Sudan University of Sciences and Technology

College of Engineering

School of Electrical and Nuclear Engineering

Modern Automatic Irrigation System

نظام ري آلي حديث

A Project Submitted In Partial Fulfillment for the Requirements of

the Degree of B.Sc. (Honor) In Electrical Engineering

Prepared By:

1. **Ahmed Mutrif Siddig Ali**
2. **Ahmed Salah Mohammed Abdulraheem**
3. **Mohammed Abdulwahab Ahmed Abduljaleel**
4. **Mohammed Almostafa Mutasim Mohammed Alamin AbuBakr**

Supervised By:

Ust. Jalal Abdalrahman Mohammed

October 2015

الآية

قال تعالى:

(وَهُوَ الَّذِي أَنزَلَ مِنَ السَّمَاءِ مَاءً فَأَخْرَجْنَا بِهِ نَبَاتَ كُلِّ شَيْءٍ فَأَخْرَجْنَا مِنْهُ خَضِرًا نُخْرِجُ مِنْهُ حَبًّا مُتَرَاكِبًا وَمِنَ النَّخْلِ مِنْ طَلْعِهَا قِنْوَانٌ دَانِيَةٌ وَجَنَّاتٍ مِنْ أَعْنَابٍ وَالزَّيْتُونَ وَالرُّمَّانَ مُشْتَبِهًا وَغَيْرَ مُتَشَابِهٍ ; انْظُرُوا إِلَى ? ثَمَرِهِ إِذَا أَثْمَرَ وَيَنْعِهِ C إِنَّ فِي ذَ ?لِكُمْ لَآيَاتٍ لِقَوْمٍ يُؤْمِنُونَ) سورة الأنعام. الآية(99)

DEDICATION

We dedicate this graduate project to our families, who taught us the importance of education and to pursue our dreams and face our fears. The discipline was not only provided in our conversations, but by examples they provide in our daily life.

To our teachers, who taught the importance of education and how it can affect in our lives. They taught us the meaning of engineering and how to deal with the problems we will face in the real life, not with our hands but with our brains. For all of that and so many other things we thank you and we are deeply appreciating your efforts.

To our colleagues, who spent with us our entire educational levels, and stand with us in joy and weal.

ACKNOWLEDGEMEN

We thank our God for guiding us to accomplish this project, and also we thank Ust. Jalal Abdalrahman Mohammed for assistance and comments in this project that greatly improved the manuscript.

We would also like to show our gratitude to our project colleagues and engineer Mojtaba for sharing their pearls of wisdom with us during the course of this project. Also we thank our brother and friend Mohammed Mousa for helping us and sharing his experiences with us.

ABSTRACT

Control and monitoring of the water is difficult especially when there are many types of irrigation for different kinds of a vast cultivated areas and it needs many workers : and continuous monitoring. To have a stable irrigation we need a fuel for engines, so the high cost of oil is one of the big problems.

Flood irrigation that proposed to be used as a model in solving the problem of irrigation in this scheme by using components connected to a Microcontroller as a circuit design of the project.

المستخلص

عملية التحكم والمراقبة للري صعبه, خاصة بوجود عدة أنواع للري لمختلف النباتات عبر المساحات الواسعه, يتطلب ذلك الكثير من الأيدي العاملة والمراقبة المستمرة. للمحافظة على استقرار ميه الري يتطلب ذلك وقود للمحركات وتعد التكلفة الزائدة للوقود احدى اكبر المشاكل, الري بالغمر- المقرر استخدامه كنموذج في هذا المشروع- استخدم فيه مجموعة من المكونات والمعدات المتصلة مع بعضها عن طريق المعالج الدقيق لحل المشاكل أعلاه

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF SYMBOLS

C	Celsius
Cm	Centimeter
V	Voltage
K	Kelvin
R	Resistance
F	Farad

LIST OF ABBREVIATIONS

PSI	Pound Per Square Inch
CPU	Central Processing Unit
PID	Proportional Integrated Derivative
ALU	Arithmetic Logic Unit
CISC	Complex Instruction Set Computing
RISC	Reduced Instruction Set Computing
ARM	Advanced Risc Machine
MEMS	Micro Electro Mechanical System
PIR	Passive Infrared Sensor
PC	Personal Computer
TTL	Transistor Transistor Logic
LED	Light Emitting Diode
AWG	American Wire Gauge

CHAPTER ONE

INTRODUCTION

1.1 General Concepts

Irrigation is the artificial application of water to the land or soil. It is used to assist in the growing of agricultural crops, maintenance of landscapes, and re vegetation of disturbed soils in dry areas and during periods of inadequate rainfall. Additionally, irrigation also has a few other uses in crop production, which include protecting plants against frost, suppressing weed growth in grain fields and preventing soil consolidation . In contrast, agriculture that relies only on direct rainfall is referred to as rain-fed or dry land farming .

Irrigation systems are also used for dust suppression, disposal of sewage, and in mining. Irrigation is often studied together with drainage, which is the natural or artificial removal of surface and sub-surface water from a given area. Traditional irrigation methods causes wastage of water and Machines cannot be used because during spray of insecticides or fertilizers, the earthen walls of basins are damaged so the modern methods of irrigation have been designed to fix those problems.

1.2 Problem Statement

Irrigation process is one of the most important step of agricultural production, so the control and monitoring of the water is difficult especially when there are many types of irrigation for different kinds of a vast cultivated areas and it needs many workers and continuous monitoring, like irrigation by submerge that proposed to be used as a model in solving the problem of irrigation in this scheme, it needs a certain amount of water to give a good production. To have a stable

irrigation we need a fuel for engines, so the high cost of oil is one of the big problems.

1.3 Objectives

The main objective of this project is to:

- √ To get an accurate control system works automatically.
- √ To reduce the cost of irrigation.
- √ To have high production.
- √ To reduce the number of workers.
- √ Utilization of solar energy in operation.

1.4 Methodology

In this project we have managed to work on a certain type of irrigation called flood irrigation using several components controlled by microcontroller and programmed by bascom avr.

1.5 Project Layout

The research consist Abstract and five chapters

Chapter one deals with general introduction ,that consists of general concept, research problem, the objective and methodology , Chapter two covers the irrigation, control system ,microcontroller, solar cells and sensors, Chapter three contains the system components and circuit design. Chapter four deals with application the automatic irrigation and finally chapter five consist of conclusion and recommendations.

CHAPTER TWO

OVERVIEW

2.1 Introduction

Modernizing the irrigation services, through existing resources to meet the need of gradually growing demand of crop production, is a challenge to researchers. Increasing population stressed pressure on available natural resources to meet the need. Stress on water resources is not far away from this challenge but into the core of all. Over 70% of usable water is used for agricultural production and remaining 30% for domestic purposes. To meet the need of food demand there is need to enhance the crop production either increase in cultivated land or improve agriculture technique. Irrigation is playing major role in agricultural production as well as water resource management

One of the surface irrigation method is flooding method where the water is allowed to cover the surface of land in a continuous sheet of water with the depth of applied water just sufficient to allow the field to absorb the right amount of water needed to raise the soil moisture up to field capacity,. A properly designed size of irrigation stream aims at proper balance against the intake rate of soil, the total depth of water to be stored in the root zone and the area to be covered giving a reasonably uniform saturation of soil over the entire field.

2.2 Irrigation

The large amount of acreage under irrigation indicates that water and energy efficiency and conservation can have great impact.There are many types of irrigation systems, here are some of the most famous systems:

2.2.1 Center-pivot and linear or linear/lateral-move systems

Center-pivot and lateral-move systems can cover large areas with a very high degree of uniformity. Center-pivot systems (Figure 2.1) have a radial pipe supported by towers that pivot around a center point. These systems can cover about 130 acres with a straight system and about 155 acres with a corner or swing-arm system. The sprinklers near the pivot cover less area so their water flow rates are less than those located near the end of the pivot where each sprinkler covers a much larger area.

