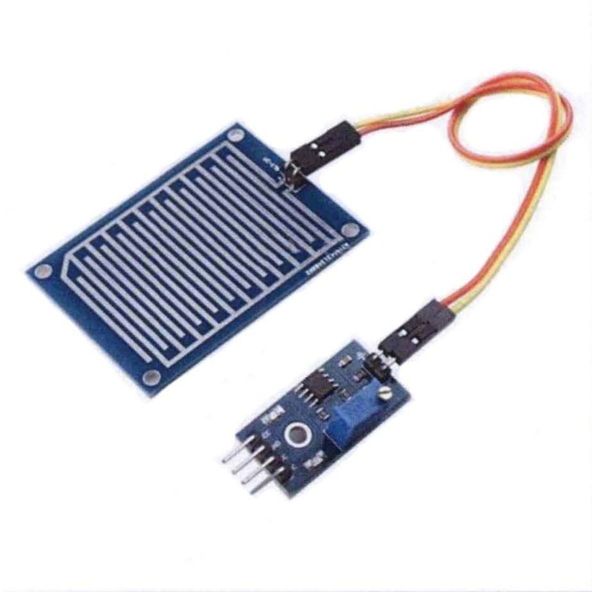

Figure 3.2.2: Rain Sensor

3.3 Overall Block diagram

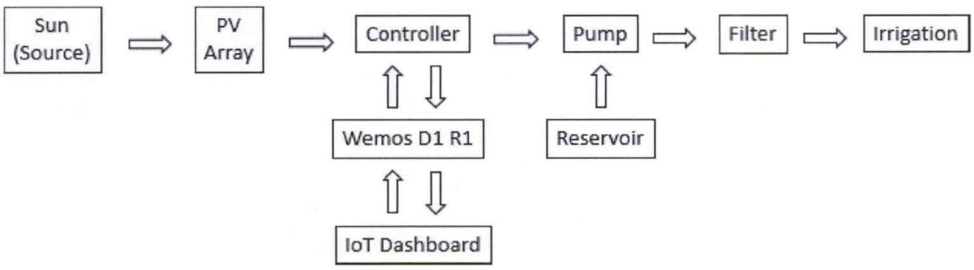

Figure 3.2.3: Block Diagram of Solar Water Pump

3.4 Electrical Components

The water pump in figure 3.2.4 below used is a water pressure diaphragm pump of 12V, 8A, 100W rated power, the maximum output water pressure is 1.1MPa with a maximum flow rate of 6.5 litres per minute per hour.

Figure 3.2.4: Water Pump

The battery shown in figure 3.2.5 below is a Konita lead acid 12v, 7.5aH battery that cope with the micro diaphragm water pump. It has a dimension of 15.1 cm (L) x 9.4 cm (H) x 6.5 cm (W) and weight about 2.85kg. The battery capacity can supply electricity to the motor up to 1-2 hour whenever is required.

