MICROCONTROLLER BASED PUMP AND LEVEL INDICATOR

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THESIS SUBMITTED TO DEPARTMENT OF COMPUTER ENGINEERING, FACULTY OF ENGINEERING, FEDERAL UNIVERSITY OYE- EKITI (FUOYE), EKITI, NIGERIA.

IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF BACHELOR OF ENGINEERING (B.ENG) IN COMPUTER ENGINEERING,

NOVEMBER, 2017.

CERTIFICATION

This project with the title

MICROCONTROLLER BASED PUMP AND LEVEL INDICATOR

Submitted by

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Has satisfied the regulations governing the award of degree of

BACHELOR OF ENGINEERING (B.Eng)

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DEDICATION

This research work is dedicated to God Almighty, the Alpha and Omega of my life.

ACKNOWLEDGEMENTS

I want to appreciate my supervisor Engr. Ms. Precious Odiase, the honourable Head of my department Dr. I.A. Adeyanju, my lecturers Dr. O.M Olaniyan, Engr. Mrs Omodunbi (My school mother) and Engr Okoli, Mr Mutiu and my brother Mr Omotayo Seyi S. for their tremendous contributions to this work and advice they gave me during the course of this work. I sincerely want tó appreciate my distinguished parents Mr. & Mrs. Omotayo and Past. Ojo Bankole for their love and parental care.

Finally, I appreciate all my course mates, all my friends especially Miss Ikhazuagbe Elizabeth O. who have in one way or the other contributed immensely to the construction of this project. God bless us all.

ABSRACT

Water is one of the most important nature's gift to mankind. However, water scarcity is a major problem currently faced by major Cities of the World. This project develops a microcontroller based water pump controller and level indicator system aimed at reducing water wastages and pump failures. Pump failure occurs most when it is not switch off immediately when there is no water from the source. There is need for a control system by which water level of both tanks and the source (well) are observed simultaneously in order to control water pump. This project is based on the use of floating switch to sense the level of water in both tank (storage) and well (source). A prototype of the proposed microcontroller based water pump controller and level indictor system was implemented and tested. The system was tested by using two buckets to represent well and tank with floating switch placed at two intervals in both buckets and 13amps socket was used for AC pump inlet. At the end of the test each LEDs glow according to their interval and pump socket was controlled according to predefined conditions. The system will help to eliminate the cost and inefficiency of human interference associated with manual monitoring and controlling of pump, while maximizing the performance and life span of the electric water pump.

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LIST OF ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
DC	Direct current
GND	Ground (negative power supply terminal)
IDE	Integrated development environment
I/O	Input and output
IC	Integrated Circuit
LED	Light emitting diode
LCD	Liquid crystal display
NO	Normally open
NC	Normally closed
PC	Personal computer
PCB	Printed Circuit Board
PV	Photovoltaic cell
UV	Ultraviolet
Vcc	Positive terminal connection
WSN	Wireless system network

CHAPTER ONE

INTRODUCTION

Water is a common chemical substance that is most essential to man for daily usage and survival as it forms an average of 60% of the human body (Davis, 2017). Water forms a larger mass of the earth, it is not readily available to man for use as a result of its composition and distance from place of necessity in some Africa countries like, Somalia, Tanzania, South Africa Nigeria as a case study (GlobalResearch.ca, 2017). Human life, as with all animal and plant life on the planet, is dependent upon water. Not only do we need water to grow our food, generate our power and run our industries, but we need it as a basic part of our daily lives - our bodies need to ingest water every day to continue functioning. Davis (2017) water consumption is required to keep all cells, tissues and organs functioning properly. Body must remain hydrated to keep replenishing water that has been lost throughout the day so that the body can have a constant supply of new water to keep functioning. Communities and individuals can exist without many things if they have to but they can be deprived of comfort, shelter, even of food for a period, but they cannot be deprived of water and survive for more than a few days. Because of the intimate relationship between water and life, water is woven into the fabric of all cultures, religions and societies in myriad ways.

African countries like Nigeria, Kenya, Ghana and so on, do fetch water from ground source in three ways, these are through construction of well, bore hole and surface stream water. A water well is an excavation or structure created in the ground by digging, driving, boring, or drilling to access groundwater in underground aquifers. Two broad classes of well are shallow or unconfined wells completed within the uppermost saturated aquifer at that location, and deep or confined wells, sunk through an impermeable stratum into an aquifer beneath. A collector well can be constructed adjacent to a freshwater lake or stream with water percolating through the intervening material. The site of a well can be selected by a hydrogeologist, or groundwater surveyor. Impurities from the surface can easily reach shallow sources and contamination of the supply by pathogens or chemical contaminants needs to be avoided. The well water is drawn by a pump, or through the use of containers, such as buckets that are raised mechanically or by hand. Soil salination can occur as the water table falls and the surrounding soil begins to dry out. While borehole is drilled into the ground to access deeper water than well water supply. They tap porous rocks called aquifers. A borehole pump is lowered into the borehole and the water can be pumped out.

Most well water is pumped out of the ground automatically using a submersible pump, or a jet pump that sits on top of the ground and draws water out of the ground to create water pressure for the home. Some well water systems use a large storage tank to store the water before it is pumped again to the house. Other well water systems are gravity fed, and use gravity to provide water pressure to the house. A home water system has two important components in addition to the well:

i. Pump
ii. Pressure tank.

There are many types and sizes of pumps for water systems. Some are only designed to remove water from a source. Others are not only remove the water, but also force it through the rest of the water system.

1.1 Statement of problem

Water scarcity is one of the major problems facing some African countries Nigeria as a case study. Practically all public water supply difficulties encountered during recent years have been blamed either directly or indirectly on the drought. A drought is generally thought of as a period of little or no rainfall, but engineers will probably want to qualify that definition with additions, such as:

i. A period of low stream flow

ii. a time of low water levels in wells and water supply reservoirs

Another factor causing scarcity is wastage during transmission.

Both domestic and industrial water requirements have increased greatly. Many communities are experiencing demands that are four to six times those that occurred in the period from 1930 to 1943. This growth has been due to extension of water service to a larger proportion of the population, as well as increases in population. Increases in demand caused by new water-using devices have not yet taken place to a material extent in the smaller communities. As sales of automatic washing machines, garbage grinders, dish-washing machines, and air conditioners grow, further increases in demand will take place.

1.2 AIMS AND OBJECTIVES

The aim of this project is to develop a microcontroller based pump and level indicator. Some of the objectives are:

i. To design microcontroller based automatic pump controller and level indicator.

ii. To implement an interactive medium between the end user and the machine in other not to over labor of the pumping machine and prevent it from burning off

iii. To test the design microcontroller based automatic pump controller and level indicator.

1.3 Scope of the project

Microcontroller based automatic pump controller and level indicator is to controls, monitor and maintain the water level in the storage tank and ensures the continuous flow of water round the clock without the stress of going to switch the pump ON or OFF thereby saving time, energy, water, and prevent the pump from overworking and burning off. Microcontroller based automatic pump controller and level indicator is to monitor both storage tank and underground source. It displays the water level and when it is getting to a low level the pump is activated automatically to refill the tank. When the tank is filled to its maximum capacity, the pump is automatically switch off.

CHAPTER TWO

LITERATURE REVIEW

Several works has been done on the control of water pumping machine and level indication before but these systems have their own disadvantages as a result of the method of sensing employed. Khaled *et al.* (2010) introduced the notion of water level monitoring and management within the context of electrical conductivity of the water. The technique of water level monitoring and controlling system concentrated with some basic parts which are softly aggregated together in the proposed method. For water level indication unit can use some LED light which will work for water level indication. By touching different water levels through water level sensor, LED should be indicated as on/off (i.e. on: yes sensor senses water).

To make special water level sensor the author introduce some convenient materials such as iron rod, nozzles, resistance, rubber etc. A connecting rod made by iron and steel which should be connected with ground and at least four nozzles which should be connected with +5v via a 1kΩ resistance. There is need to bind them together and put a rubber at their joint point which will act as an insulator for every nozzle. When the sensor touches water, nozzles and connecting rod get electric connection using water conductivity. The system can control the water pump by connecting it with an output pin of microcontroller via a motor driver circuit. When microcontroller sends a positive signal (+5v) or a ground signal (0v) to the motor driver circuit, then the water pump become on or off respectively. Also used a manual switch on the motor driver circuit which is supposed to use for controlling it manually. It makes this system more users friendly.

2.1 Design of automatic irrigation

Awelewa, *et al.* (2006) design an automatic irrigation control system to facilitate the automatic supply of adequate of water from a reservoir to field or domestic crops in all agricultural seasons. One of the objectives of this work is to see how human control could be removed from irrigation and also to optimize the use of water in the process. The method employed is to continuously monitor the soil moisture level to decide whether irrigation is needed, and how much water is needed in the soil. A pumping mechanism is used to deliver the needed amount of water to the soil. The work can be grouped into four subsystems namely; power supply, sensing unit, control unit and pumping subsystems which make up the automatic irrigation control system. A moisture sensor was constructed to model the electrical resistance of the soil; a regulated 12 volts power supply unit was constructed to power the system; the control circuit was implemented using operational amplifier and timer; and the pumping subsystem consisting of a submersible low-noise micro water pump was constructed using a small dc-operated motor. System response tests were carried out to determine the time taken for the system to irrigate potted samples of different soil types having different levels of dryness. The results obtained showed that sandy soils require less water than loamy soils and clay soils require the most water for irrigation.

