Senior Design Project (CSE499B) Report

Design and development of a sensor based intelligent auto irrigation system: Jol-Shinchon

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Declaration

We, M Abu Muyeed (013018040) Shahriar Sadat (1020204042) K.M. Ragibul Haque (1210820042), This report on “Jol-shinchon: Design and development of a sensor based intelligent auto irrigation system” has been prepared for Dr. Rajesh Palit, Associate Professor of the Department of Electrical and Computer Engineering, North South University for the partial fulfillment of CSE499: Capstone Project by the students mentioned below. This report discusses in extent all the technical aspects and research work associated with the project, as well as focuses on the process of the development of the mobile application in order to reach completion of the project. We would like to request you to accept our project report as a partial fulfillment of our Bachelor of Science degree in Computer Science and Engineering (BS in CSE).

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Approval

This project report has been submitted as part of a collaborative work between M Abu Muyeed (ID: 013018040), Shahriar Sadat (ID: 1020204042) and K.M. Ragibul Haque (ID: 1210820042) to the Department of Electrical and Computer Engineering (ECE), for partial fulfillment of the requirements for the degree of Bachelor of Science in Computer Science and Engineering (BS in CSE). To the best of my knowledge, this project report is original in nature and has been prepared by them. I wish them every success in life.

Supervisor's signature

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Abstract

Agriculture is the mainstay for Bangladesh since time immemorial. The agro-based economy is crippled by a great number of factors in attaining its desired goal. One of the factors determining the agricultural output is the provision of water. Since natural water availability is prone to many aspects of nature – especially rain, irrigation or alternative supply of water becomes a critical element in the agriculture sector. The existing irrigation mechanisms through the motor-pumps are heavily dependent on fossil fuel – regarded as an offender in the carbon footprint debacle. The poor farmers find themselves with insurmountable hurdles as they are constrained by the financial cost on fuel. The profit maximization gets a major setback due to the exorbitant amount of expenditure due to fuel consumption. An innovative approach to do away with such limitation is the utilization of natural resource for irrigation purpose. An intelligent auto irrigation system is based on the concept of harnessing the power of sun. Through the use of solar panel, sunlight is captured into the photovoltaic cells and transferred to a battery to be charged during the day. All this setting is facilitated by circuits – one associated with the solar panel and the other one for detecting the presence of sunlight during the day since the system would not allow any water to flow unless it is the night time. In order to drive the pump into action, two conditions need to be fulfilled – one darkness, detected by a photo resistor and the second one is the dryness of soil, to be determined by a moisture sensor, and this setting would be programmed by a platform – both hardware and software – named Arduino Uno. Although the charging time of the battery by solar panel would be a little lengthy, the long exposure to the sun would provide enough time and charging volume to the battery. And the battery would comfortably provide a considerable duration of power to the water pump that can supply sufficient amount of water to agricultural land of any decent size. A 6-volt battery would need 15 hours to be charged by a solar panel of decent configuration and later on can supply charge for 5 hours incessantly. Under this calculation, a staggering 740 liter of water can be lifted and flown by a pump of even smaller wattage rating. When put up with a pump of higher horse power and battery with higher power rating, such a system would be more than enough for any rural area in Bangladesh. As expected, such a scheme would not only have a greater saving on fossil fuel cost and very little maintenance cost, the environment would be blessed with clean air – thereby ensuring better health - along with the fact that solar energy driven approach would have a significant contribution on job creation also. If installed properly, such a system would be the precursor to an agricultural revolution.

Acknowledgements

At first, we like to express our gratitude to the Almighty GOD for giving us the courage to accomplish this task. Then we like to thank the ECE Department of NSU to provide the opportunity to carry out the job in a nice setting. Moreover, we like to acknowledge our debt to various people and sources for our information and guidelines for exploring the facets of this work, especially Tazwar Ibne Aleef, an Electrical Engineer, for his invaluable help in giving us the accurate direction when we were baffled by the difficulty of the task. Lastly, we would like to declare our greatest gratitude to our honorable Instructor – Dr. Rajesh Palit – who selected this interesting topic and provided the enthusiasm and relentless support for fulfilling this mammoth undertaking.