Figure 3.2.5: Acid Lead battery

3.5 Microcontroller Flowchart Diagram

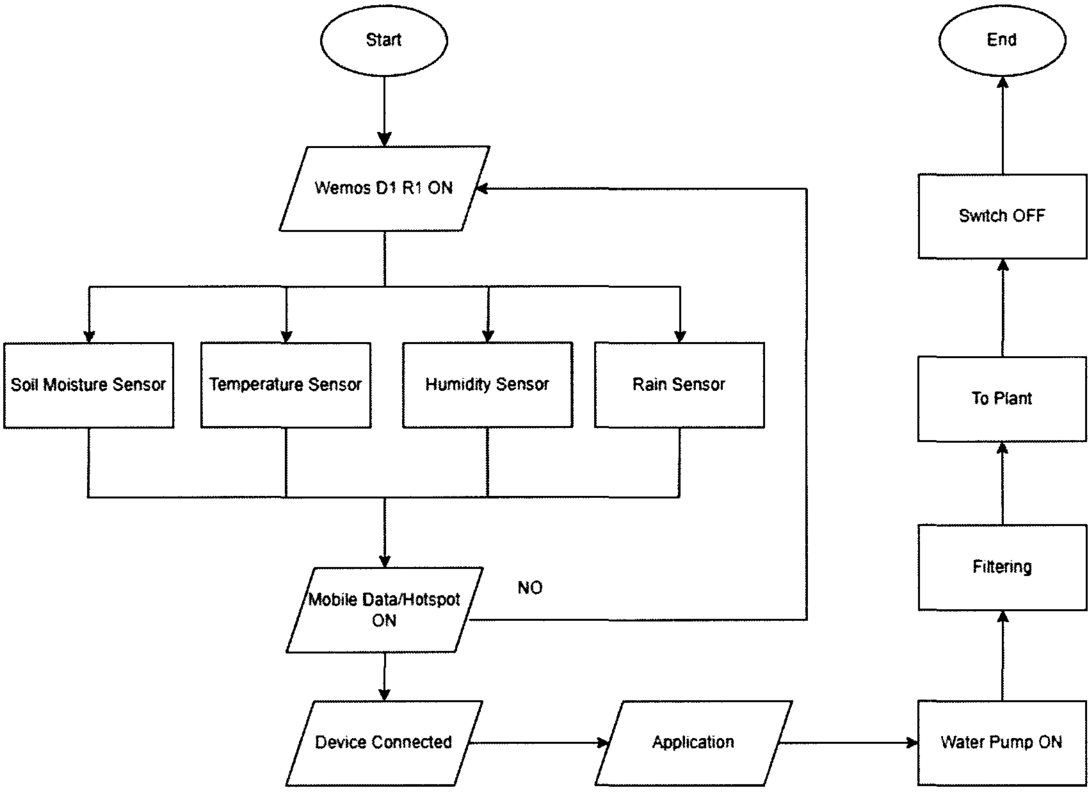

Figure 3.2.3: Flowchart Diagram

3.6 Costing

Our goal is to design and create a portable solar water pump that farmers can afford in today's market. A low-cost pump is advised so that farmers may use it right away without having to pay for utilities or infrastructure, and so that it can be utilised in a variety of situations can be used by the general public (particularly youth) who have a low level of living. A way to live to be affordable, it must be made of locally sourced and easily accessible materials. To satisfy the farmer's geographic location as well as his mechanical knowledge. Since we were working on a budget, the team prioritised which costs would be the most expensive.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Final Design

In the figure shown below is the design that have been create to make the prototype of the water pump. The component in figure 4.1 is a plastic toolbox. It use two set of plastic toolbox that uses as a storage box for the electrical and mechanical parts of the solar water pump prototype. The volume of two toolbox are same which is L x W x H equal to 43cm x 25cm x 30cm .This toolbox made from a plastic so it will reduce the weight of the prototype. The prototype will have a pair of plastic roller tire that will build in.

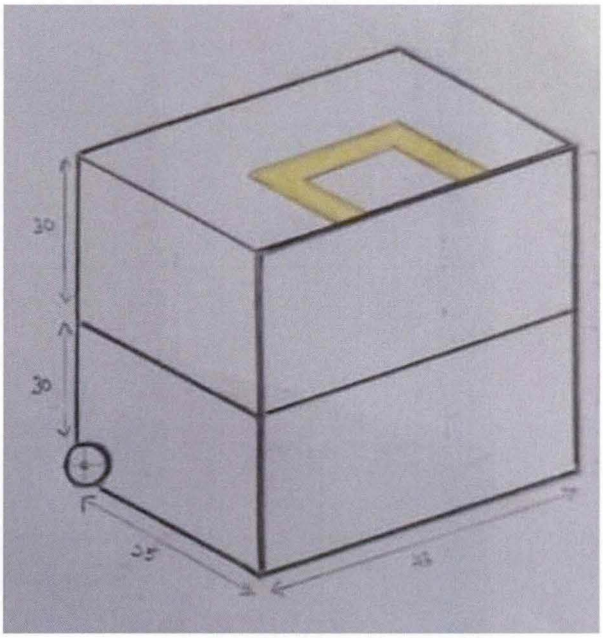

Figure 4.1 : Compartment Solar Water Pump Proposed Design

Based on the figure 4.2 and figure 4.3, it is the solar panel will use for this solar water pump prototype. The difference between the two figures are the volume of the dimension which is L xW x H equal to 45cm x 2.0cm x 60 cm or 45cm x 1.5cm x 60cm.

This is to reduce the size of the prototype. The solar panel will use aluminium frame by mono-crystalline type.