2.2 Design of an automatic water level system

Ejiofor and Oladipo (2013) design an automatic water level system in which the monitor consists of the following major units: sensors, comparator circuit, microcontroller, display unit, and the pump. The core work of detecting the level of water is done by the comparator. Taking advantage of the electrical conductivity property of water, the copper conductors was used as the water level sensor. When water touches the copper sensor positioned at a particular level in the tank, voltage is transferred to the copper which in turn is transferred to the comparator circuit for further processing. The LM324 comparator was used to compare the inputs from the electrodes in the tank and with a pre-set resistance and output a HIGH or a LOW with respect to the result from the comparison. This HIGH or LOW was fed into the microcontroller which in turn uses this to control the water pump and display the appropriate status on an LCD screen. The programmable Atmel 89C52 microcontroller was programmed in Assembly Language and was used as the processor to control the functionalities of the entire system. A Liquid Crystal Display (LCD) served as the output unit which showed the status of the system on a screen. Relays were used in building a switching unit that simply triggers the pump on or off, depending on the signal received from the microcontroller. Four I/O ports were used and they have the connection to the microcontroller.

2.3 Design of a solar powered auto irrigation system

Ishwar, *et al.*(2014) design a solar powered auto irrigation system, the system checks the moisture content in the soil, based on that pumping motor will automatically pump the water into the field. Here tin probes was used as moisture sensor. By using this sensor, it can find whether the soil is wet or dry. If it is dry, pumping motor will pump the water. This project, the main controlling device is AT89S52 microcontroller. Here soil sensor will give the status of the soil to the microcontroller, based on that microcontroller will display the status of the soil on the LCD and switch on or off the pumping motor through relay. The pumping motor will pump the water into the field until the field is wet which is continuously monitored by the microcontroller.

The main objective is to find the maximum sun radiations in order to get maximum charge for the batteries. Electricity can be generated from the sun in several ways. Photovoltaic (PV) has been mainly developed for small and medium-sized applications, from the calculator powered by a single solar cell to the PV power plant. For large -scale generation, concentrating solar thermal power plants have been more common, however new multi megawatt PV plants have been built recently. A photovoltaic cell (PV cell) is a specialized semiconductor that converts visible light into direct current (DC). Some PV cells can produce DC electricity from infrared (IR) or ultraviolet (UV) radiation. Photovoltaic cells are an integral part of solar-electric energy systems, which are becoming increasingly important as alternative sources of power utility. Solar cells generate DC electricity from light, which in turn can be used in many applications such as: charging batteries, powering equipment, etc. This solar tracker works on the photovoltaic technology.

2.4 Construction of a flow control system

Thwe and Ohn (2011) construct a Flow control system which is a technology resource for the fluid handling industry's critical disciplines of control, containment and measurement. It covers products, processes, and services for efficient, reliable, and cost-effective control and delivery of fluids in a variety of industries. There are many flow control mechanisms. In this system, automatic water flow control system is implemented and can be used as process control system. As sensing unit, photo interrupter and slotted disk are used to produce pulse train for frequency input of the microcontroller. The sensor signal is counted as frequency and converted to the flow rate by using the software program in PIC. In the system, the rate of water flow was maintained at the desired value 25 liter per minute. This is done by adjusting a valve that controls water. Valve is connected to the DC motor shaft. DC motor can be operated on 12 volts dc. The motor is driven by driver IC TA7291P. This IC has four modes – stop, brake, clockwise (CW), counterclockwise (CCW). IC pin No. 5 and 6 get input commands from PIC 16F628.

These commands are manipulated values from the controller and are applied to correct the deviation of the measured value from a desired value. When water flows through the pipe, measured value is made by an optocoupler with a slotted disk that provides a pulse train proportional to water flow. This pulse train is fed into PIC pin No.12 as a frequency input. These input frequencies within a precise range are converted into flow rate by the program. This flow rate is compared to the set point value.

2.5 Development of simple water level indicator

Dipanjan, *et al.*(2016) a simple water level indicator was made using resistors, LEDs, etc. For this it may be designed a water sensor by using conducting wires. In this project the sensor to measure water up to four levels was designed. Take 4 segments of insulated conducting wires. Tore out the ends of these wires, approximately 1cm. Adjust the length of the wire segments according to the water levels. In the following diagram it has been displayed with 4 different colours. The wire with Black colour is connected to buzzer. The wires with colours Yellow, Red, &Green are adjusted to check Level1, Level2, Level3 and Level4 respectively. Water level indicator works through the following circuit diagram. Here this circuit is connected to 9 volt dc voltage source. The positive end of the dc source is connected to the overhead water tank and the negative end of the dc source is connected the diode LEDs and the buzzer accordingly. The other end of the LEDs are connected to the 220 ohm resistors and the resistor ends are connected to the separately to the overhead water tank. The buzzer's other end is connected to the overhead water tank here the resistor is not connected. One switch is connected between the positive voltage source of the circuit and the battery.

2.6 Design and implementation of a microcontroller based automatic water pumping control system.

Okhaifoh, *et al.* (2016) Design a microcontroller based automatic water pumping control with ultrasonic sensor, In order to achieve the aim set out, some water supply schemes were studied. The system was designed using proven electrical and electronic principles with focus on reducing complexity, hence reduced high cost and energy requirement. It was broken down into four sections: the power supply unit, the sensing unit, control unit and the switching/output unit. The device uses an ultrasonic sensor installed at the top of the storage tank which is triggered by the microcontroller to send and receive sound waves, and the time it takes to send and receive the signal is converted to distance to give out corresponding digital outputs which will be used by the microcontroller to drive digital outputs. If the distance calculated is less than or equal to the preset minimum distance, the pumping machine is automatically switched ON and the process continues as shown in figure 2.1 below.

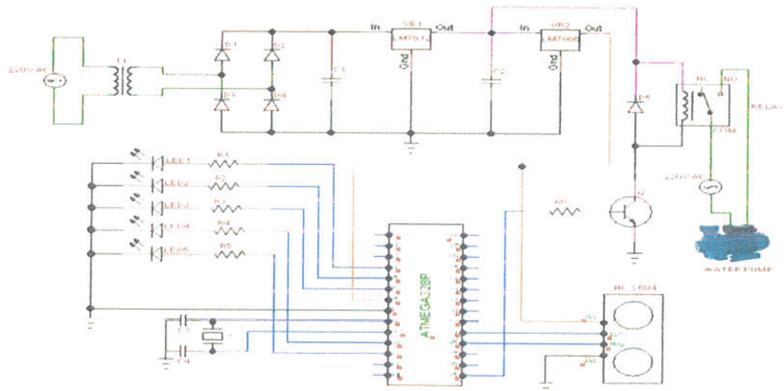

Figure 2. 1 Circuit Diagram of Microcontroller Based Automatic Control for Water Pumping Machine (Okhaifoh, *et al*, 2016)

Again, the microcontroller sends another pulse of 10µs to the trigger pin of the sensor, the sensor then transmit an 8 x 40 KHz sound wave to enable the echo pin, the reflected sound wave is received to disable the echo pin. The time it takes to transmit and receive the sound wave is used by the microcontroller to calculate the distance. If the distance calculated is greater than the preset minimum distance and less than or equal to the preset distance of LEVEL 1, LED 1 is switched ON. This process continues until the maximum level is reached to automatically switch OFF the pumping machine.

2.7 Design an automatic water level controller

Abang, (2013) Design an automatic water level controller for both overhead and underground tank is designed to monitor the level of water in a tank. It displays the level of water and when it is at the lowest level; a pump is activated automatically to refill the tank. When the tank is filled to its maximum capacity, the pump is automatically de-energized. Several circuits are put together to ensure proper working of this design, and the block diagram includes the supply unit, the micro-processor unit, the sensor unit, the display unit and the pump drives unit. The power unit is responsible for turning on the entire circuit. Some components are used to set up power unit and they include; a 15v step down transformer, a bridge rectifier circuit. a smoothening capacitor and a voltage regulator IC. The microprocessor (AT89S50) controls virtually all the actions carried out in this design. (AT89S50) is used in the design. The sensor unit is responsible for sensing the level of water and transfer the current position of water to the microprocessor. The display unit in the circuit is use to physically show the current position of water in the tank, the properties of seven segment display are been used. He stated that there are many methods of designing an automatic water level control with switching device but all these methodologies require human assistance. In this project an automatic water level control for both overhead and underground tank with switching device is designed using electronic control to refill the water without human intervention. The system design was carefully arranged to refill the water tank any time water get low to a certain level finally the system automatically shut down the water pump by putting the electric pump by putting the electric pump off when the tank is full

2.8 Design of water level indicator with alarms

Ahmed, *et al*, (2015) designed a Water Level Indicator with Alarms Using PIC Microcontroller, this design is to solve that problem. This design not only indicates the amount of water present in the overhead tank but also gives an indication when the tank is full. This design uses widely PIC microcontroller 18F452, bilateral switches to indicate the water level through LCD display. When the water is empty the wires in the tank are open circuited and resistor pulls the switch low hence and open the switch. As the water fill in the first reservoir tank its fill-up percentage shown in the LCD display. Today in the world most of the developing countries using this in their home and also industries. All probes used to implement was made of aluminum.