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Chapter 1: Introduction

Irrigation is a process of supplying water from sources other than rain or any such natural phenomenon for arid agricultural land where places like dams, barrages, channels, or other devices are utilized. Irrigation has been in practice for as long as ten thousand years, predominantly in areas where annual rainfall is not more than 500 mm, typically in number of countries in Africa, Asia and America. It is inevitable for places with wet characteristics, with specific crops, like rice. Estimation of total area under irrigation around the globe ranges in the figure of 543 to 618 million acres – with approximately 50% of them in India, Bangladesh, Pakistan, and China.

Bangladesh, being located in southern Asia, in the northeast of the Indian subcontinent, covering a total area of 144 000 km², is known to the global community for various reasons. The country is mainly flat with some upper regions in the northeast and some in the southeast. A plain – vast in proportion – spreads from the southern part at sea level by rising in a gradual fashion up to the north. Land elevation in the plain is of great variety ranging from 0 to 90 m above sea level. The geo-morphological study of the country reveals that a bigger fraction of floodplains (79.1 percent) occupy the landscape, with a little allocation for terraces - 8.3 percent - and a tiny existence of hilly geography.

1.1 Some facts and figures for Agriculture

A total of 8 774 000 ha of cultivable area is available in Bangladesh, which is almost equivalent to 61 percent of the territory of the country. Among them, the land boasts about 19 percent of being single cropping, another 59 percent being cropped twice a year, and the rest of the 22 percent in the triple cropping category. Bangladeshi agriculture goes through subsistence farming practices. Cereals and rice dominate the agricultural output while annual crops like pulses, oilseeds, jute and sugar cane figure prominently.

Till date, the agriculture sector remains the breadwinner for the country by contributing about 30 percent of GDP and 61 percent employment creation; 57 percent of the labor force finds their ways to be direct part of farming activities.

1.2 Climatic impact on agriculture and water resource availability

Climate of Bangladesh is characterized by a tropical monsoon setting which significantly varies in precipitation rate and temperature across the landscape. The seasons come in four appearances: pre-monsoon (March-May) possess the extreme heat and allocates the highest frequency of cyclonic storms, specifically in May; the monsoon – spanning June-September - when the bigger chunk of precipitation occurs; the post-monsoon (October-November) is accompanied by tropical cyclones on the coastal region; and the relatively cooler and moderate level of sunshine (December-February). The mean annual temperature stands at about 25 ^{0} C while humidity has a range between 60 - in the hot months - and 98 percent occurring in the rainy days. Around 80 percent of the total rainfall takes place during the monsoon, and the average annual precipitation throughout the country is 2 666 mm. rate of rainfall fluctuates - from 1 110 mm in the western region to 5 690 mm in the northeastern districts. Drought, floods and cyclones are regular occurrence of the climatic pattern for the country.

Despite the huge gush of water during the rainy season, stark disparity exists due to the lesser flow in the hotter period, surface water resources that can be utilized are regarded as equivalent to 80 percent of the reliable water-flow in March, leaving no alternative but to depend on surface water resources to be put into use comprehensively during dry seasonal extent for irrigational purpose.

Basic statistics and population

Physical areas			
Area of the country	2009	14 400 000	ha
Cultivated area (arable land and area under permanent crops)	2009	8 549 000	ha
• as % of the total area of the country	2009	60	%
• arable land (annual crops + temp fallow + temp meadows)	2009	7 569 000	ha
• area under permanent crops	2009	980 000	ha
Population			
Total population	2009	147 030 000	inhabitants
• of which rural	2009	72	%
Population density	2009	1 021	inhabitants/km^2
Economically active population	2009	69 585 000	inhabitants
• as % of total population	2009	47	%
• female	2009	40	%
• male	2009	60	%
Population economically active in agriculture	2009	32 220 000	inhabitants
• as % of total economically active population	2009	46	%
• female	2009	50	%
• male	2009	50	%
Economy and development			
Gross Domestic Product (GDP) (current US$)	2009	89 360	million US$/yr
• value added in agriculture (% of GDP)	2009	19	%
• GDP per capita	2009	608	US$/yr
Human Development Index (highest = 1)	2010	0.469	
Access to improved drinking water sources			
Total population	2008	80	%
Urban population	2008	85	%
Rural population	2008	78	%

Figure 1 Basic statistics and population

1.3 Water withdrawal

Agriculture sector consumes a huge volume of water in Bangladesh. To just get an idea, it can be shown that in 2008, the total water withdrawal in sectors like agriculture, households and industries was approximated at close to 35.67 km^3, where nearly 88 percent was utilized by agricultural sources.