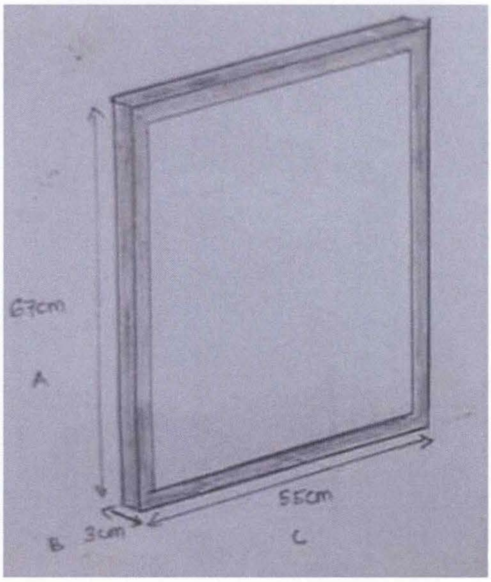

Figure 4.2: Solar Panel Proposed

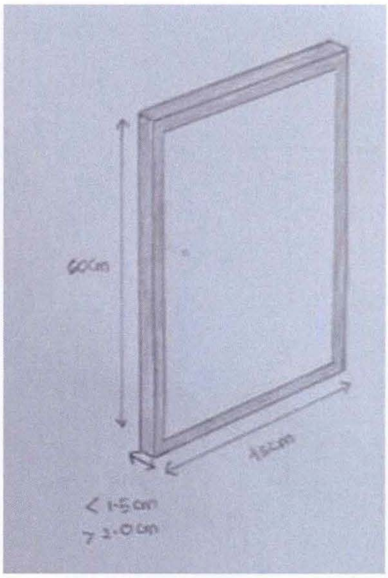

Figure 4.3 : Solar Panel Proposed

Figure 4.4 and figure 4.5 are the final proposed design of the solar water pump prototype. The assemble part i (aluminium profile for handle) to form U shape. At the part ii will gather two of 50W solar panel by using hungers and make sure it can flip properly. The first solar panel that have been attached with slider and aluminium plate will be facing toolbox and will be attach to aluminium profile conduit that has been attach to toolbox.

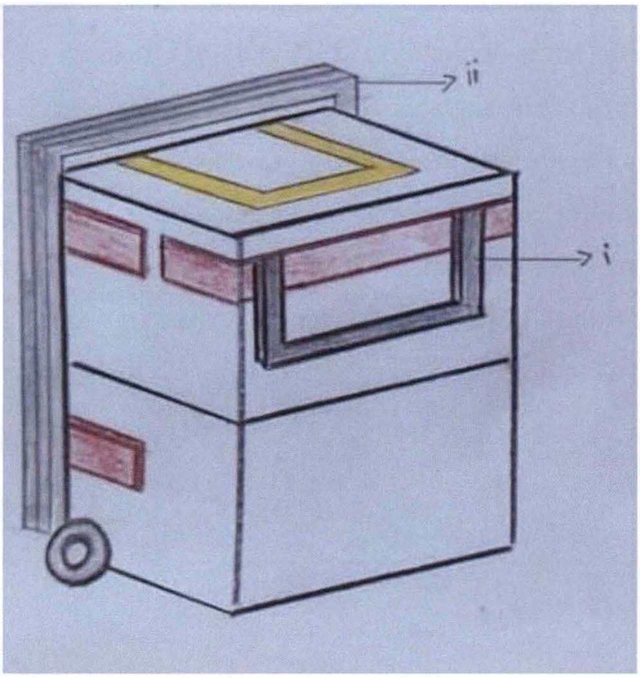

Figure 4.4: Final Proposed Back Design

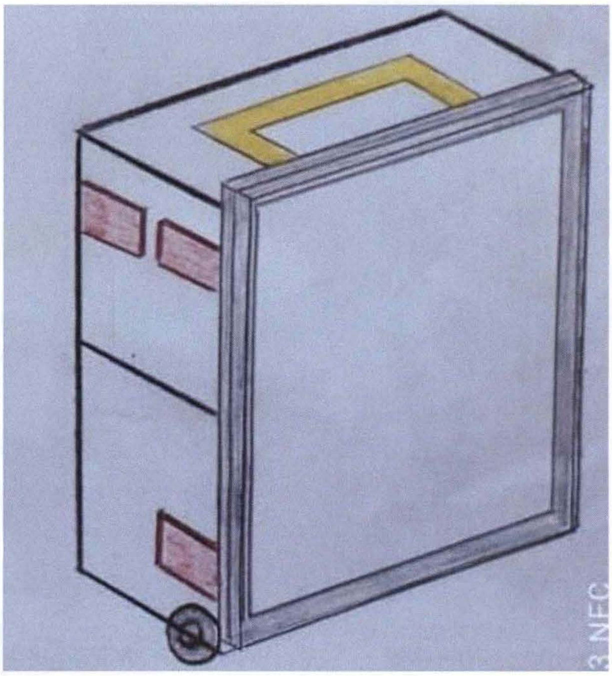

Figure 4.5: Final Proposed Front Design

4.2 Final Prototype

The microcontroller was installed in a microcontroller box, which also contained electrical components such as, a relay, a 9V battery to power the microcontroller, and a 12V battery to power the water pump. Inside the upper box was the microcontroller box. The water pump was hidden inside the prototype's lowest section. In addition, the prototype has a solar panel and a solar charge controller. The soil moisture sensor, rain sensor, humidity and temperature sensor are also affixed to the prototype's side. The prototype shown in figure 4.6 below. In figure 4.7 and figure 4.8 show the microcontroller box and the water pump box.