The design is applicable for both reservoir and main tank in home or industries.PIC 18F452 used in this design. There is also buzzer and LCD in this design. LCD used to show the level of water in both reservoir and main tank. Buzzer used to create a siren to stop the pump or water coming channel. There are 10 DIP switches used in this design. These switches indicate water level of both tanks. PIC microcontrollers also controls the motor which pumps the water in the tank from the reservoir. In the auto mode, motor is automatically turned on when water level reaches 20% in the tank and it is turned off when water level reaches 100%. Choose PIC microcontroller for programming flexibility, faster speed of execution since microcontrollers are fully integrated inside the processor

2.9 Design and implement a microcontroller based water pump controller

Olufemi *et al*, (2016) design and implement a microcontroller based water pump controller a microcontroller based, the water pump controller aimed reducing water wastages and pump failures, due to not switching it off immediately when not needed. The control system from which water level of both tanks are observed with simultaneous water pump control is based on existing water level technology using the principle of ultrasound for level sensing. A prototype of the proposed microcontroller based water pump controller was fabricated and tested. This paper provided an improvement on existing water level controllers by its use of calibrated circuit to indicate the water level and use of DC instead of ac power, thereby eliminating risk of electrocution.

The developed system is capable of powering a 1HP pump from the input voltage, which can deliver an output current up to 20A. The system will help to eliminate the cost and inefficiency of human interference associated with manual monitoring and controlling of pump, while maximizing the performance and life span of the electric water pump. In the water level indication unit, light emitting diode (LED) light which will work for water level indication is used. By touching different water levels through water level sensor, LED should be indicated as ON/OFF. When the sensor touches water, nozzles and connecting rod get electric connection using water conductivity (Khaled et al., 2010). The pump is controlled by connecting it with an output pin of the microcontroller via a motor driver circuit.

2.10 Design a simple, automatic water level controller

Viswanathan (2004) design a simple, automatic water level controller for overhead tanks that switches on/off the pump motor when water in the tank goes below above the minimum/maximum level. The water level is sensed by two floats to operate the switches for controlling the pump motor. Each sensors float is suspended from above using an aluminum rod. This arrangement is encased in a PVC pipe and fixed vertically on the inside wall of the water tank. Such sensors are more reliable than induction-type sensors. Sensor one senses the minimum water level, while sensor two senses the maximum water level. Leaf switches S1 and S2 (used in tape recorders) are fixed at the top of the sensor units such that when the floats are lifted, the attached 5mm dia. (approximate value) aluminum rods push the moving contacts (P1 and P2) of leaf switches S1 and S2 from normally closed (N/C) position to normally open (N/O) position. Similarly, when the water level goes down, the moving contacts revert back to their original positions. Normally, N/C contact of switch S1 is connected to ground and N/C contact of switch S2 is connected to 12V power supply. IC 555 is wired such that when its trigger pin 2 is grounded it gets triggered, and when reset pin 4 is grounded it gets reset. Threshold pin 6 and discharge pin 7 are not used in the circuit. When water in the tank goes below the minimum level, moving contacts (P1 and P2) of both leaf switches will be in N/C position. That means trigger pin 2 and reset pin 4 of IC1 are connected to ground and 12V, respectively. This triggers IC1 and its output goes high to energize relay RL1 through driver transistor SL100 (T1). The pump motor is switched on and it starts pumping water into the overhead tank if switch S3 is 'on.' As the water level in the tank rises, the float of sensor 1 goes up. This shifts the moving contact of switch S1 to N/O position and trigger pin 2 of IC1 gets connected to 12V. This doesn't have any impact on IC1 and its output remains high to keep the pump motor running.

2.11 Design a low cost automatic water level control

Ishwar and Laloo (2013) Design a low cost automatic water level control, in which water level controller depends on two detection points in the OHT. The water level must be controlled at these two points. To facilitate this, we use sensors. In our case, these sensors are metallic contacts with space between them present at each detection point. When water reaches a sensor, a proper circuit must be present such that the presence of water is detected and a signal is produced. This signal must pass through logic circuits to give the correct actuator output. Also it must be strong enough to activate the actuator as shown in figure 2.2 below. A similar action must take place when water reaches another sensor. The circuit essentially uses the high and low states of a NAND gate to activate or deactivate the actuator. Simply put, relay on the ON and OFF states of the actuator.

Metallic Contacts are L-shaped aluminium contacts which conduct electricity when the space between them is bridged by water. For the project, L-shaped brackets was used. Two contacts at the bottom part of the tank form the indicator for low level of water. Similarly two contacts at the upper part of the tank indicate that water is about to overflow. They assembled the circuit which works on the conduction of electricity by water. The circuit works using logic gates and the output obtained is in the form of ON and OFF state of the centrifugal submersible pump.

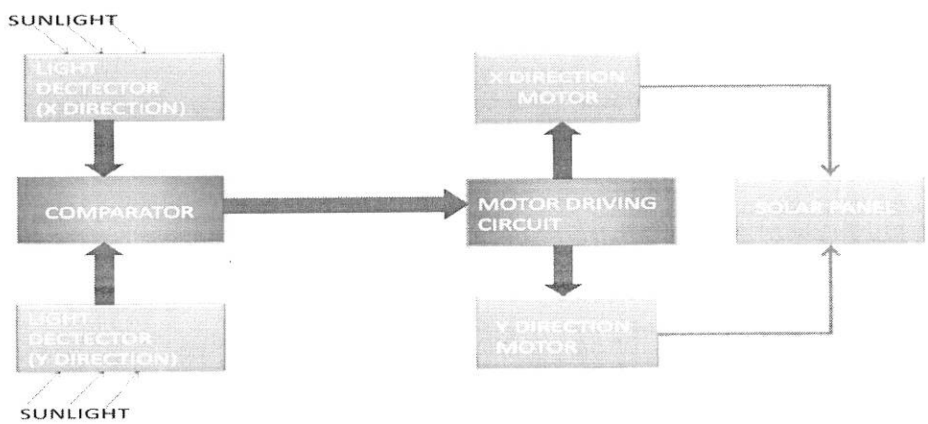

Figure 2. 2 Solar Powered Auto Irrigation System Block Diagram (Ishwar and Laloo, 2013)

2.12 Design water level monitoring system

Bhad, *et al* (2016) Design water level monitoring system in real time mode using WSN. Automatic water level monitoring is possible with the help of WSN (wireless sensor network) which is an attractive field of environment monitoring. In current system it is not possible to monitor the water level accurately, due to natural disaster water levels increases, and it is hard to detect the actual level and volume of water therefore many problems have to face so to overcome this drawback it was proposed a system which monitors the water level periodically. To help of wireless sensor network and send the notification message to the mobile application user and digital notification board. For that communication it will form zigbee network which has lower energy and real time behavior and it automatically check the water level periodically.

A number of software and hardware implementation techniques were used to design and develop the system. A microcontroller, water level sensor and a pair of Raspberry pi and DAS have been used to design the system. The Sensor used to detect the water level, then the data will go to transmit and receive through the Raspberry pi and the whole procedure is then control by this unit. The WSN system is thus suitable for the water source like dam, river, Lake Etc. The system explains the auto monitoring of the water level. The requirements of WSN increases very much, because they are used in a many different application areas sensor generates high frequency sound waves and evaluates the echo from the water level of the reservoirs which is received back by the sensor. At the transmission side, a DAS module has been attached to transmit the sensor data through Raspberry pi. At the receiving side, another Raspberry pi module has been also used to receive the sense data. An integrated Light Emitting Diode (LED) associated with DAS module is also used for real time display of water level sensed data. The Light Emitting Diode (LED) is used to indicate the different level of water and an alarm (beeper) will be active in the case of overflow and empty level.

2.13 Intelligent irrigation system

Tayyeb, *et al*, (2015) presents an intelligent irrigation system for gardens or orchards to increase the productivity of watering while saving the expenses of labors and the amount of water that need to be watered. The usage of soil moisture sensors, water pump, hose, LDR sensor and a microcontroller which is loaded with C programming codes made this smart system completely intelligent to do the lightening and watering intelligently without any monitoring. To construct this invention one of the most challenging parts of designing was the moisture sensor. Soil moisture sensor allows determining the needs of water to plants. Which it helps avoid wasting water or harming plants by watering too often. When soil is wet, electrical conductivity of water lowers the resistance between the probes. As soil dries, the resistance increases again. To make a suitable and cheap soil moisture sensor a few design were made but each one of them was rejected because of some demerits. The first design of the soil moisture sensor was a simple design which two probes with a fixed distance between them was installed. The probes were able to measure the moisture content of the soil but the reason that the first design was not proved because the erosion of the material was extremely high in wet soil. Another problem thing was that the two probes only occupy a very small area of the irrigation basin. Therefore, it might be problematic if that spot is wet, so the whole plant might not be irrigated.

2.14 Analysis of existing oil-pumping system

Rojiha, (2013) analyzed this existing oil-pumping system and discovered that they have a high power-consuming process and needs more manual power. He then proposed a sensor network based intelligent control system for power economy and efficient oil well health monitoring. Several basic sensors were used for oil well data sensing, and the sensed data was given to the controller which processed the oil wells data and it was given to the oil pump control unit which controls the process accordingly. If any abnormality is detected then the maintenance manager is notified through SMS via the GSM. This system allowed oil wells to be monitored and controlled from remote places.in easy way to comply with the conference paper formatting requirements is to use this document as a template and simply type the text into it.

Meanwhile, (Omolola, 2010) worked on the design and construction of a water level detector with pump control based on a microcontroller. The project involved the use of a digital water level detector with pump control and an instrument that indicates the level of water in a tank, using seven-segment display to indicate the following levels; 0%, 25%, 50%, 75%, and 100%. Like (Olabimpe, 2010)it has an alarm to indicate when water is at the 0% level. However, the alarm emits a continuous sound for 10s indicates the 100% level of the tank.