A linear-move system travels in a straight line down the field so all nozzles cover the same area and have the same flow rate (Figure 2.2) provided the nozzle spacing is equal. Energy for irrigation can be reduced by lowering the system operating pressure and by testing the well pump to ensure it is operating efficiently and water is flowing into the well at a sufficient rate. Converting a system from high-pressure (greater than 60 psi), to low-pressure (30 psi or less), can reduce energy costs by up to 40 percent. The system pressure affects how far the water can be thrown but not the volume of water being pumped. Lowering the system pressure will affect the wetted diameter that a single nozzle covers. As the pressure is reduced, more sprinklers will be needed, spaced closer together to provide uniform application. Since the water flow rate entering the pivot is not impacted by the operatingpressure but the area covered by the sprinklers is reduced, the instantaneous application rate will increase (same amount of water - distributed over a shorter period of time), which can lead to runoff and erosion if the soil infiltration rate is lower than the water application rate. Runoff is usually not a problem for irrigation systems installed in fields with low slopes and coarse soils with high infiltration rates.

Converting to a lower operating pressure requires replacing the sprinklers and modifying the well pump to adjust the flow rate and pressure generated. Asthe

system pressure is reduced the pump output will increase. If the well replenishment capacity is lower than the pumping capacity at the lower pressure, then the pump will need to be modified or replaced to match the well's capacity. If the well has higher replenishment capacity, the pumping flow rate can be allowed to increase resulting in shorter irrigation cycles. Runoff and erosion are concerns with increased application rates so assessing if the soil infiltration rate and soil surface storage capacity are high enough to prevent erosion is critical. The slope of the field also needs to be taken into consideration because as slope increase the soil surface storage capacity decreases and erosion potential increases. Sandy soils are most commonly irrigated and have the highest infiltration rates so they can often accommodate increase application rates. Too often the impact that reduced operating pressure has on the pumping plantefficiency is forgotten or overlooked. If the pump and motor are not included in redesigning the system, the energy saved by reducing the operating pressure can be lost due to the pump becoming less efficient at the new operating point.[5]

Figure 2.1: Center pivot irrigation system

Figure 2.2: Linear/lateral-move irrigation system

2.2.2 Side-roll systems

Side- or wheel-roll systems consist of a lateral pipe mounted on four to eight foot diameter wheels (Figure 2.3). The pipe acts as an axle and sections of pipe with wheels can be connected together to increase the length up to about 1,320 feet. A small onboard power unit is located near the center of the system to move the system from set to set by rotating the wheels. Once in position, the system operates similarly to a solid set or hand-move system with the only moving parts being the sprinklers. The sprinklers are attached to the pipeline at equal distances and are weighted so they are always right side up as the pipeline/axle rotates when moving the system from one position to another. To irrigate a field, the lateral position, (referred to as a "set") covers two or three acres and one system is used to irrigate up to 50 acres. The distance between sets is typically 50 to 80 feet based on the operating pressure and the type of sprinkler being used. A side-roll system is basically a hand-move system on wheels. Side-roll systems are not recommended for slopes greater than 5 percent or rolling topography because of alignment issues. When not in use, they can be moved by the wind. They adapt well to low-growing crops and require medium water pressures of 35 to 60 psi at the

inlet. Lower pressure can be used but it will reduce the throw distance of the water, so more sets would be needed per acre. The well pump should be tested every two to three years to identify potential problems and ensure it is operating efficiently.[5]

Figure 2.3: Side-roll irrigation system

2.2.3 Solid-set or hand-move systems

Hand-move and solid-set sprinkler irrigation systems are similar, in that they have piping with sprinklers laid out in a grid pattern to apply water to crops (Figure 2.6). The sprinkler layout can be in a square, rectangle or triangle pattern, with overlapping spray patterns to increase the uniformity of application. Historically, medium- and high-pressure impact sprinklers have been used. Lowering the system pressure will save energy while delivering the same amount of water, but the laterals and sprinklers may need to be spaced closer together to ensure adequate coverage because of the smaller wetted diameters at lower pressures. After each section is watered, a hand-moved system is moved manually to the next area. Solid-set systems are often installed in high value vegetable and perennial crops such as cranberries, orchards and pastures. One downfall of these types of systems is that wind distorts the water pattern, and because the systems are stationary, non-uniform

water applications result in some areas not being fully irrigated. The impact of non-uniform water application tends to accumulate as the growing season progresses and often reduces the yield of grain, fruit, or forage.[5]

Figure 2.4: Hand-move sprinkler system

2.2.4 Traveling gun

Traveling guns have the advantages of being portable, requiring less labor to setup than a hand-move system, covering a wider swath per pass (up to 300 feet) and offering versatility for covering irregularly shaped fields (Figure 2.5). Swath lengths can range up to 1575 feet. There are two types: a hose-reel system or a cable-tow system. With the hose-reel system, the hose is attached to a cart that has the gun sprinkler mounted to it, and as the hose winds up on the reel, the sprinkler is moved down the field as it distributes water. A cable-tow system uses a cable to drag the sprinkler gun cart instead of the hose. The water is supplied by a soft hose that is dragged along behind the cart. Traveling guns require high system pressure to overcome friction losses in the long run of hose and high sprinkler pressures, 90 to 150 psi. Lowering the irrigation system pressure would reduce the power requirements but also reduce the wetted area, requiring more passes to irrigate an area. Irrigating with a traveling gun will require the most energy of any irrigation system and is generally used on smaller acreages. A well pump should be

tested every two to three years to identify potential problems and to ensure it is operating efficiently.

Figure 2.5: Traveling gun irrigation

2.2.5 Boom cart systems

A new alternative to the traveling gun is the boom cart. This is a four-wheel cart fitted with a horizontal folding boom that uses low-pressure nozzles to apply water (Figure 2.6). A hose reel is typically connected to the cart to move the cart down the field. This type of system can cover a swath of up to 210 feet. These systems operate at lower pressures, reducing pressures up to 70 psi compared to travelling guns. Aside from reducing energy costs, these systems apply water more uniformly and gently compared to a traveling gun.[5]

Figure 2.6: Boom cart with hose-reel

2.2.6 Flood irrigation

Flood irrigation consists of level or graded border and basin systems used in the production of small grains like rice or wheat and fruits, forage crops, andvegetables for harvest but can also be used on other crops as long as the soil does not stay waterlogged too long. Water is discharged into a levee-surrounded field along the highest elevation and allowed to run down slope (Figure 2.7). Valves are used to control water flow into the field based on the set time assigned to the border or basin. Once the flooding time period iscompleted, water can be reclaimed by allowing it to leave the field by gravity flow or by pumping it into a storage pond for re-use. This conserves water and saves energy if water is pumped from a well. This is a low cost method but precise field grading is essential or the water application uniformity will be very poor.[5]

Figure 2.7: Flood irrigation

2.2.7 Furrow irrigation

Furrow irrigation requires precisely graded fields with furrows or small ditches formed between crop rows for the water to flow by gravity from one side of the field to the other (Figure 2.8). The crops can be planted on a ridge between the furrows or furrows can be established after plant emergence in

fields where off-season tillage is performed. When irrigation is desired, water is pumped, siphoned from supply ditches or flows by gated pipe into the furrows. As the water fills the furrow it flows towards the down slope side of the field. The water infiltrates into the soil based on the length of time water is pounded on the soil surface. Often the entire root zone is refilled with each irrigation event. This method of irrigation is very energy efficient but the uniformity of the water distribution along the length of the furrow can vary widely. Shorter furrow lengths and appropriate set times typically help increase the uniformity of water distribution as do management practices like cut-back or surge irrigation.[5]

Figure 2.8: Furrow irrigation

2.2.8 Trickle and drip irrigation

Drip irrigation is the most energy- and water-efficient of all the irrigation systems. Water savings of up to 50 percent compared to sprinkler irrigation are common. Ideally, water is applied in the proper amount to the root ball of the plant, minimizing water leaching from the root zone and minimizing evaporation of water since the water isn't sprayed into the air. The water can be emitted at uniform distances along a pipe or a tube with an emitter that directs water to one plant volume of soil. The drip hose can be placed above

ground (Figure 2.8) or buried in the ground, which is called sub-surface drip irrigation (Figure 2.9). Sub-surface irrigation has the advantage of nearly zero evaporation, but it can be harder to tell if an emitter becomes plugged or damaged. Drip irrigation operates at low pressures, 10 to 20 psi at the emitter. The system pressure will need to be higher to overcome pressure loss in filters, valves, backflow preventers, pressure regulator and tubing. Typically, about 40 psi is needed at the pump outlet. Drip irrigation can bedesigned to fit any situation or field. It can also reduce disease problems, because it doesn't get the plant wet. It does require some experience to learn how much water to apply, but a soil water sensor in the row or next to the plant can provide feedback to aid in determining the correct amount of water. Drip irrigation requires understanding of the system to assure good management and maintenance.[5]

Figure 2.8: Surface drip irrigation

Figure 2.9: Sub-surface drip irrigation

2.3 Control

Control systems are an integral part of modern society. Fundamental to any control system is the ability to measure the output of the system, and to take corrective action if its value deviates from some desired value, this in turn necessitates a sensing device.Open-loop control systems are those in which controller tells the system to do something, but doesn't use the results of that action to verify the results or modify the commands to see that the job is done properly.