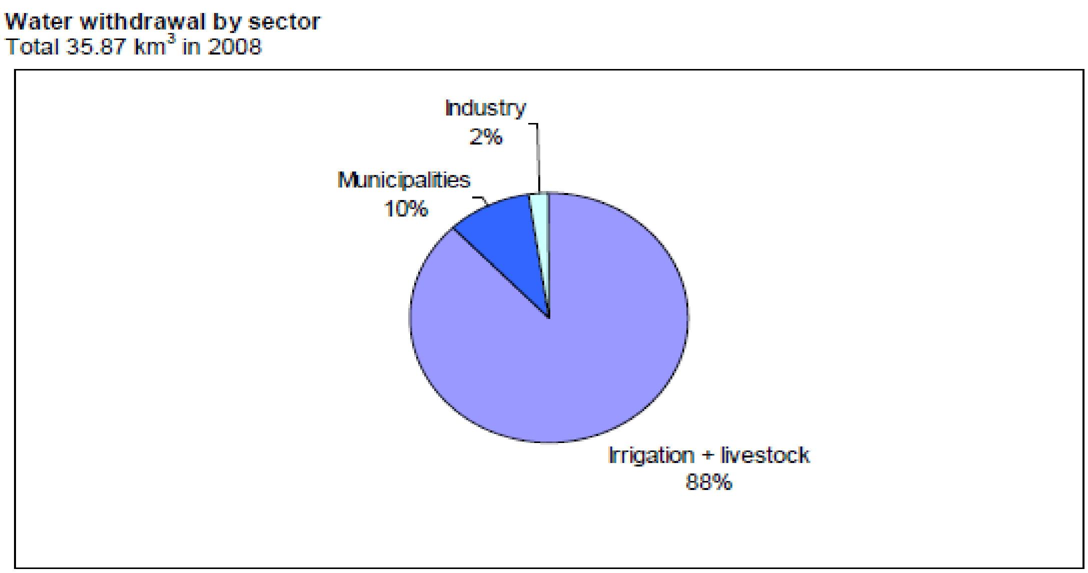


Figure 2 Water withdrawal by sector

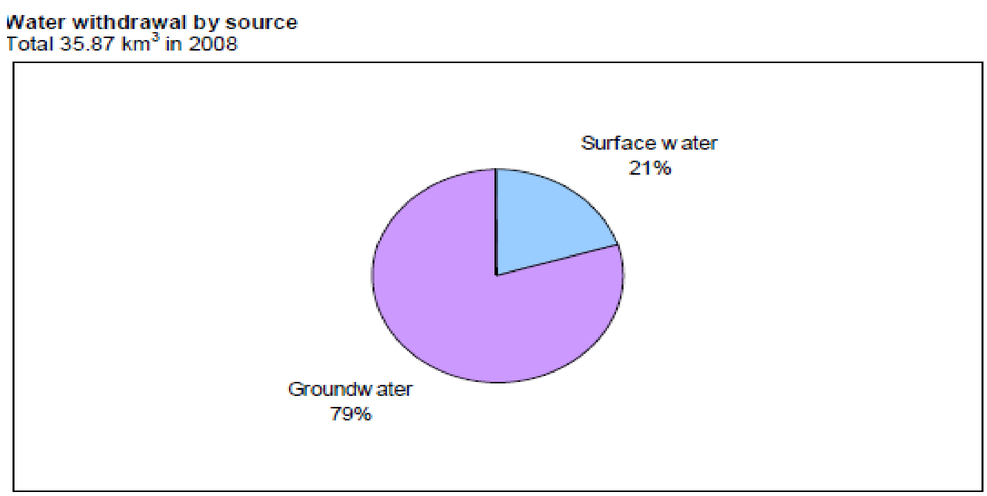


Figure 3 Water withdrawal by source

Other kind of water consumption included navigational and fisheries purpose amounting to almost at 10 km³. About 73 percent of the aggregate water withdrawal originates from groundwater.