Most of the earlier mentioned system use the electrical conductivity of water by installing metallic conductors at separate levels along the tank height to act as sensors. Over time, the metallic conductor corrodes as it comes in contact with the water, thereby making it to lose its electrical conductivity. This also result in reduced water quality due to contamination of the water - change in the pH level, introduction of stains, colourations, deposits and change in taste of the water. In general, the water becomes unhygienic for use and hazardous to health over time. The proposed system addresses these shortcomings as it uses floating switch as its sensing device which do not react or corrode with water when in contact.

CHAPTER THREE

METHODOLOGY

There are many methods of designing an micro controller based automatic pump controller and water level indicator with switching device but most of these methodologies require human assistance. In this project a micro controller based automatic pump controller and water level indicator is for both overhead tank and underground water source (well or borehole) with which the switching device is designed using floating switch to sense water level at four major designated point (three points in the overhead tank and one in the well) to refill the water without human intervention.

The system design is carefully arranged to refill the water tank any time water get low to a certain level finally the system automatically shut down the water pump by putting the electric pump off when the tank is full or whenever the well runs out of water to supply (in case of no water from the source, the system gives allowance of 30mins before sensing it again. To avoid pumping of little water from the source and stopping). The approach used in this work is the modular design approach the overall design was broken into functional blocks. Where each block represent a section of the circuit that carries out a specific function. The system was designed using functional blocks as shown in the block diagram Figure3.1 below. In this method, the circuit is designed to display three different level using three sensors to monitor the inflow of water in the tank. However, these displays can be increased and decrease depending upon the level resolution required. This can be done by increasing or decreasing the number of level detector and associated component.

3.1 Block diagram of the project

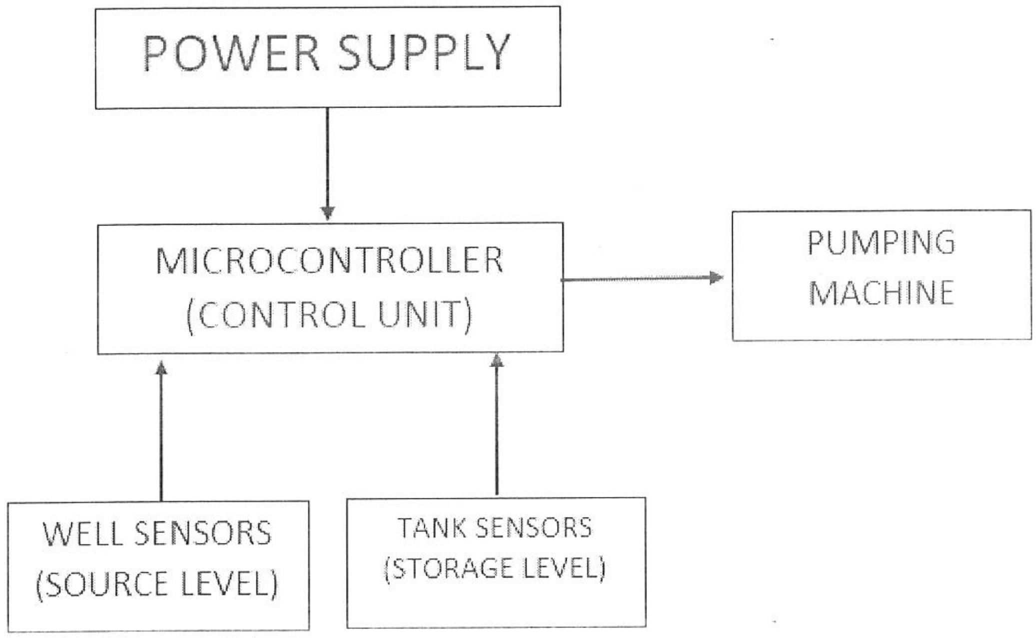

Figure 3.1 Block Diagram of Microcontroller based automatic pump controller and level indicator

3.2 System units

Several units are combined to ensure proper working of this design. The unit include:

i. Power supply and backup unit,

ii. Control unit (Micro controller),

iii. Sensor and Actuator unit,

iv. Display unit

3.2.1 Power supply and back up unit

A power supply is used to converts alternating current from the outlet on the wall into direct current which is required to power ON the system. In order to get a steady and reliable Direct current (DC) for the system, the power unit is developed following this stages;

3.2.1.1 Step down stage

Alternate Current Input Coming from the wall, the AC alternates from a minimum to a maximum voltage at a frequency of 50Hz between the range of 220 – 240 volts (in Nigeria and other 60Hz countries) is step down through the use of step down transformer to about 22 -24 volts. Figure 3.2 illustrate a step down transformer.

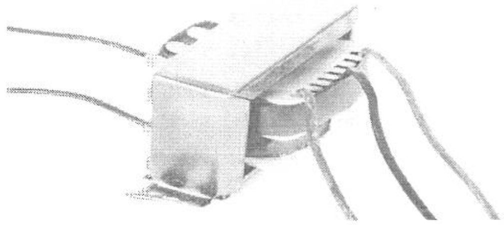

Figure3. 2 Step down transformer

3.2.1.2 Rectification Stage

Rectification is the conversion of AC to DC. This consist of four diode connected together to form a full wave rectifier. The simplest kind of rectifier circuit is the half-wave rectifier. It only allows one half of an AC waveform to pass through to the load. For most power applications, half-wave rectification is insufficient for the task. The harmonic content of the rectifier's output waveform is very large and consequently difficult to filter. Furthermore, the AC power source only supplies power to the load one half every full cycle, meaning that half of its capacity is unused. There is a need to rectify AC power to obtain the full use of both half-cycles of the sine wave, a different rectifier circuit configuration is used which is a circuit is called a full-wave rectifier this is shown in Figure 3.3.

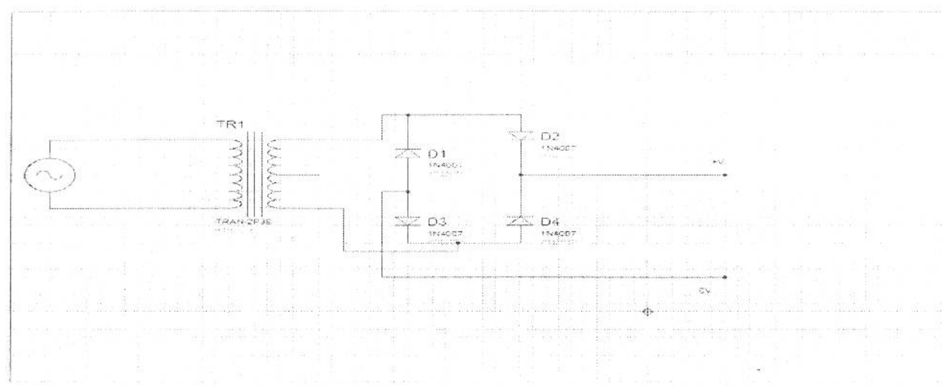

Figure3. 3 Rectification (Full wave rectifier)

3.2.1.3 Smoothing

Now we have at least consistently positive voltage levels, but they still dip down to zero 120 times per second. A large capacitor, which can be thought of like a battery over very short time periods, is installed across the circuit to even out these rapid fluctuations in power. The capacitor charges when the voltage is high and discharges as the voltage is low.

3.2.1.4 Regulation

In this stage the smoothed voltage is then controlled to maintain a constant range. In this project voltage regulator LM7805 was used to regulate the voltage to 5V. Two lithium battery of 3.5V each was connected in series to obtain 5V to serve as backup power supply in case of AC failure Figure3.4 shows the interconnection of power unit.

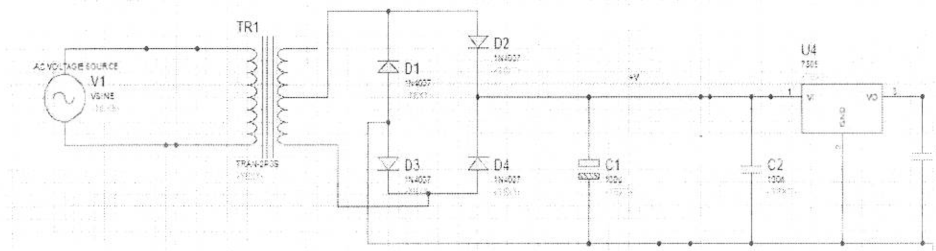

Figure3. 4 Power Unit

3.2.2 Control unit

This unit is to coordinate the perception from the sensor and activate the signal to power the pumping machine through the relay. The microcontroller ATMega328 is used in the design. ATMega328 is a high-performance Microchip 8-bit AVR RISC-based microcontroller combines 32KB ISP flash memory with read-while-write capabilities, 1KB EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts (Atmel Cooporation, 2000) Figure3.5 shows the pins of ATMega328p-pu IC.

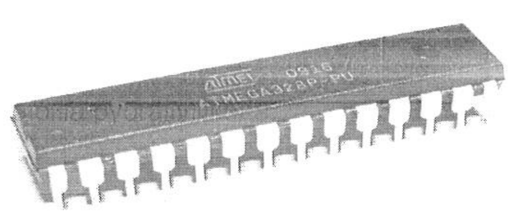

Figure3. 5 Micro - controller (ATMega328)

3.2.3 Sensor and actuator unit

This unit is responsible for detecting the level of water and transfer the current position of water to the microcontroller. The sensor used here is a floating switch.