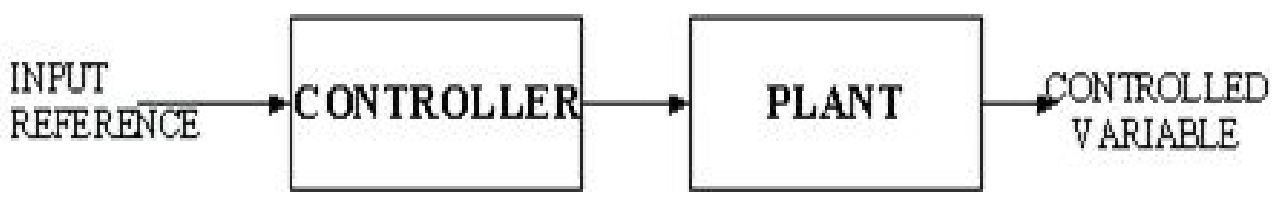

Figure 2.10: Open loop control

The above block diagram shows the components of an open-loop control system. The "input reference" is the signal sent to the controller and the "controller" block represents the calculations done to control some servo or motor or something else. Closed-loop control starts out like open-loop in that you send an input reference to the system, but then feedback is used to monitor the performance resulting from the command; and if the performance is different than desired, changes are made to the command to get back on track. This is done by comparing the input reference to the feedback signal and computing an error from the reference. The controller then has equations which adjust the commands to the plant to reduce the error. Closed-loop control starts out like open-loop in that you send an input reference to the system, but then feedback is used to monitor the performance resulting from the command; and if the performance is different than desired, changes are made to the command to get back on track. This is done by comparing the

input reference to the feedback signal and computing an error from the reference. The controller then has equations which adjust the commands to the plant to reduce the error. PID equations are the usual method to make these corrections, the Figure 2.11 of closed loop control is shown below.[1,2]

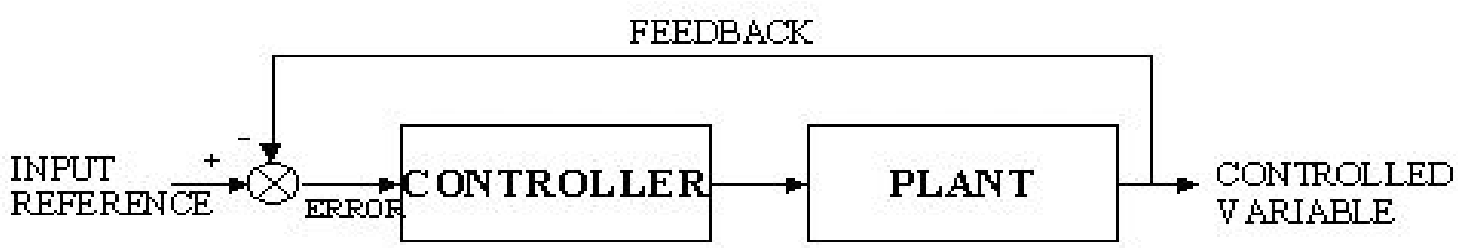

Figure 2.11: Closed loop control

2.4 Microcontroller

It's an integrated circuit that contains many of the same items that a desktop computer has such as CPU, memory, etc., but does not include any "human interface" devices like a monitor, keyboard, or mouse. Microcontrollers are designed for machine control applications, rather than human interaction.

2.4.1 Types of microcontrollers

Microcontrollers can be classified on the basis of internal bus width, architecture, memory and instruction set. Figure 2.12 shows the various types of microcontrollers.

√ The 8 bit microcontroller

When the ALU performs arithmetic and logical operations on a byte (8bits) at an instruction, the microcontroller is an 8-bit microcontroller. The internal bus width of 8-bit microcontroller is of 8-bit. Examples of 8-bit microcontrollers are Intel 8051 family and Motorola MC68HC11 family.

√ The 16 bit microcontroller

When the ALU performs arithmetic and logical operations on a word (16 bits) at an instruction, the microcontroller is a16-bit microcontroller. The internal bus width of 16-bit microcontroller is of 16-bit. Examples of 16-bit microcontrollers are Intel 8096 family and Motorola MC68HC12 and MC68332 families. The performance and computing capability of 16 bit microcontrollers are enhanced with greater precision as compared to the 8-bit microcontrollers.

√ The 32 bit microcontroller

When the ALU performs arithmetic and logical operations on a double word (32- bits) at an instruction, the microcontroller is a 32-bit microcontroller. The internal bus width of 32-bit microcontroller is of 32-bit. Examples of 32-bit microcontrollers are Intel 80960 family and Motorola M683xx and Intel/Atmel 251 family. The performance and computing capability of 32 bit microcontrollers are enhanced with greater precision as compared to the 16-bit microcontrollers.[7]

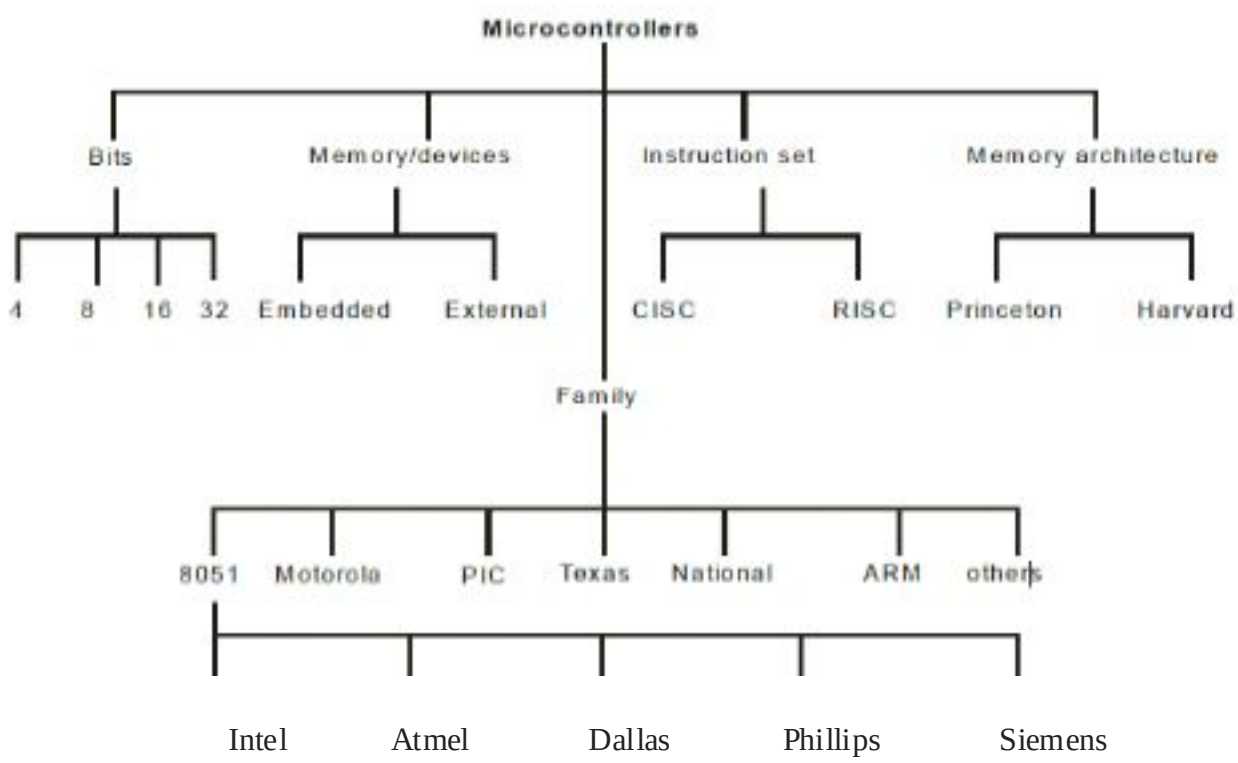

Figure 2.13: Types of microcontroller

2.5 Solar Cells

Solar cells are thin silicon disks that convert sunlight into electricity. These disks act as energy sources for a wide variety of uses, including: calculators and other small devices; telecommunications; rooftop panels on individual houses; and for lighting, pumping, and medical refrigeration for villages in developing countries. Solar cells in the form of large arrays are used to power satellites and, in rare cases, to provide electricity for power plants. A type of solar cell to fully meet domestic energy needs has not as yet been developed, but solar cells have become successful in providing energy for artificial satellites. Fuel systems and regular batteries were too heavy in a program where every ounce mattered. Solar cells provide more energy per ounce of weight than all other conventional energy sources, and they are cost-effective.