Figure 4.6: Final Prototype of Solar Water Pump

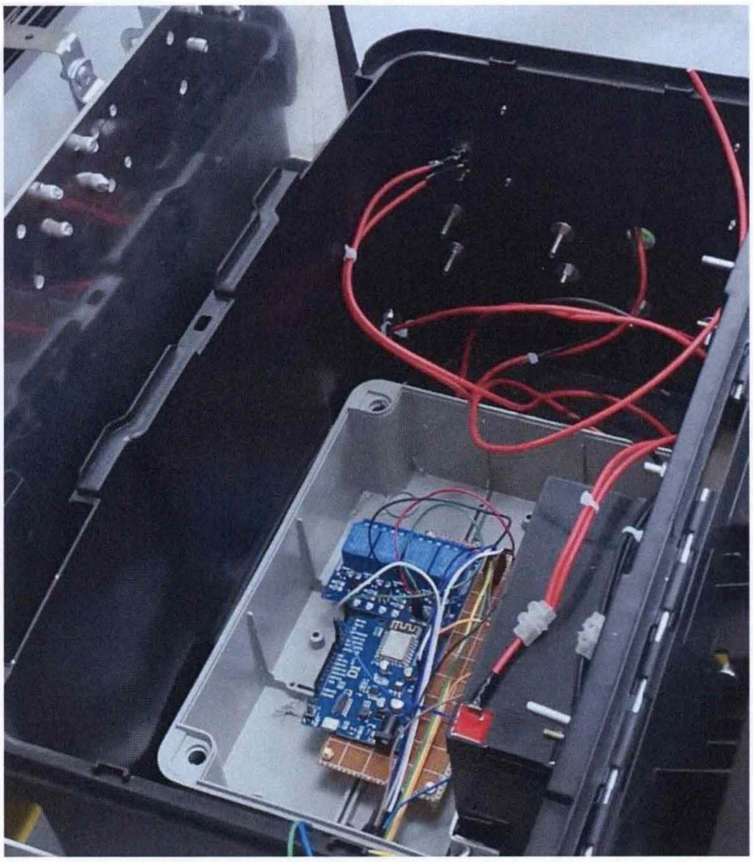

Figure 4.7: Microcontroller Box

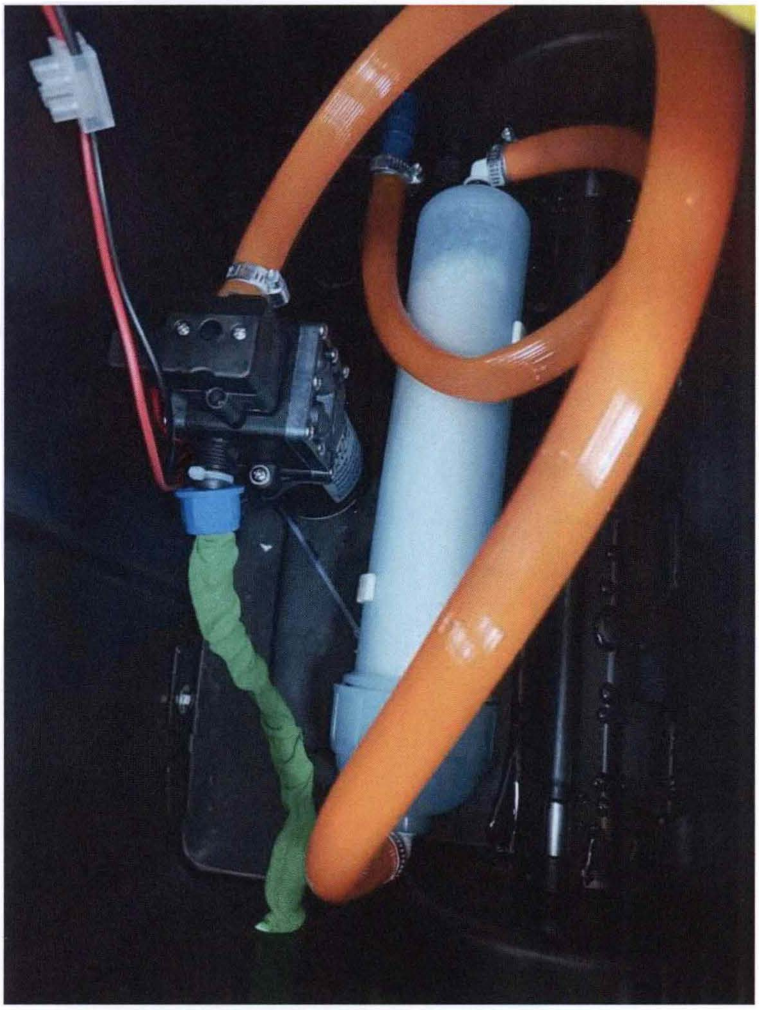

Figure 4.8: Water Pump

4.3 On-Site Testing

The testing in figure 4.9 below have been conduct at the nursery of FTKEE,UMP. The testing is to make sure the water pump is functioning.

Figure 4.9: On-Site Testing

The prototype can be control from the application that have created. From the application display it can turn on/off the water pump. It also can display the data of the sensor that uses in this product. The data can monitor by live, days, weeks, or months. In figure below show the display of the application.

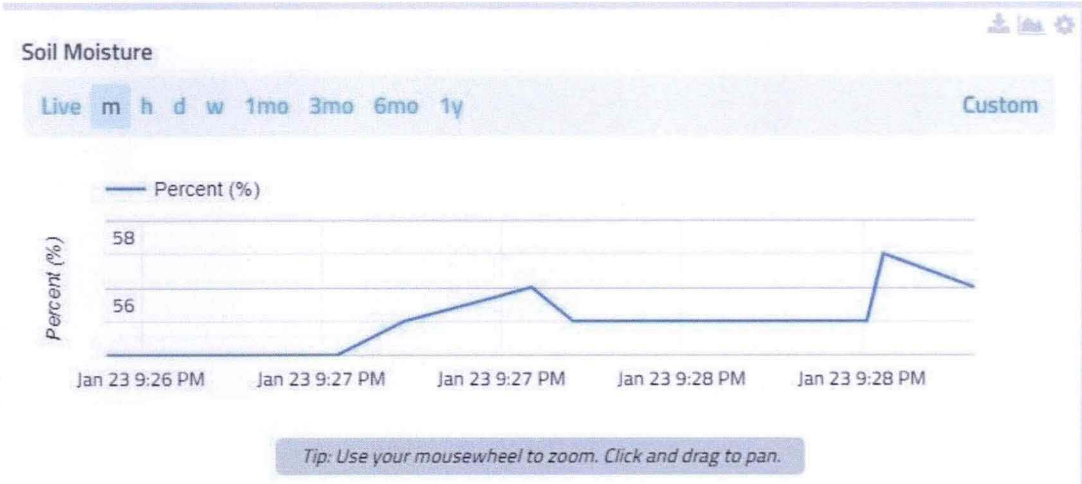

Figure 4.10: Data Display

CHAPTER 5

CONCLUSION

5.1 Conclusion

Finally, the project's goal has been accomplished. Using the given product design, this project has successfully developed for the portable solar water pump. The Cayenne application may be used to control the produced solar water pump. This programme can be downloaded from the app store for iPhones and Android phones, and the data may be seen on a desktop, tablet, or smartphone. Furthermore, the new solar water pump is made from low-cost materials, making the solar water pump more economical than existing water pumps. The created solar water pump is functional, and the analysis and data collection processes were also successful. All the data collected is within acceptable limits.

5.2 Recommendation

The recommendation for this project is the materials and design of the prototype can be changed to minimize the weight of this water pump. Next, a timer can reduce the waste of water and power while there is no usage in the frame time that been set. This project might be updated to make it moveable by adding a motor to the turning wheel and a light sensor to detect the direction of the sun. The solar panel will automatically shift its direction based on the direction of the sun. Furthermore, the project's platform may be converted into a hydraulic cylinder, which allows for automatic height adjustment of the solar panel based on the amount of sunlight. This ensures that the solar panels' energy harvesting is always at full capacity, supplying the maximum amount of power to charge the battery and run the water pump

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APPENDICES A

Appendix A:

Title: Gantt Chart SDP 2

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14
Project meeting														
SDP 2 Briefing														
Specify Detail Requirements														
Develop Prototype														
Apply Final Consucion														
Implementation (Roll-out Final Design)														