3.2.3.1 Floating Switch

This switch is a device used to sense the level of liquid within a tank, it may actuate a pump, an indicator, an alarm, or other devices. When the float ball rises or falls with the liquid to the level of the switch, the magnetic force of magnet which inside of the float ball will cause the reed switch to turn ON. When the float ball move away from the reed switch, the reed switch will turn OFF, the image is shown in figure 3.6.

Figure3. 6 Floating switch

Specification

i. Cable length: 40cm
ii. Maximum load: 10w
iii. Max Switching voltage: 100V DC
iv. Max BreakDown Voltage: 250v DC
v. Maximum Switching Current: 0.5A
vi. Max load current: 1.0A
vii. Max contact resistance: 0.4 Ω

viii. Temp Rating: -10 ~ +80°C

ix. Net weight: 16g

Since the pumping machine utilizes the AC voltage supply and the project works with DC current there is a need for a unit to control the AC pump with a DC signal. To solve this a relay is required to drive the pump. In order to activate 12volts relay in this project.

3.2.3.2 Pump control

The pump will be controlled with the use of a relay. A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to contr e several circuits must be controlled by one signal. A relay switches one or more poles, each of whose contacts can be thrown by energizing the coil. Normally open (NO) contacts connect the circuit when the relay is activated; the circuit is disconnected when the relay is inactive. Normally closed (NC) contacts disconnect the circuit when the relay is activated; the circuit is connected when the relay is inactive. Relays are used wherever it is necessary to control a high power or high voltage circuit with a low power circuit.

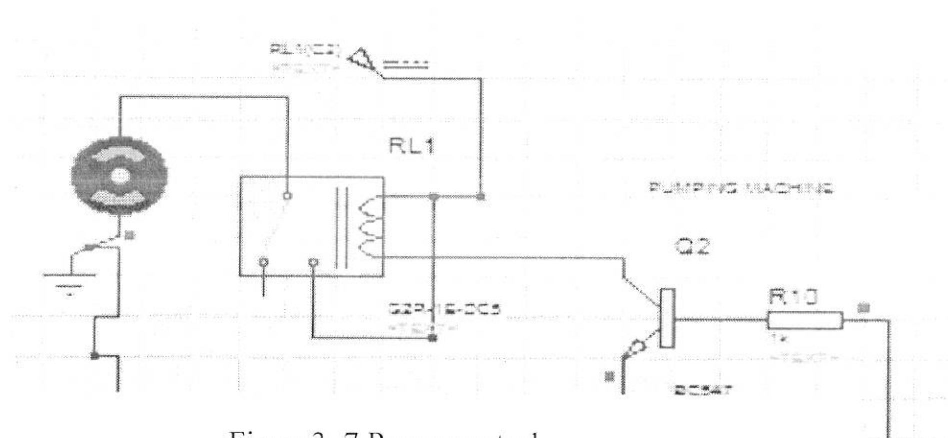

Figure3. 7 Pump control

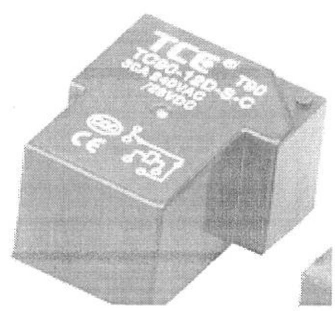

Figure3. 8 12V Relay

The pump control segment consists of a 10k resistor diode, an NPN transistor and 1 12v relay. The 240vac is attached to the common of the relay while the pump is attached to the normally open pin of the relay. A diode is connected across the energizing coil of the relay to bias the relay while the microcontroller controls the biasing of the relay by sending logic 1 or logic 0 to the base of the NPN transistor, which in turn biases the relay.

3.2.4 Display unit

Figure3.9 is a 16x2 Liquid crystal display and Light emitting diode was used in this unit to physically show the current position of water in the tank. A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome.

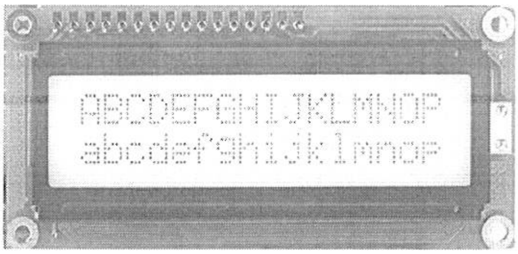

Figure3. 9 16x2 Liquid crystal display

3.3 Design algorithm

Step 1: Start.

Step 2: Initialise the well and tank level.

Step 3: Check if tank is empty?

Step 3.1: If tank is empty, go to 4.

Step 3.2: Else, go to step 5.

Step 4: Check if well is below level 1?

Step 4.1: If yes stop pump then display "Empty source".

Step 4.2: Else, Start pump then display "Pumping".

Step 4: Sense water tank at level 1 sensor.

Step 4.1: If water has reach level 1, display "Water level 20%".

Step 4.2: Else, go to step 4.

Step 5: Sense water tank at level 2 sensor.

Step 5.1: If water has reach level 2, Stop pump and display "Water level 100%".

Step 5.2: Else, go to step 4.

Step 9: Stop.

3.4 Design flowchart

Figure3.10 shows the flowchart of the microcontroller based pump and level indicator system. This shows the conditions necessary to switch ON and OFF the pump as well as showing the level on both the LCD and LEDs.

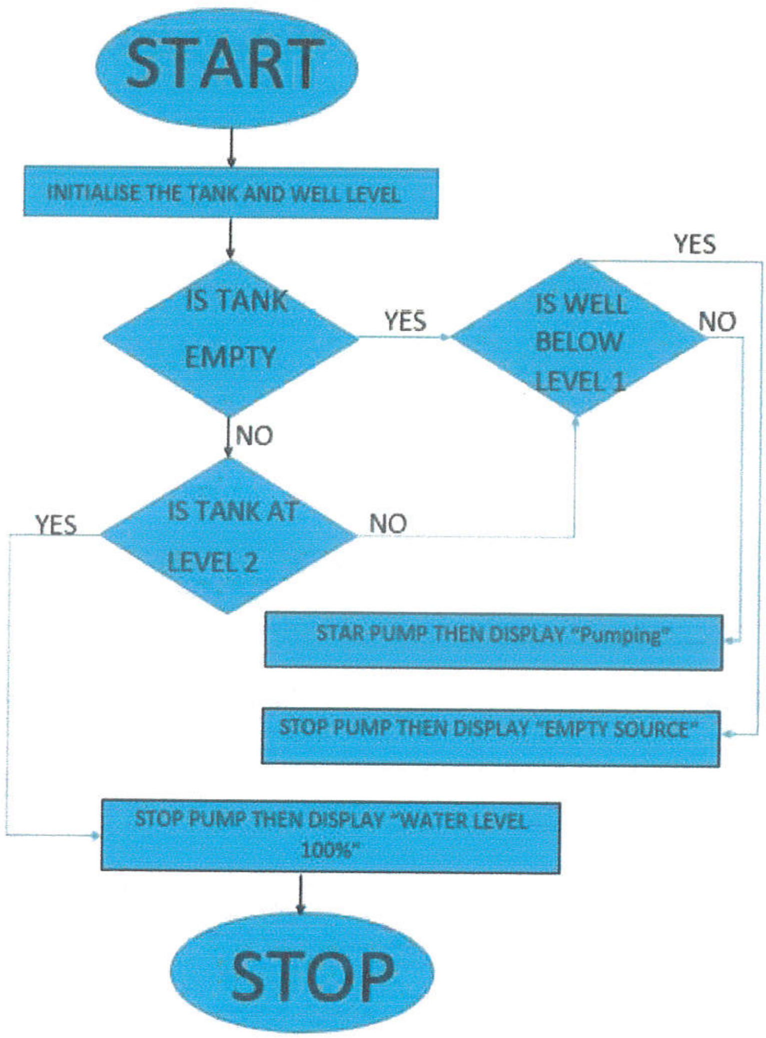

Figure3. 9 Design flowchart of the system

3.5 Software requirement

The following software were used in this project for writing the codes, compilation and generation of HEX files for both simulation and burning into the microcontroller.

3.5.1 Arduino IDE

Arduino is a cross-platform application written in the programming language Java. That provides an open-source and easy-to-use programming tool, for writing code and uploading it to the board. It is often referred to as the Arduino IDE. It includes a code editor with features such as text cutting and pasting, searching and replacing text, automatic indenting, brace matching, and syntax highlighting, and provides simple one-click mechanisms to compile and upload programs to an Arduino board. It also contains a message area, a text console, a toolbar with buttons for common functions and a hierarchy of operation menus. A program written with the IDE for Arduino is called a sketch. Sketches are saved on the development computer as text files with the file extension .ino. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures.

3.5.2 Software simulation

The Software which have used for this project is "Proteus" version 7.8. Proteus is one of the user friendly software in simulation world. For both electrical and electronics based circuit simulation and implementation can be done very easily with this software. Before starting the implementation and the simulation of the project circuit it is necessary to develop an algorithm. Because a fruitful algorithm can makes the path easier to implement a circuit both virtually and practically. The complete circuit diagram of the system is illustrated in Figure3.11 below.