Only a few large scale photovoltaic power systems have been set up. Most efforts lean toward providing solar cell technology to remote places that have no other means of sophisticated power. About 50 megawatts are installed each year, yet solar cells provide only about 1% of all electricity now being produced. Supporters of solar energy claim that the amount of solar radiation reaching the Earth's surface each year could easily provide all our energy needs several times over [4]. The following are some of the different types of solar cells:

√ Amorphous Silicon Solar Cell.

√ Buried Contact Solar Cell.

√ Cadmium telluride solar cell.

√ Concentrated PV cell .

√ Copper indium gallium selenide solar cells.

√ Crystalline silicon solar cell.

√ Dye-sensitized solar cell.

√ Hybrid solar cell.

√ Micro morph.

√ Mono crystalline solar cell.

√ Multi junction solar cell.

√ Nano crystal solar cell

√ Organic solar cell.

√ Photo electrochemical cell.

√ Plastic solar cell.

√ Polycrystalline solar cell.

√ Polymer solar cell.

2.6 Sensors

A sensor is a transducer whose purpose is to sense (that is, to detect) some characteristic of its environments. It detects events or changes in quantities and provides a corresponding output, generally as an electrical or optical signal; for example, a thermo couple converts temperature to an output voltage. But a mercury in glass thermometer is also a sensor; it converts the measured temperature into expansion and contraction of a liquid which can be read on a calibrated glass tube. Sensors are used in everyday objects such as touch-sensitive elevator buttons (tactile sensor) and lamps which dim or brighten by touching the base, besides innumerable applications of which most people are never aware. With advances in micro machinery and easy-to-use microcontroller platforms, the uses of sensors have expanded beyond the more traditional fields of temperature, pressure or flow measurement, for example into MARG sensors. Moreover, analog sensors such as potentiometers and force-sensing resistors are still widely used. Applications include manufacturing and machinery, airplanes and aerospace, cars,

medicine and robotics. A sensor's sensitivity indicates how much the sensor's output changes when the input quantity being measured changes. For instance, if the mercury in a thermometer moves 1 cm when the temperature changes by 1 °C, the sensitivity is 1 cm/°C. Some sensors can also have an impact on what they measure; for instance, a room temperature thermometer inserted into a hot cup of liquid cools the liquid while the liquid heats the thermometer. Sensors need to be designed to have a small effect on what is measured; making the sensor smaller often improves this and may introduce other advantages. Technological progress allows more and more sensors to be manufactured on a microscopic scale as micro sensors using MEMS technology. In most cases, a micro sensor reaches a significantly higher speed and sensitivity compared with macroscopic approaches. A good sensor obeys the following rules:

√ Is sensitive to the measured property.

√ Is insensitive to any other property likely to be encountered in its application.

√ Does not influence the measured property.

The sensitivity is then defined as the ratio between output signal and measured property. For example, if a sensor measures temperature and has a voltage output, the sensitivity is a constant with the unit [V/K]; this sensor is linear because the ratio is constant at all points of measurement. For an analog sensor signal to be processed, or used in digital equipment, it needs to be converted to a digital signal, using an analog to digital converters[3].

2.6.1 Types

There are many types of sensors including:

Temperature sensors are thermally sensitive resistors whose prime function is to exhibit change in electrical resistance according to change in body temperature. Pressure sensor which measures pressure of gases or liquids, it is

used for control and monitoring in thousands of every day applications. Ultrasonic sensors are transducers that convert ultrasound waves to electrical signals or vice versa. Humidity sensor senses the humidity in the soil. Gas sensor is a device that detects the presence of gases in an area, often as part of a safety system. PIR motion sensor, the acceleration sensor is a device that measures proper acceleration, used to measure vehicle acceleration. Position sensor is any device that permits position measurement.

CHAPTER THREE

CIRCUIT DESIGN

3.1 Introduction

Automatic control has become very important part in recent systems, and it has been used recently in different irrigation systems to facilitate the operation of traditional irrigation which it depends on manual control of water, and that is inaccurate method [1]. Automatic irrigation is a trusted way for accurate and delicate irrigation system.

3.2 System Components

The system components are:

√ Atmega 16 Microcontroller.

√ LCD 2x16 Module.

√ Ultrasonic distance sensor.

√ Stepper Motor.

√ Solenoid Valve.

√ Relay.

√ ULN2803.

√ Sp70 Solar Panel.

√ LM317T Variable Voltage Regulator.

√ Diode.

3.2.1 Atmega 16 microcontroller

The Atmega 16 is one of the latest products from AVR. It features all the components which modern microcontrollers normally have. For its low price, wide range of application, high quality and easy availability, it is an ideal solution in applications such as: the control of different processes in industry, machine control devices, measurement of different values etc. Some of its main features are listed below. The selection has been done due to their Small instruction set to learn, Inexpensive microcontrollers, Built in oscillator with selectable speeds, Wide range of interfaces. Figure3.1 shows the pin outs of Atmega 16.

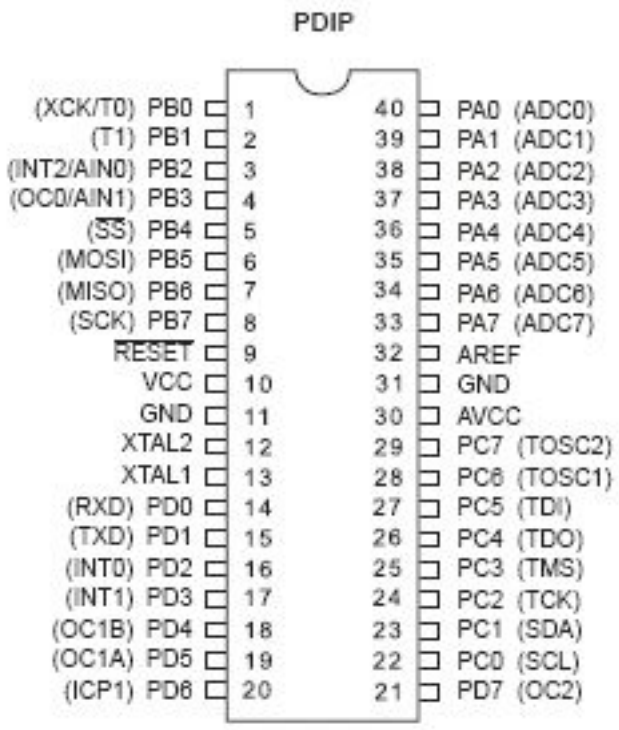

Figure 3.1: Pin outs ATmega16

3.2.2 LCD 2x16 module

Innovati's LCD 2x16 A Module provides versatile display functions. Through its simple connections, it can be controlled by innovati's BASIC Commanderfor a wide range of LCD applications .we selected it because It can be used to display the operating status at any time for various applications. It can display status or error messages directly on the screen without using the PC. With the user-defined characters, special patterns can be created to produce creative messages. Figure3.2 shows LCD 2×16.