Type of water control	Irrigated area in ha	% of total
Surface water		
Gravity flow	355 000	9.5
LLP (including floating pump)	577 216	15.4
Traditional (manual pumping)	226 363	6.1
Subtotal	1 158 579	31
Groundwater		
STW, DSSTW and VDSSTW	2 004 500	53.4
DTW and FMTW	537 865	14.3
Unmechanized (HTW)	50 101	1.3
Subtotal	2 592 466	69
Total	3 751 045	100

LLP: low lift pump; DTW: deep tube-well; STW: shallow tube-well; HTW: hand tube-well; FMTW: force mode tube-well; DSSTW: deep-set shallow tube-well; VDSSTW: very deep-set shallow tube-well.

Figure 4 Type of water control

In 2008, the total water withdrawal was an estimated 35.87 km^3, of which 31.50 km^3 (88 percent) was for agriculture, 3.60 km^3 (10 percent) for municipalities and 0.77 km^3 (2 percent) for industries

Water use

Water withdrawal			
Total water withdrawal	2008	35 870	million m^3/yr
- irrigation + livestock	2008	31 500	million m^3/yr
- municipalities	2008	3 600	million m^3/yr
- industry	2008	770	million m^3/yr
• per inhabitant	2008	247	m^3/yr
Surface water and groundwater withdrawal	2008	35 870	million m^3/yr
• as % of total actual renewable water resources	2008	2.9	%
Non-conventional sources of water			
Produced wastewater		-	million m^3/yr
Treated wastewater		-	million m^3/yr
Reused treated wastewater		-	million m^3/yr
Desalinated water produced		-	million m^3/yr
Reused agricultural drainage water		-	million m^3/yr

Figure 5 List of water use

In the context of the thirst for water and failure to provide efficient irrigation mechanism, the time has come to go through a thorough understanding of the existing system for improving the irrigation approach and then build a robust system that would go a long way to mitigate the sufferings of the farmers who heavily rely on irrigation.

Chapter 2: Background

At present Bangladesh is trying within its limitation to break the barriers in agriculture – especially in irrigation. However, the spiraling cost of fuel and uncertainty in availing electricity obstructs the irrigation required for producing crop in Bangladesh.

2.1 Problems on fuel pumped system

According to an estimate, about 1.71 million irrigation pumps are in operation in Bangladesh - 83% of them being diesel engine and 17% are driven by electricity. Electricity's demand for irrigation is rising up since the cost of pump operated by electric power is cheaper in comparison with the pump running on diesel. Solar pump could be presented as an alternative in small scale irrigation schemes to produce crop in the regions off-grid in Bangladesh. Situated in the tropic of cancer, Bangladesh is gifted with copious flow of solar energy. Solar rays are radiated within a low of4.0 and a high of 6.5 kWhm-2day-1 and the sun shining bright brightly for hours varying in the range of 6 to 9 hours/day [2-3]. Bangladesh finds about 60% of land to be irrigable. A vast region worthy of irrigation is available in the country where majority of the areas (Charland, coastal area, hilly area, etc.) are devoid of any grid connection. Solar PV pump could be an option for irrigation purpose for such lands to have better yield and to amplify cropping intensity.

Solar pumps were proved to be technically suitable for low lift small scale irrigation in Bangladeshi landscape since a decade later after independence but these pumps lacked economic viability since PV cost were unwieldy. Utilization of solar pumps on a larger measure would help to reduce energy demand in irrigation considerably. Hence, this study was commenced to appraise the technical and economic role of PV powered solar pumps at the open field setting for land to be irrigated for rice as well as other type of crops.

Irrigated crops in full control irrigation schemes			
Total irrigated grain production		-	metric tons
• as % of total grain production		-	%
Harvested crops			
Total harvested irrigated cropped area	2008	5 976 810	ha
• Annual crops: total	2008	5 936 810	ha
- Wheat	2008	313 000	ha
- Rice	2008	4 341 000	ha
- Maize	2008	90 000	ha
- Millet	2008	400	ha
- Sorghum	2008	100	ha
- Barley	2008	810	ha
- Other cereals	2008	25 000	ha
- Potatoes	2008	263 000	ha
- Pulses	2008	156 000	ha
- Vegetables	2008	236 000	ha
- Cotton	2008	6 500	ha
- Tobacco	2008	18 000	ha
- Sesame	2008	30 000	ha
- Sugarcane	2008	43 000	ha
- Other annual crops	2008	414 000	ha
• Permanent crops: total	2008	40 000	ha
- Tea	2008	40 000	ha
Irrigated cropping intensity (on full control actually irrigated area)	2008	118	%
Drainage - Environment			
Total drained area	1993	1 501 400	ha
- part of the area equipped for irrigation drained	1993	118 400	ha
- other drained area (non-irrigated)	1993	1 383 000	ha
• drained area as % of cultivated area	1993	17	%
Flood-protected areas		-	ha
Area salinized by irrigation	1993	100 000	ha
Population affected by water-related diseases		-	inhabitants