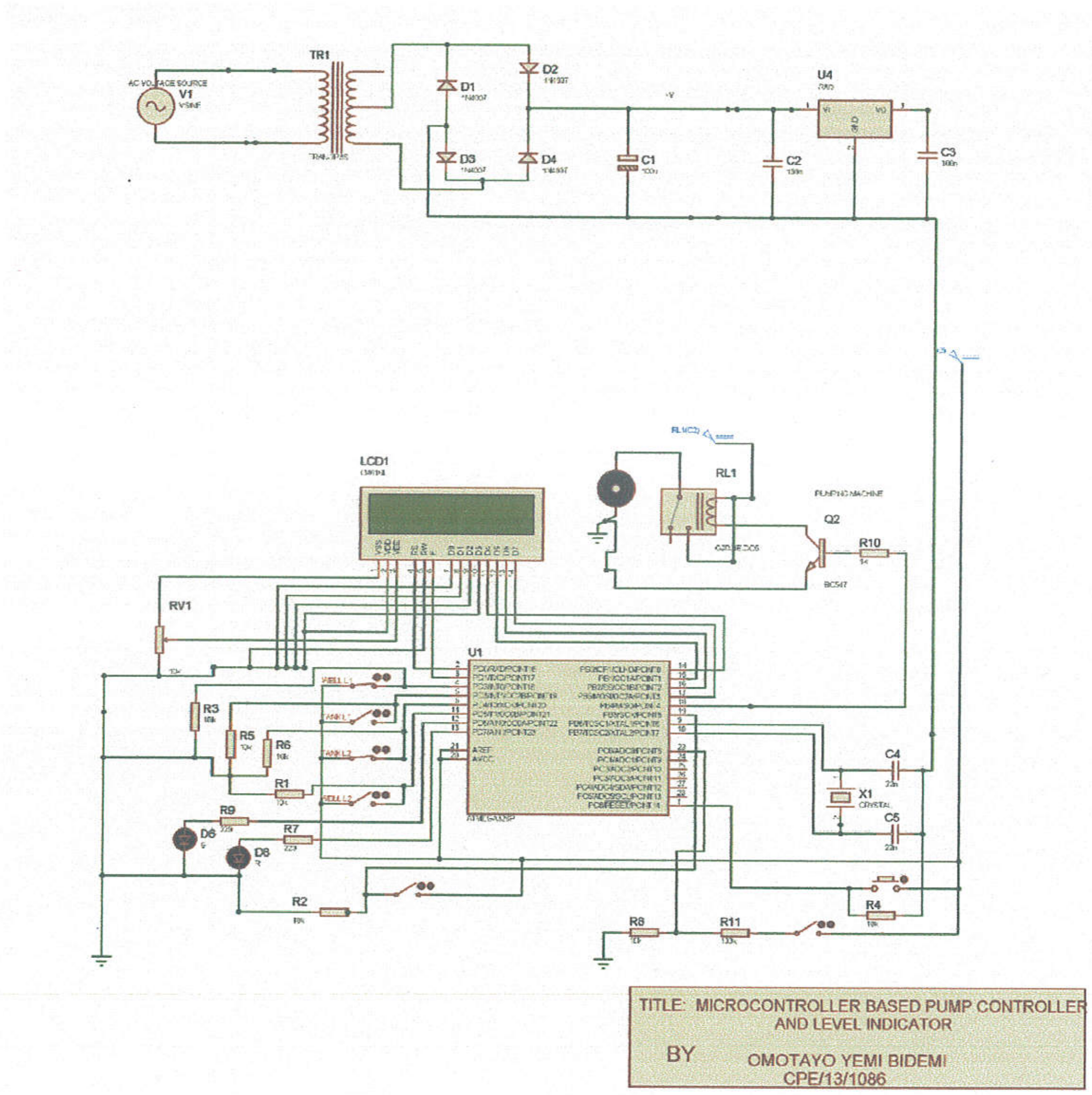

Figure3. 11 System circuit diagram

CHAPTER FOUR

DESIGN AND IMPLEMENTATION

4.1 Simulation test and result

Proteus software version8.1 was used for the simulation of the project which enables me to know the interaction of the hardware with the software before the implementation in order to know the behavior of the system and reduce damages of the components. The arduino IDE version 1.83 was used to write and compiled code and also used to generate HEX files which was uploaded to the ATMega328 integrated circuit on proteus in order to perform the simulation. The obtained simulation results are depicted in Figure4.2 to Figure4.8.

Figure4.2 and Figure4.3 shows the initialization of the simulation of the project as displayed on the LCD, Figure4.4 shows the status of AC input. Figure4.5 shows the level of water in the well (100%), Figure4.6 shows the level of water in the tank (50%). When AC is present, Figure4.7 shows when the pump is starting, Figure4.8 shows when the pump has started before and after checking the status of well and tank level it will shows "PUMP ON"p rather than starting pump again.