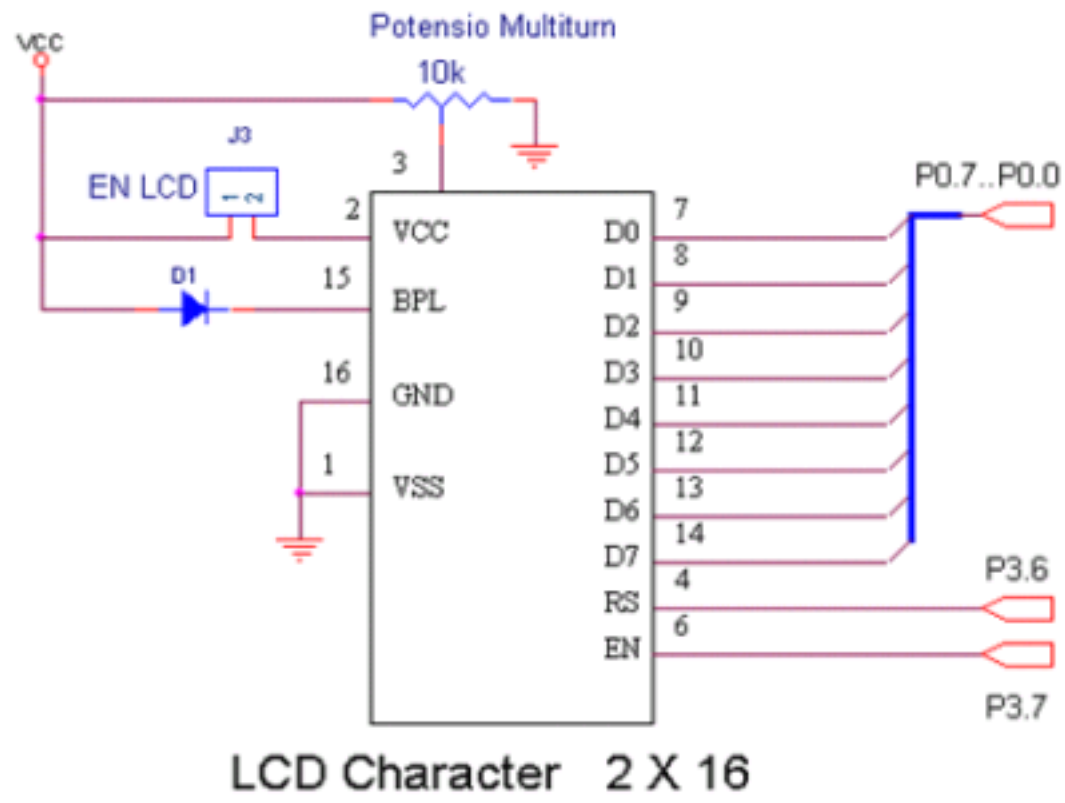

Figure 3.2: LCD 2×16

3.2.3 Ultrasonic distance sensor

Ultrasonic sensor provides an easy method of distance measurement. This sensor is perfect for any number of applications that require you to perform measurements between moving or stationary objects.Ultrasonic transmitter emitted an ultrasonic wave in one direction, and started timing when it launched. Ultrasonic spread in the air, and would return immediately when it encountered obstacles on the way. At last, the ultrasonic receiver would stop timing when it received the reflected wave. As Ultrasonic spread velocity is

340m / s in the air, based on the timer record t, we can calculate the distance (s) between the obstacle and transmitter, namely: s = 340t / 2, which is so-called time difference distance measurement principle .The principle of ultrasonic distance measurement used the already-known air spreading velocity, measuring the time from launch to reflection when it encountered obstacle, and then calculate the distance between the transmitter and the obstacle according to the time and the velocity. Thus, the principle of ultrasonic distance measurement is the same with radar. Distance Measurement formula is expressed as:

$$L = C \times T$$

In the formula, L is the measured distance, and C is the ultrasonic spreading velocity in air, also, T represents time (T is half the time value from transmitting to receiving). Figure 3.3 shows Ultrasonic distance sensor.

Figure 3.3: Ultrasonic distance sensor

3.2.4 Stepper Motor

A stepper motor is an electromechanical device which converts electrical pulses into discrete mechanical movements. The shaft or spindle of a stepper motor rotates in discrete step increments when electrical command pulses are applied to it in the proper sequence. The motors rotation has several direct

relationships to these applied input pulses. The sequence of the applied pulses is directly related to the direction of motor shafts rotation. The speed of the motor shafts rotation is directly related to the frequency of the input pulses and the length of rotation is directly related to the number of input pulses applied. We selected it because the rotation angle of the motor is proportional to the input pulse, the motor has full torque at standstill, Excellent response to starting/ stopping/reversing[6]. Figure 3.4 shows unipolar stepper motor.

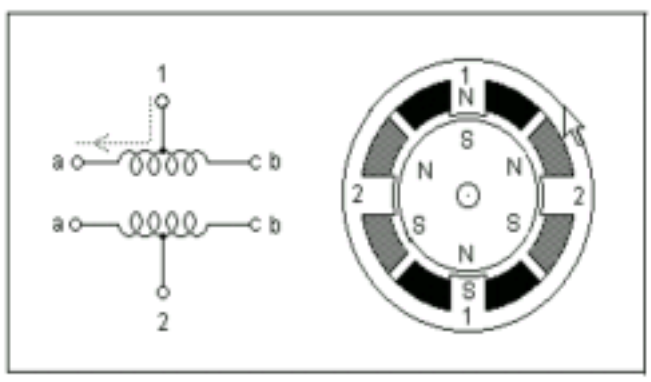

Figure 3.4: Unipolar stepper motor

3.2.5 Solenoid Valve

Solenoid valve bodies and electrical coils are normally supplied separately and then combined together .we selected it because they are assembled quickly and simply without any tools. This provides optimum product flexibility and availability. If a coil does need to be replaced then it can be done without stopping or draining any system. The solenoid valves are also available as assembled units if required. Figure 3.5 shows solenoid valve.

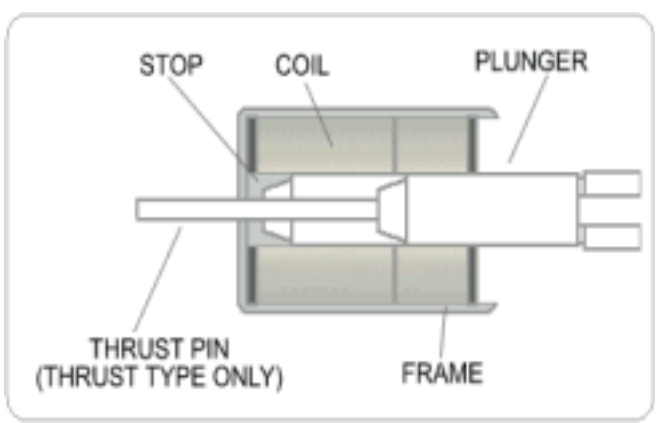

Figure 3.5: Solenoid valve

3.2.6 Relay

A relay is usually an electromechanical device that is actuated by an electrical current. The current flowing in one circuit causes the opening or closing of another circuit. Relays are like remote control switches and are used in many applications because of their relative simplicity, long life, andproven high reliability. Relays are used in a wide variety of applications throughout industry, such as in telephone exchanges, digital computers and automation systems. Highly sophisticated relays are utilized to protect electric power systems against trouble and power blackouts as well as toregulate and control the generation and distribution of power. In the home, relays are used in refrigerators, washing machines and dishwashers, and heating and air-conditioning controls. Although relays are generally associated with electrical circuitry, there are many other types, such as pneumatic and hydraulic. Input may be electrical and output directly mechanical, or vice versa.

The contacts at the top are normally open (i.e. not connected). When current is passed through the coil it creates a magnetic field that pulls the switch closed (i.e. connects the top contacts). Usually a spring will pull the switch open again once the power is removed from the coil. The Normally Closedcontact will be connected to the Common contact when no power is applied to the coil. The Normally Open contact will be open (i.e. not connected) when no power is applied to the coil. When the coil is energized the Common is connected to the Normally Open contact and the Normally Closed contact is left floating, as shown in figure below.