Figure 6 List of irrigated crops

2.2 Existing moisture sensor based system

The system was inspired by studies which have demonstrated that a suitably arranged soil moisture sensor can cut down outdoor water consumption by as far as to more than 62 percent when compared to traditional irrigation procedures. If water is provided to plants in time of need, a rise in landscape improvement, promotion in deep level root flourishment, and resistance to disease can be attained. The question is raised as if, despite having simplicity, a soil moisture sensor can deliver so many advantages, then why such treasured tool not utilized on all irrigation schemes. According to the finding, individuals in the professional level who use devices for irrigation are frequently acquainted with substandard soil moisture sensors that fail to provide anticipated outcomes, and such experience has undermined the worth of soil moisture sensors in general. In addition, decision regarding irrigation approach does not always contemplate on the fact the mechanism of water molecule flow within soil, or the ways in which the various kinds of soil hold on moisture, nor the idea explores the question of difference in plants' requirements of elements in various degrees. The target of the present text is to establish the credibility of the Baseline soil moisture sensor as a significant irrigation tool and to aid professionally capable irrigators meeting their requirements by raising their cognizance on the questions relevant to active watering solution.

Chapter 3: Design and Development

The scenario presented above has provided us the motivation to put our intellectual resources to utilize the available facilities to come with a better solution for dealing with the irrigation bottleneck. It would be an automated system for irrigation mainly consisting of two major subsystems:

- An Arduino Based Power System.
- A Solar Panel Associated Circuit System.

3.1 Arduino-based Power System

- List of hardware:

1. **Breadboard:** A breadboard is a container or hub for defferent circuit components for prototyping of electronics. It is usually identified as a polished piece of wood. In the project, two breadboards are required. In one board, the LDR and Mositure Sensor is connected, and with the other,the solar panel circuit would be built upon. In the bread board, there is a connection to the ground and Vcc, the (-) column is for ground which is connected to arduino ground, and (+) is for Vcc there.

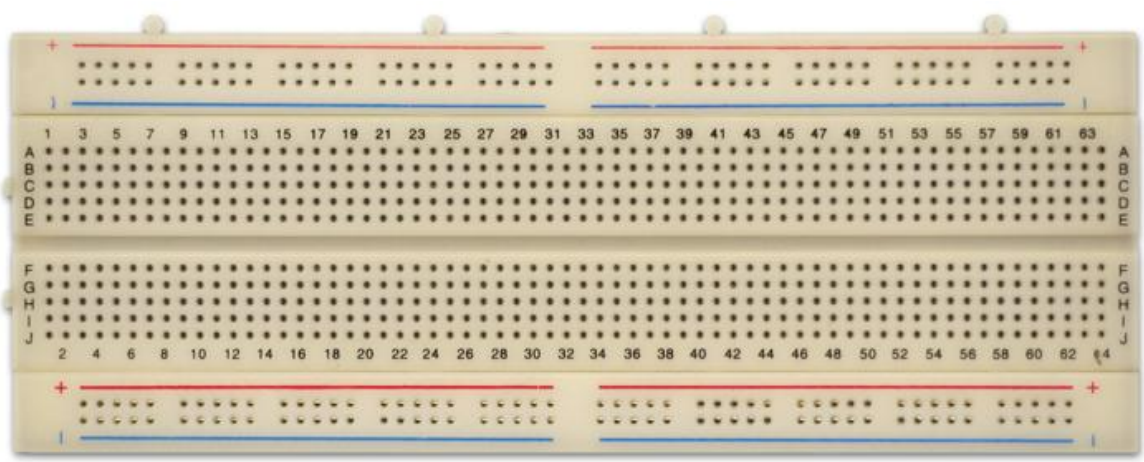


Figure 7 Bread board

2. **Wires**: In this project two kinds of wires have been needed.