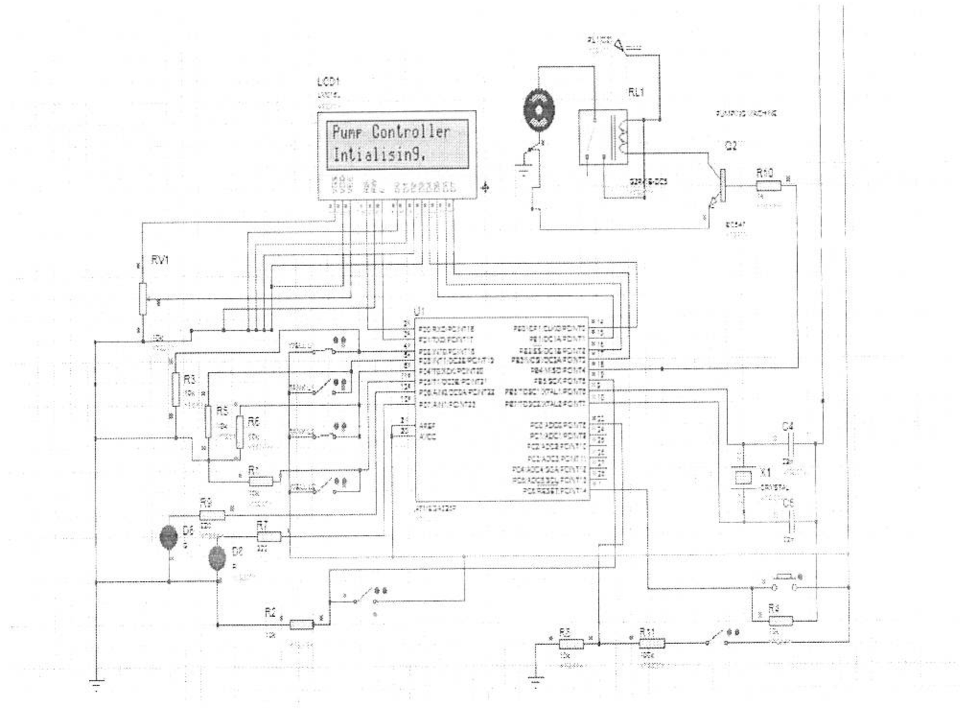

Figure 4. 1 Project initialization

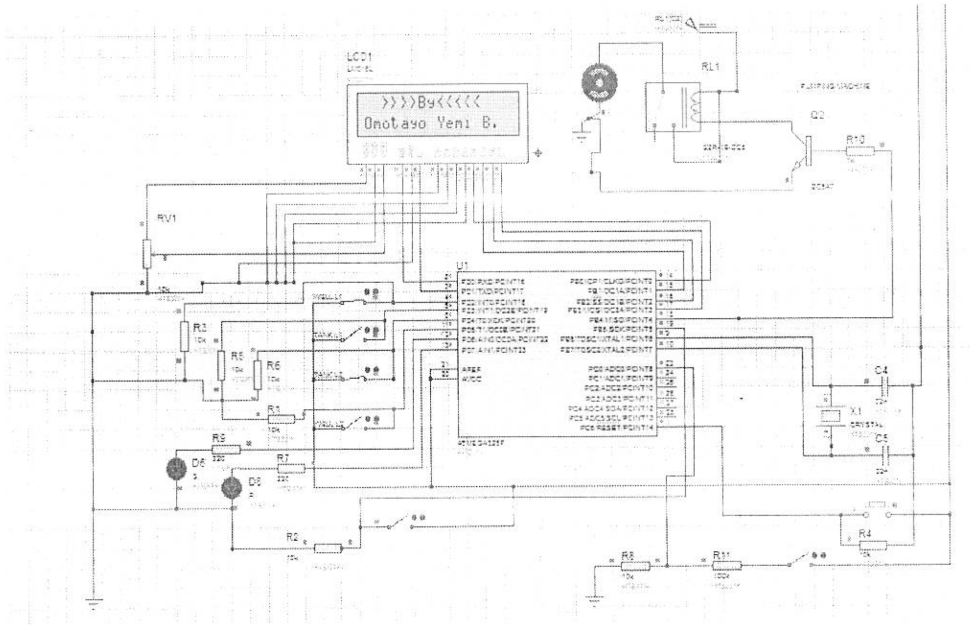

Figure 4. 2 Project Initialization

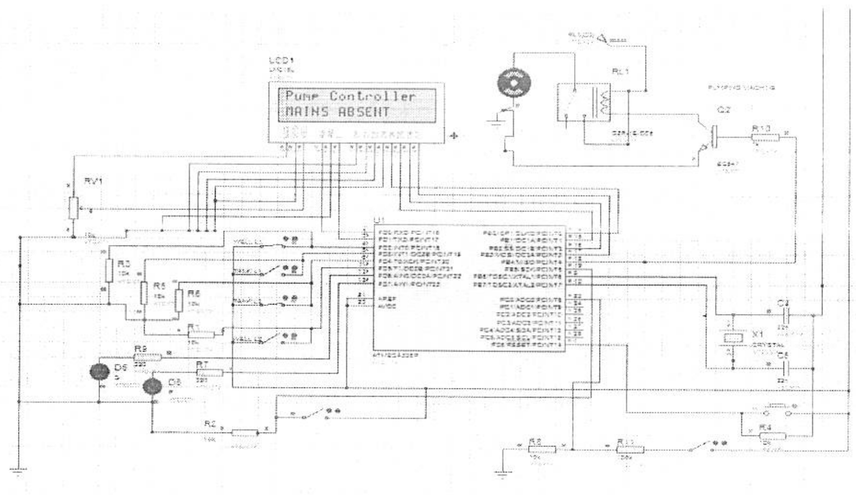

Figure 4. 3 AC Mains Input status

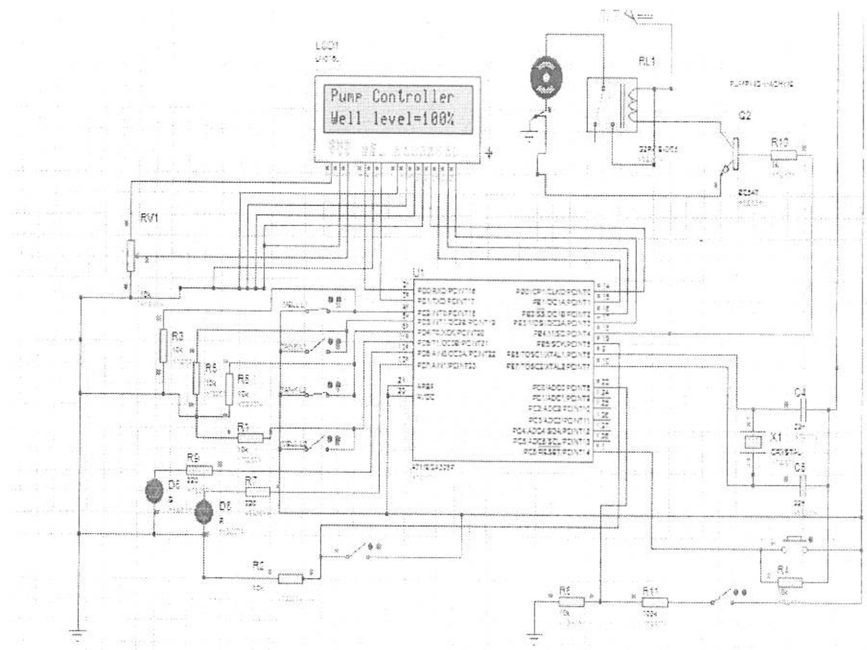

Figure 4. 4 Well Level status

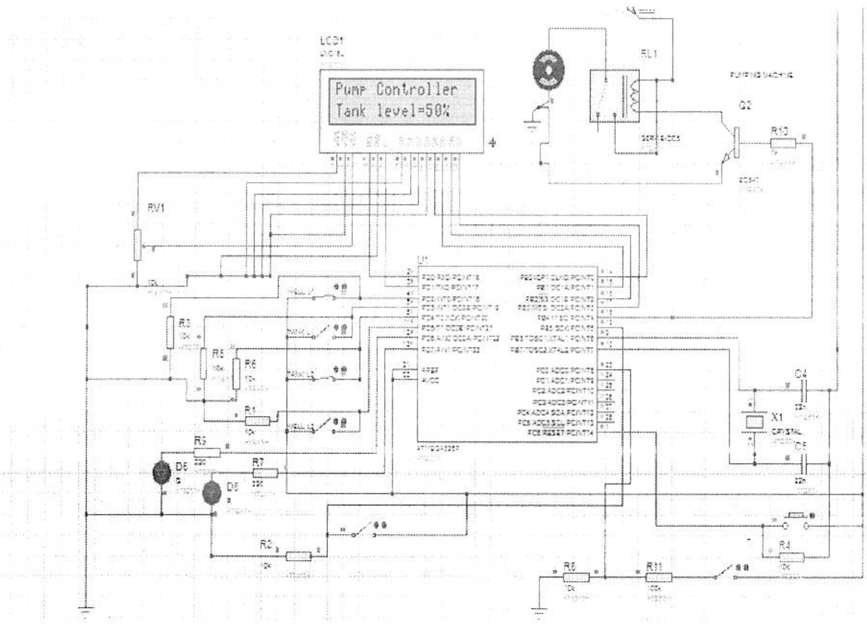

Figure4. 5 Tank Level status

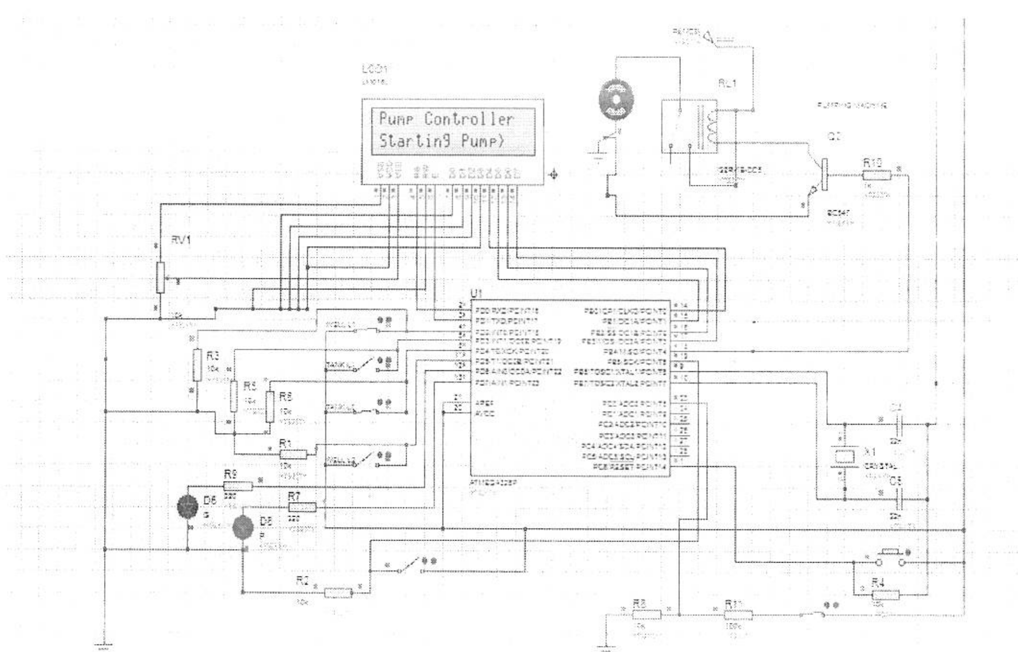

Figure4. 6 Starting Pump

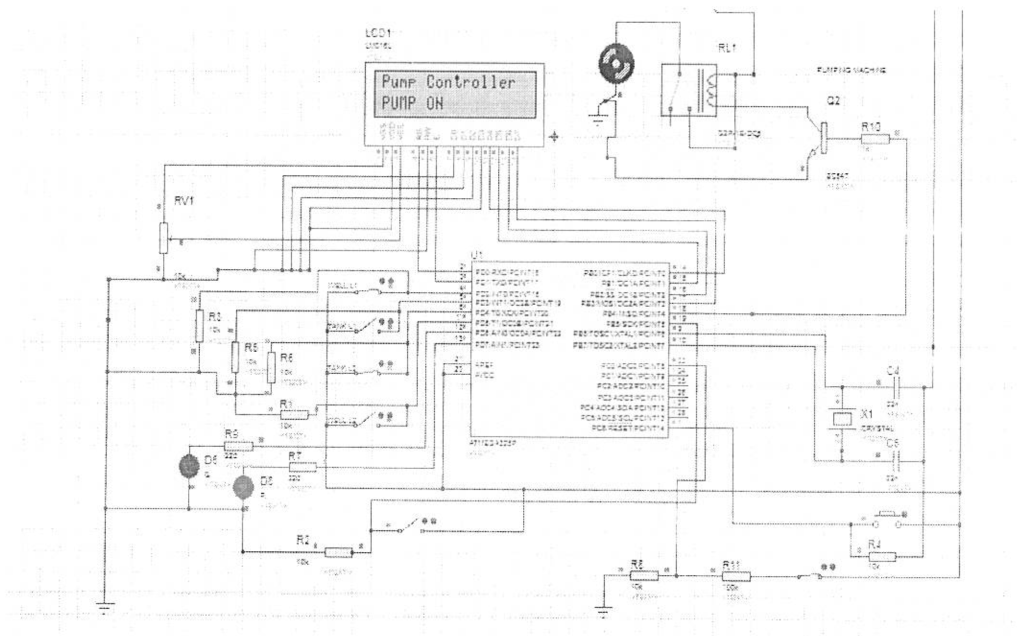

Figure4. 7 Pump working

4.3 Hardware design and Testing

This section entail the overall system testing of integrated design. The testing and integration is done to ensure that the design is functioning properly. However, this involves checks made to ensure that all the various unit and subsystem function adequately also there has to be good interface existing between the output/inputs unit subsystem. When the totality of the modules was integrated together, the system was created and all modules and sections responded to as specified in the design through the power supply delivering into the system designed. Figure4.9 shows hardware implementation of the system.