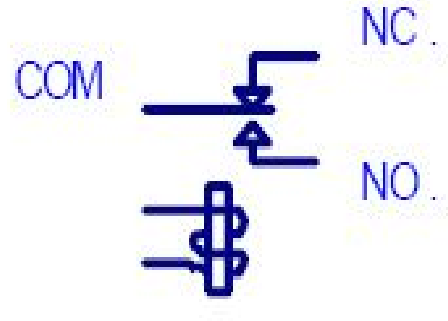

Figure 3.7: Relay

3.2.7 ULN2803

The ULN2803A is a high-voltage, high-current darlington transistor array. The device consists of eight npn darlington pairs that feature high-voltage outputs with common-cathode clamp diodes for switching inductive loads. The collector-current rating of each darlington pair is 500 mA. The darlington pairs may be connected in parallel for higher current capability. Applications include relay drivers, hammer drivers, lamp drivers, display drivers (LED and gas discharge), line drivers, and logic buffers. The ULN2803A has a 2.7-kΩ series base resistor for each Darlington pair for operation directly with TTL or 5-V CMOS devices. Figure 3.8 shows pin outs of ULN2803.

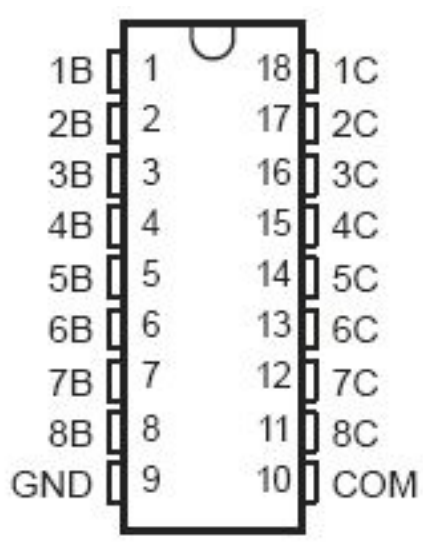

Figure3.8:ULN2803

3.2.8 Sp70 solar panel

Solar panels are photovoltaic power source used for providing power to the system, as well as charging lead acid batteries. The SP70 solar panel is supplied with a 20 ft long, 16 AWG cable with two leads terminated with spade lugs. This cable connects to the external voltage regulator. The voltage regulator is not supplied with the SP70 solar panel, and must be purchased separately. Figure 3.9 shows the SP70 Solar Panel

Figure 3.9:SP70 solar panel

3.2.9 LM317T variable voltage regulator

The LM317T is a adjustable 3 terminal positive voltage regulator capable of supplying in excess of 1.5 amps over an output range of 1.25 to 37 volts. The device also has built in current limiting and thermal shutdown which makes it essentially blow-out proof. Output voltage is set by two resistors R1 and R2 connected as shown below. The voltage across R1 is a constant 1.25

volts and the adjustment terminal current is less than 100uA. The output voltage can be closely approximated from Vout=1.25 * (1+(R2/R1)) which ignores the adjustment terminal current but will be close if the current through R1 and R2 is many times greater. A minimum load of about 10mA is required, so the value for R1 can be selected to drop 1.25 volts at 10mA or 120 ohms. Something less than 120 ohms can be used to insure the minimum current is greater than 10mA. The example below shows a LM317 used as 13.6 volt regulator. The 988 ohm resistor for R2 can be obtained with a standard 910 and 75 ohm in series.When power is shut off to the regulator the output voltage should fall faster than the input. In case it doesn't, a diode can be connected across the input/output terminals to protect the regulator from possible reverse voltages. A 1uF tantalum or 25uF electrolytic capacitor across the output improves transient response and a small 0.1uF tantalum capacitor is recommended across the input if the regulator is located an appreciable distance from the power supply filter. The power transformer should be large enough so that the regulator input voltage remains 3 volts above the output at full load, or 16.6 volts for a 13.6 volt output.

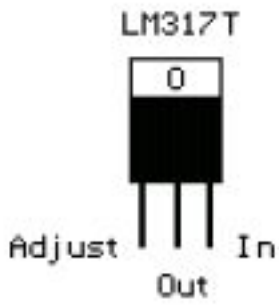

Figure 3.10: LM317T variable regulator

3.2.10 Diode

A diode is a specialized electronic component with two electrodes called the anode and the cathode. We selected it because reduced power consumption, long operational life, high reliability minimum heat emission, fully recyclable.

Figure 3.10: Diode

3.2.11 Water level sensor

Global Water's Water Level Sensors are fully encapsulated with marine-grade epoxy. The submersible pressure transducer's electronics are encased in marine grade epoxy so that moisture can never leak in or work its way down the vent tube to cause drift or level sensor failure (as is the case with other pressure sensors). The vent tube is sealed directly to the sensing element, and any moisture that may enter the vent tube only comes in contact with a silicon sensing device, not the electronics.

Figure 3.11: Water level sensor

CHAPTER FOUR

APPLICATION RESULTS

4.1 Introduction

Greenhouses have become a new and popular technique in agriculture, this new method needs wise and professional management to gain the best production of crops. This leads to have an elaborate system that works perfectly to control and observe the growing of plants step by step.

4.2 System Operation

The main block diagram is shown in Figure 4.1:

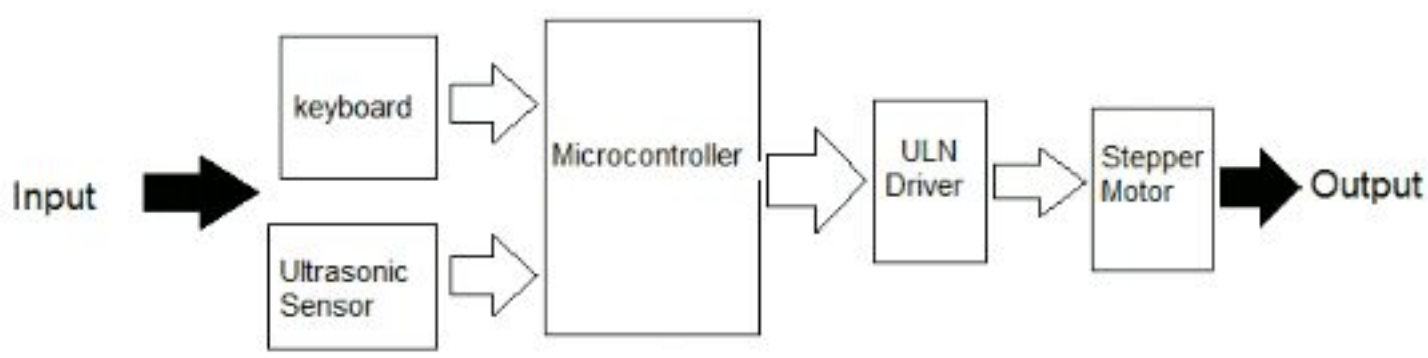

Figure 4.1: block diagram of the automatic irrigation system

The project is a simulation (or implementation) for one of the irrigation methods, and it is Flood Irrigation in Greenhouses, which is controlled by the microcontroller. The operation begins by entering a number on the keyboard, this number represent the percentage of water height to the plants we want to water. After the input operation, the ultrasonic sensor –which is thread on a certain height (73 cm) - measures the length of the plants, this length will be divided by the entered percentage on the keyboard. Therefore, the keyboard will show two numbers, the result of division and height of water. This operation executed by the Microcontroller, which sends a signal to the stepper motor to carry the water level sensor to specified height of water. Water level sensor works depending on the existence of water at that level, in case there is no water, it will send a signal to the Microcontroller to open the water valve until water rise to the level which existing on it. After that it will send another signal to the Microcontroller to close the water valve. The operation repeats according to the growth of the plants with a different percentage input and different readings by the ultrasonic every time.

4.3 Programming language

BASCOM is an Integrated Development Environment (IDE) that supports the 8051 family of microcontrollers and some derivatives as well as Atmel's AVR microcontrollers. Two products are available for the various microcontrollers - BASCOM-8051 and BASCOM-AVR. In a microcontroller project one needs to know the hardware base, i.e. the microcontroller with internal and connected peripherals, and the software used, i.e. IDE handling, programming and debugging.BASCOM AVR is a very powerful and easy-to-use compiler for the AVR series of micro controllers developed by Atmel. The program comes with a very user-friendly interface and a set of simple commands, and provides more flexibility than other programs in this category.