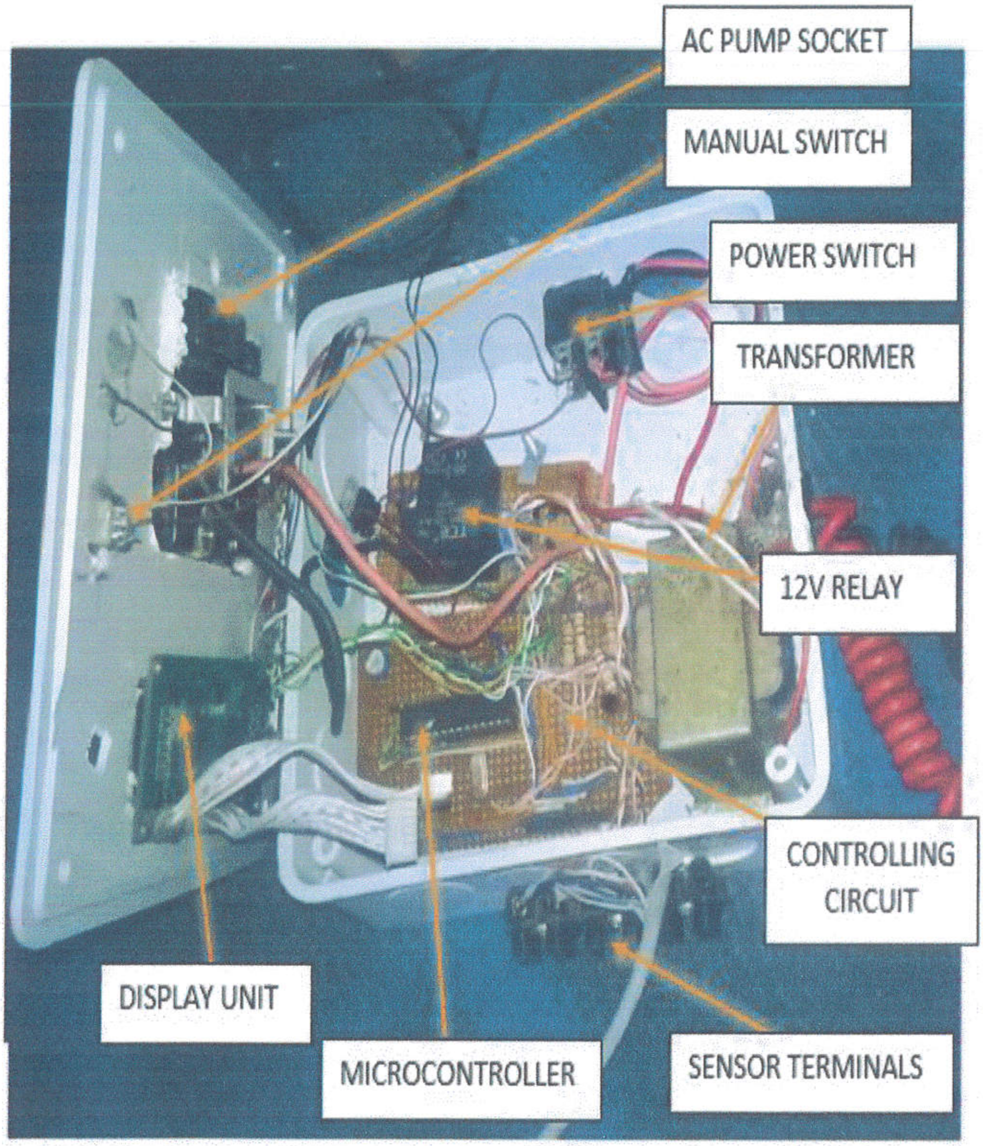

Figure4. 8 Hardware implementation

4.4 Component test

Similar component like resistor were packed together. The other component include capacitor, switch, transformer, resistor, Diodes (rectifier and LEDs), transistor, voltage regulators etc. Reference was made to colour coding data sheet to ascertain the expected value of resistors used. Each resistor was tested and the value read and recorded.

Table4. 2 Resistor Test

RESISTOR	DIGITAL MULTIMETER VALUE
1KΩ	1.0KΩ
10KΩ	9.9KΩ
100KΩ	88.2KΩ
220Ω	219Ω

Also, for transistor test the DIMM was switched to the diode range. The collector, base, emitter junctions were tested in the following order. The collector, emitter and base pins were gotten from the data analysis on power transistor.

4.4.1 Test for transistors

Table4. 3 Test for Transistors

Sequence of test	Black probe	Red probe	Values on multimeter
1st test on pins	Collector	Base	705.21
2nd test on pins	Emitter	Base	710.24

4.4.2 Transformer test (step down)

Expectedly the transformer was rated 220v/12v, 1200mA. From the mains power supply, the primary coil receives 223v input, the output was measure to be 17.75v using a Digital Multimeter. Test data on transformer has it that the resistance of the primary windings for step down transformer is higher than that of the secondary side this was ascertained.

COMPONENT	EXPERIMENTED VALUE	ACTUAL VALUE	UNIT	TOLERANCES
REGULATOR	5.00	5.02	Ω	
TRANSFORMER	12Vac @ 230Vac	13.2	V	

TRANSISTOR	Rbe 520 Rbc 510	550 548		
CAPACITOR	10 10	10.20 10.15		
RESISTOR	1000 2000 220 1000	1000 2000 218 9980		5%

4.4.3 Other tests

The buckets used as tank and well in my project was tested in other to make sure there was no leakage, the lid of the bucket representing both well and tank level was manually opened in other to add water and tap was connected to each bucket to reduce water from each bucket as shown in figure4.10.

Figure4. 9 Project testing

4.5 Result based on functionality

Table 4. 4 Result of relationship between well level, indicators and pump

S/N	LITRES OF WATER	L1 INDICATOR STATE	L2 INDICATOR STATE	L3 INDICATOR STATE	PUMP STATE
1	0.5	OFF	OFF	OFF	OFF
2	1	OFF	OFF	OFF	OFF
3	1.5	OFF	OFF	OFF	OFF
4	2.0	ON	OFF	OFF	OFF
5	2.5	ON	OFF	OFF	ON
6	3	ON	ON	OFF	ON
7	3.5	ON	ON	OFF	ON`
8	4	ON	ON	ON	ON

Table4. 5 Result of relationship between tank level, indicators and pump

S/N	LITRES OF WATER	L1 INDICATOR STATE	L2 INDICATOR STATE	L3 INDICATOR STATE	PUMP STATE
1	0.5	OFF	OFF	OFF	ON
2	1	OFF	OFF	OFF	ON
3	1.5	OFF	OFF	OFF	ON
4	2.0	ON	OFF	OFF	ON
5	2.5	ON	OFF	OFF	ON
6	3	ON	ON	OFF	ON
7	3.5	ON	ON	OFF	ON`
8	4	ON	ON	ON	OFF

Table4. 6 experimented result of relationship between Tank level, Well level, indicators and pump

S/N	LITRES OF WATER	TANK	WELL	INDICATOR	PUMP STATE	FUNCTION
1	0.5	0%	0%	-	OFF	Delay for 1hr
2	1.5	50%	50%	RED	ON	PUMP ON
3	2.5	AVERAGE	AVERAGE	YELLOW	ON	PUMP ON
4	4	100%	100%	BLUE	OFF	PUMP OFF

4.6 Performance evaluation

From the table above, it shows that the relationship between tank and water level indicators with pump was properly coordinated by the predefined conditions. The system design work according to plan.

4.7 Packaging

After the completion of the work, the circuitry was enclosed in a case to avoid damages. The enclosure provides protection as well as attraction. The sizes of casing to be used for packaging was determined after considering the following factors

1. Easy integration and disintegration through the use of screw driver
2. positions of the sensor terminals for both tank and well and space for future modifications, easy accessibility to circuit board
3. Portability.

4.9 Problems encountered and solution

During the course of designing this system there were series of problem encountered during the means of achieving the desired goals of this project which includes:

- Some parts require re-designing even the circuit board was changed three times for more accuracy, neatness and functionality.
- Transformer was also changed as the current output of the transformer was not written which did cause damages to some components such as ATMega328, 16x2 LCD, resistors, rectifying diodes, it was resolved by purchasing a new transformer with clearly written specifications.
- Software debugging also created a bit of the problem as the timing of the simulation was very different from constructed board timing. also the statement of necessary conditions using "if and else statements".
- There was problem with limited available output pins for the level indicator which was resolved by connecting LED to all the floating switch input to indicate each levels and each interval indicator was connected to separate output digital pins on the microcontroller.
- Power supply was not very available in Ikole Ekiti (Maximum of 12hours in a `week), which actually slow down the implementation process.
- After installing the pump, I noticed that the bucket was leaking due to the use of plumbing thread tape which did not perfectly block water leakage from the bucket, so I resolve it by using hot glue to line the threading part of the tap and putting it inside the hole drilled on the bucket which created a perfect system without leakage

CHAPTER FIVE

CONCLUSION

After the complete design of the system, the functionality of the system was tested to know the behavior of the system to changes in the water level in both tank and well. The performance and efficiency was beyond expectation and from every ramification the design of microcontroller based pump controller and level indicator was successful

5.1 Recommendations

It is strongly recommended that government should set up industries for production of basic electronic component locally and establish research centers in each university to enable student have good sound practical knowledge on electronics component and their operations and to make components more available. I recommend that the project can still be further work on in order to add some functions that I was not able to add due to the delay in getting some important components, function such as charging details for back up battery.

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