Anybody with some basic knowledge of C or C++ can write a successful program using BASCOM, as most of its functions and its statement structure is similar to those in C. The best thing about BASCOM AVR is that it can directly burn any flash file into a micro controller using just four wires connected to your computer's parallel port (printer port, or LPT port). If you are using a laptop or a netbook with just a USB port, then you can compile and save your program as a hex or bin file and burn it later using USBISP burners with any third-party flash burning tool.

Table 4.1: Tests of the plant irrigation

Status	Ultrasonic (Cm)	Plant Heigh (Cm)	Water level before	Water level after
1	50	21	0	7
2	46	24	7	8
3	43	27	8	9

4.4 System Simulation

The main simulation circuit can be represented in Figure 4.2:

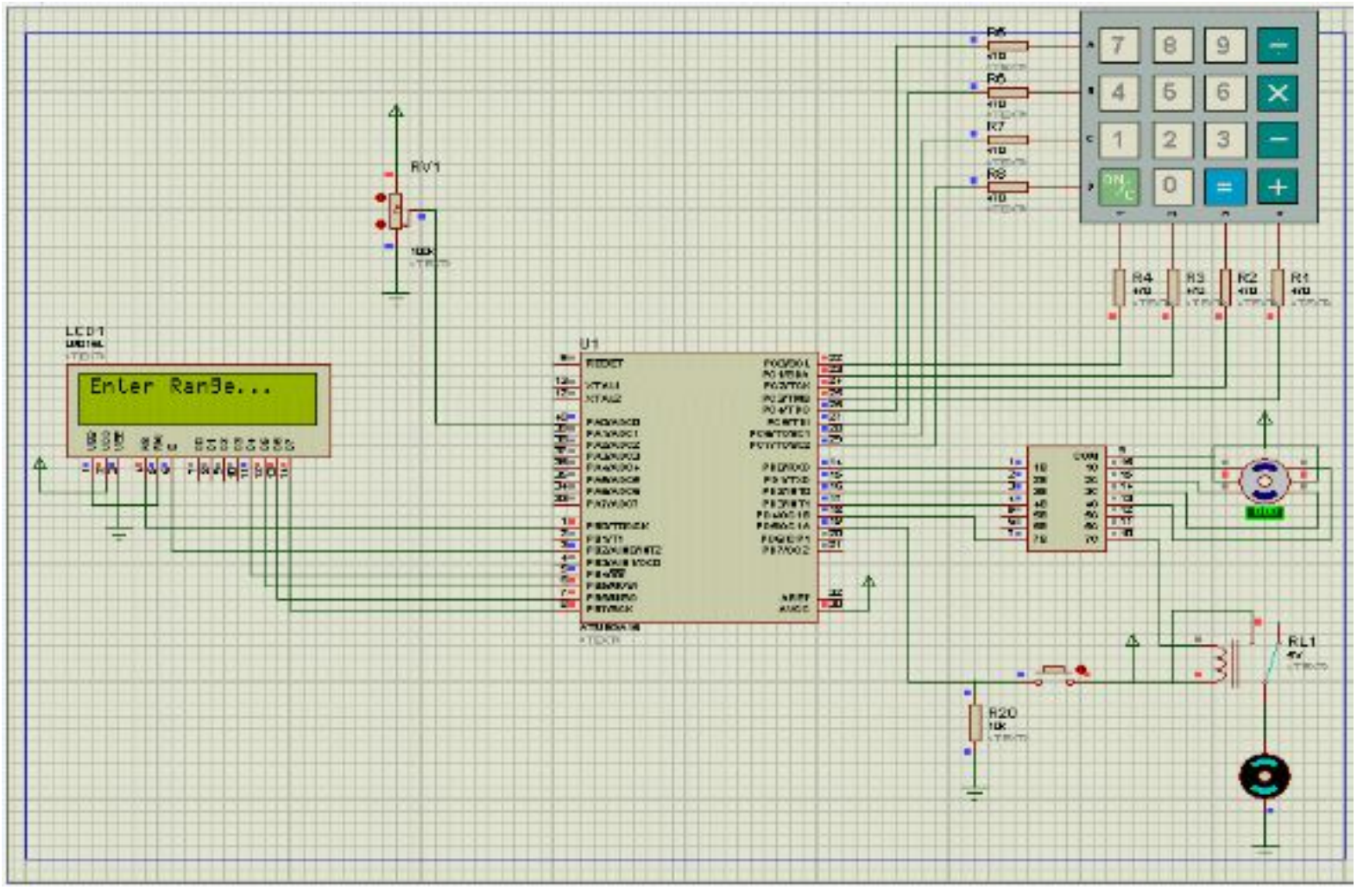

Figure 4.2: Automatic irrigation circuit

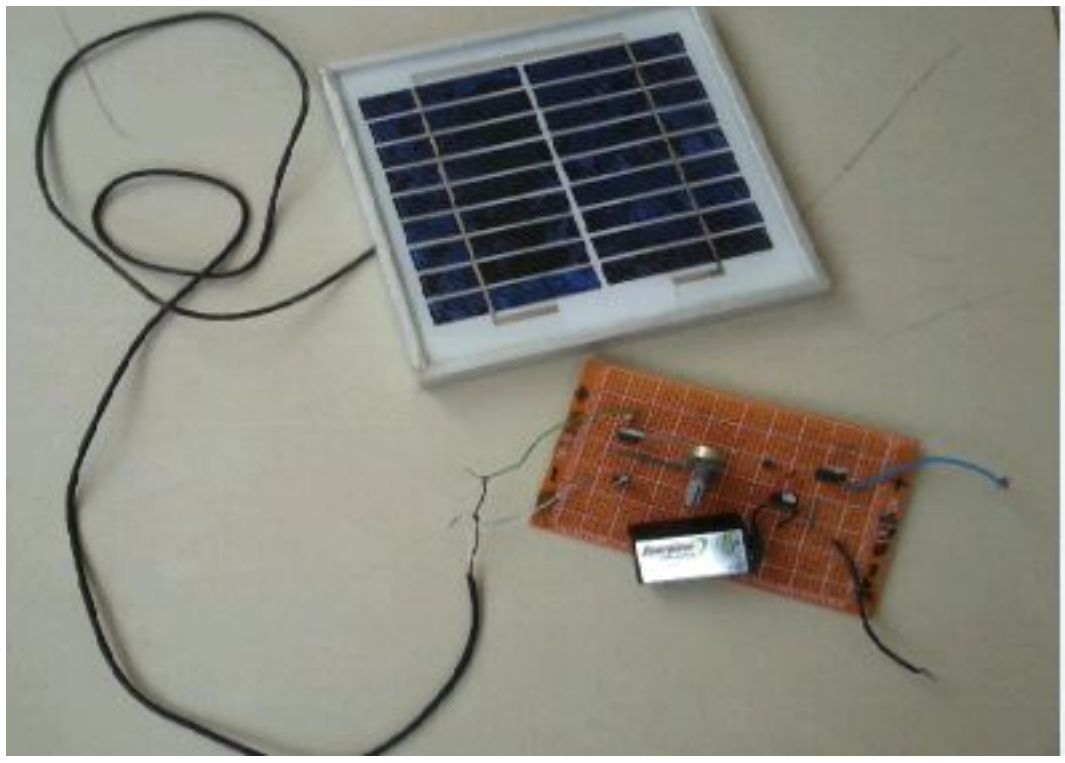

Figure 4.3: Solar cell power circuit

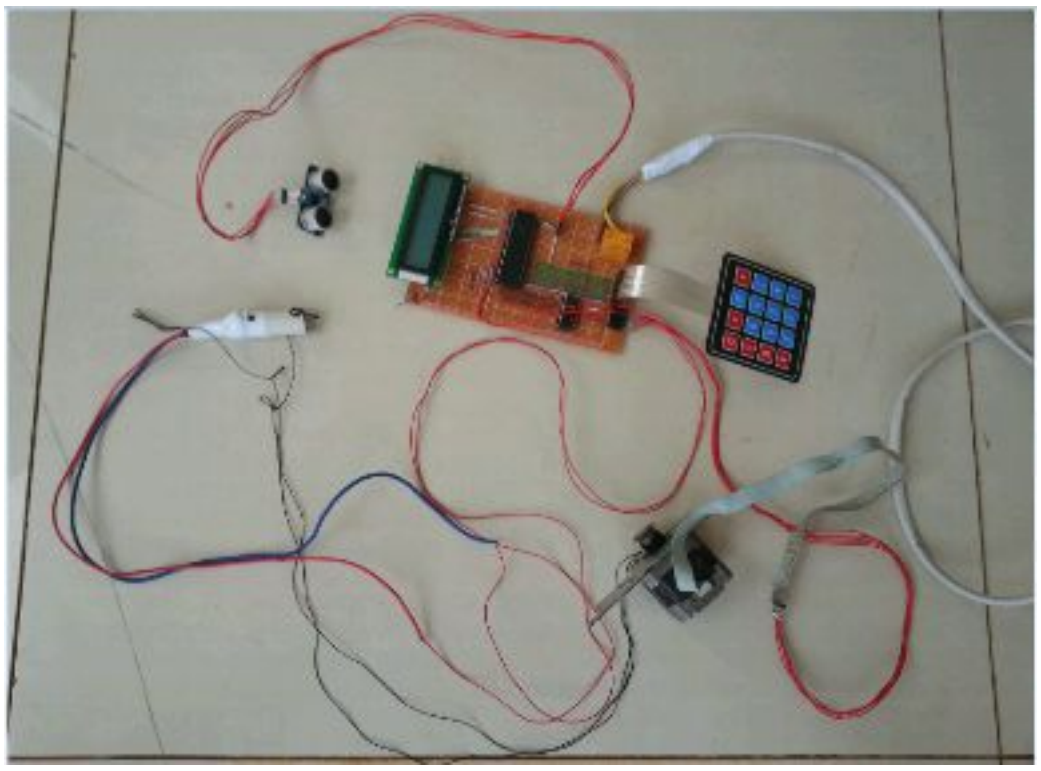

Figure 4.4: Control circuit

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Automation has become an important part in controlling systems, and the idea of getting an automatic control system that works without an error or low performance makes it so hard to get that kind of perfection in a system. Microcontrollers have been a great help in controlling and simulating systems through its components so as to have an accurate control system. Cost savings come from several locations. Development costs are greatly decreased

because of the design/flexibility advantages mentioned previously. Because so many components are included on one IC, board area and component savings are often evident as well.

In agriculture, the first aim is to have high production of crops, this can't be done without making best planting, care and best performance from workers.

In this project we've managed to have a system that doesn't need much interference from outside and can solve irrigating problems. In the past, programming has often involved tedious assembly code, today Bascom compilers are available for most microcontrollers. Microcontrollers often only require a single 5V supply as well which makes them easier to power and use.

Solar cells become a great replacing in power sources, and have a high, safe power layout than other sources. This makes it a reliable power source.

5.2 Recommendations

In order to increase the efficiency of this system we recommend the following:

√ For the project to be more integrated, attention to the mechanism of transfer of water from source to reservoir must be taken care of.

√ In order to achieve more crop production, the process of fertilization must be placed under consideration by type of crop, also water filtration process.

√ Improve the project so as to work with the different types of irrigation.

REFERENCES

1. Roland S. Burns," Advanced Control Engineering", Plymouth, UK, 2001.
2. P.N. Paraskevopoulos, "Modern Control Engineering",Madison Avenue, New York, 2002.
3. Banica Florinel Gabriel, "Chemical Sensors and Biosensors",2012.

4. Herwig. Lloyd O., "National center for Photovoltaic's", 1999.

5. J.G. Thomas,"Irrigation System Selection", Mississippi State Universit,2010.

6. Reston Condit ,’’Stepping Motors Fundamentals’’, Microchip Technology Inc,New York,2004.

7. Odd Jostein Svendsli,"Atmel'sSelf-Programming Flash Microcontroller", 2008.

APPENDIX

Programming Code

```
$regfile = "m16def.dat"
$crystal = 8000000



Config Pina.0 = Input
```

```
Config Porta.1 = Output


Config Portd.0 = Output                    'motor
Config Portd.1 = Output                    'motor
Config Portd.2 = Output                    'motor
Config Portd.3 = Output                    'motor
Config Portd.4 = Output                    'bump
Config Pind.5 = Input                     'water level


Config Lcd = 16 * 2
Config Lcdpin = Pin , Db4 = Portb.4 , Db5 = Portb.5 , Db6 = Portb.6 ,
Db7 = Portb.7 , E = Portb.2 , Rs = Portb.0
Cls
Cursor Off


Config Kbd = Portc
Config Timer1 = Timer , Prescale = 64


Dim Data_timer As Integer
'Dim C As Byte
Dim V As Byte
Dim C1 As Word
Dim D As Byte
Dim P As Byte
Dim S As Byte
```

```
Dim M As Byte
Dim Y As Integer
Dim Z As Byte
Dim H As Byte
Dim L As Byte
Dim W As Byte
Dim Q As Byte
Dim K As Byte
Dim T As Byte



Locate 1 , 1
Lcd "Enter Range..."
Waitms 300


Bigen:
Do
M = Getkbd()
If M <> 16 Then Gosub Calculation
Waitms 20
Locate 2 , 5
Lcd C1
Wait 1
If D = 2 Then
Lcd C1
```

```
Goto First
Waitms 50
End If
'Exit Do
Loop

First:
Do
Cls
Gosub Hh
Data_timer = Data_timer / 7
Data_timer = 73 - Data_timer

Y = Data_timer / C1

Locate 1 , 1
Lcd "DIST =  " ; Data_timer ; " CM"

Locate 2 , 1
Lcd "DIST =  " ; Y ; " CM"
Waitms 300

If Y > 0 And Y = 3 And H = 0 Then
H = 1
```

```
Z = 1
Gosub Motor
Waitms 50
End If


If Pind.5 = 1 Then
Portd.4 = 1
Waitms 100
End If

If Pind.5 = 0 Then
Portd.4 = 0
Waitms 100
End If


If Y > 2 And Y < 4 And L = 0 Then
L = 1
Z = 5
Gosub Motor
Waitms 50
End If
```

```
If Y > 4 And Y < 6 And W = 0 Then
W = 1
Z = 5
Gosub Motor
Waitms 50
End If

If Y > 6 And Y < 8 And Q = 0 Then
Q = 1
Z = 5
Gosub Motor
Waitms 50
End If

If Y > 8 And Y < 10 And K = 0 Then
K = 1
Z = 5
Gosub Motor
Waitms 50
End If

If Y > 10 And Y < 12 And T = 0 Then
T = 1
Z = 5
Gosub Motor
```

```
Waitms 50
End If



Timer1 = 0
Loop
Return

'=========================================

Hh:
Set Porta.1
Waitus 10
Reset Porta.1
Bitwait Pina.0 , Set
Data_timer = 0
Timer1 = 0
Start Timer1

Do
If Pina.0 = 0 Then
Data_timer = Timer1
Stop Timer1

Exit Do
```

```
End If


If Tifr.2 = 1 Then
Stop Timer1

Tifr.2 = 1
Data_timer = 0
Exit Do
End If
Loop
Stop Timer1
Return
```

```
Calculation:
S = Lookup(m , Dta)
Incr D
P = D + 6
C1 = C1 * 10
C1 = C1 + S

Waitms 200
Return
Motor:
For V = 1 To Z
```

```
Portd.0 = 1
Portd.1 = 1
Portd.2 = 0
Portd.3 = 0
Waitms 500
Portd.0 = 0
Portd.1 = 1
Portd.2 = 1
Portd.3 = 0
Waitms 500
Portd.0 = 0
Portd.1 = 0
Portd.2 = 1
Portd.3 = 1
Waitms 500
Portd.0 = 1
Portd.1 = 0
Portd.2 = 0
Portd.3 = 1
Waitms 500
Next
Portd.0 = 0
Portd.1 = 0
Portd.2 = 0
Portd.3 = 0
```

```
        Waitms 500
        Return
        Dta:
Data 15 , 14 , 0 , 13 , 12 , 9 , 8 , 7 , 11 , 6 , 5 , 4 , 10 , 3 , 2 , 1
```