Figure 8 Male to Female wires

Figure 9 Male to male wires

3. **LDR:** An LDR or light-dependent resistor is basically a light-controlled variable resistor. When the intensity of light increases, the resistance of the photo resistor starts going down. Thus it exhibits photoconductivity. An LDR is being used to detremine whether there is light available or not. The LDR would be operational under the following conditions:

- At the presence of sunlight, the water pump will stop automatically.
- While it is dark, it will will provide indication for the pump to begin the water to flow.
- A range of value would be set for Arduino for the detection of the presence of sunlight.
- Below 650 there is sunlight = water pump will remain stopped
- Above 650 the sunlight increases = water pump will start
- Above 950 there is no light = water pump will continue to operate

Figure 10 LDR (Light Dependent Resistor)

4. **Relay** (Switch): A relay is used when a circuit needes to be operated - also can be referred to as an electrically operated switch. such a component is put into use where it is necessary to regulate a circuit with two or more low-power signals - several circuits ought to be put under control through a single signal. The relay is utilized for controlling two circuits via one signal. With the help of the relay, the battery gets connected and with that, the water pump in the system woulb be started. Relay becomes operational at 5 volts.

Figure 11 Relay Switch

5. **Resistors:** A resistor is an electrical component with two-terminals. It is a passive item which is used for implementation or construction element for dealing with electrical resistance in a circuit. Resistors are capable of performing two operations simultaneously. It could be put into use for reducing current flow, as well as could be utilized to reduce the voltage strength within a circuit. In the project, several kinds of resistors would be

put into use. In this regard, actually their purpose would be to ensure to maintain a value of 3.7V to LEDs .

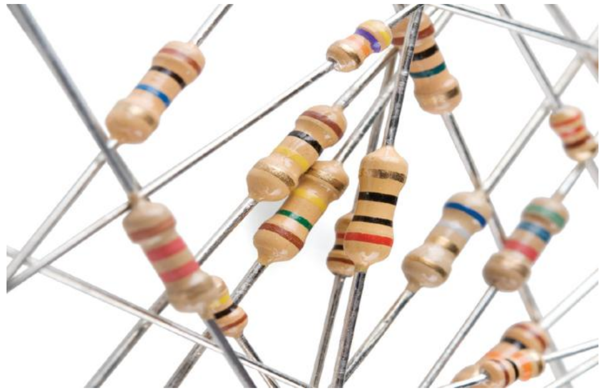


Figure 12 Resistors

6. **LED:** A light-emitting diode (LED) is a source of light that is consisted of semiconductor with two leads. Electronic literature popularly also refers to them as p–n junction diode - emitting light under activation stage. Under sufficient voltage, the LEDs provide their electrons are enough energy to rearrange with electron holes under the circuit setting, helping to release energy emitted the as photons. Such a phenomenon is termed as electroluminescence, and the color from the light comes out as an exhibition of the energy band gap from the semiconductor item. Led lights are utilised to detect the sunlight intensity and degree of moisture. 6 led lights would be put into use for this scheme. Each LED ligth would be operational at 3.7 volt. indication of light would be in the following setting:

- ✓ For Moisture Level

Red = Dry soil
Yellow = Between Dry and Wet soil
Green = Wet soil

- ✓ For Sunlight Level

Red = No light
Yellow = Increasing of sunlight
Green = Full sunlight

Figure 13 LED Lights

7. **Arduino Uno system:** The Arduino Uno is also known as microcontroller kits. It is equipped with 14 digital input or output pins where allocated are 6 pins for utilized to be as Pulse Width Modulation (PWM) outputs, 6 pins to be dedicated as analog inputs. It is armed with a 16MHz ceramic resonator, along with a USB connection, a power jack, and In Circuit Serial Programming(ICSP) header, and a reset button. It houses everything necessary for supporting the microcontroller. It has connection to a computing environment through a USB cable or power option with an AC-to-DC adapter or battery to be initiated. In the project, the voltage of the battery would be 6volts. The Uno is unique compared to all previous boards in terms of the future that it is not dependent on the FTDI USB-to serial driver chip. In lieu of that, it is equipped with the Atmega16U2 programming option for USB-to-serial converter. The Arduino Uno can be provided with power from the USB connection or an external power supply can serve the purpose. Automatic selection option is enabled for the power source. External (non-USB) power can take a route from an AC-to-DC adapter or from a battery. The adapter has the option of getting connection from a 2.1mm center-positive plug into the board's power jack. GND can accommodate the facility of a battery lead insertion as well as Vin pin headers facilitating the POWER connector. The board can carry operation by an external supply between 6 and 20 volts. When supply is below 7V, however, the 5V pin would be unable to provide a flow of a value more than five volts and the board would lose stability. the 5V pin would not be used for that reason. When the system would be flooded with a value over 12V, the voltage regulator may become a victim of overheating and find itself with damaging signs on the board. Hence, the recommendation is in between 7 and 12 volts. In the project, the Arduino Uno would be controlling the LDR resistor and the soil moisture sensor at the same time. in the setting, two pins A1 would be allocated for output from LDR and A2 output would be dedicated for Soil Moisture Sensor. The ground of LDR and Soil Moisture Sensor would have their connections to the power secgment of arduino. Arduino would provide a perfect 5V to the circuit, with the aid of relay to decide the LED lights to be allotted for output purpose.

Figure 14 Arduino Uno

8. **Soil Moisture Sensor:** Soil moisture sensor would provide measurement of the presence of the water level in soil. As the accurate level of gravimetric measurement of soil moisture necessitate the removal, drying up, and weighing of a sample, soil moisture sensors indicate measurement of the level of water through an indirect approach through the use of some other attributes of the soil. Such characteristics – among others - include dielectric constant, electrical resistance, and interaction with neutrons, for approximating the moisture content. The relationship between the attribute going through measurement and soil moisture need to be put under calibration and may cause difference relying on factors from environment, like soil nature, temperature, or electric conductivity. Soil moisture sensors determine the water amount in soil. A soil moisture probing device is built upon a number of soil moisture sensors. Technologies usually employed in soil moisture sensor constructions include:

- ✓ Capacitance sensor – functions as a frequency domain sensor.
- ✓ Water neutrons are moderate by neutron moisture gauges.
- ✓ Electrical resistance of the particular soil.

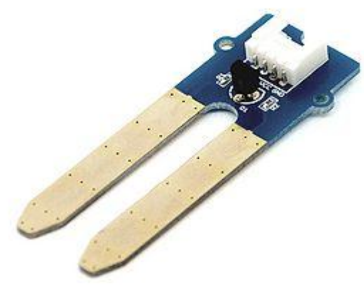


Figure 15 Soil Moisture Sensor

9. **Pump machine (miniature version):** The water pump would be used to artificially supply water from the ground for a particular task. It is subjected to electronic control by attaching it to a microcontrolling device. In the project, it would get the trigger of ON/OFF via signals being sent from the battery.

Figure 16 Water Pump

10. **A box and a narrow pipe**:

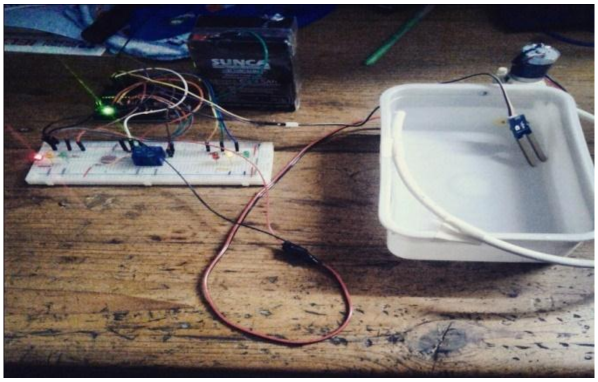


Figure 17 A box and a narrow pipe

3.2 A Solar Panel Associated Circuit System

1. **Solar Panel:** Solar panel is a specially manufactured panel made with a view to absorb the rays of sun to be used as a source of energy with a purpose of electricity generation or heating. A photovoltaic - in short PV - module cones as total package, having a connection assembled in a typical form of 6×10 solar cells. Solar Photovoltaic panels possess the collection of a photovoltaic system that would generate and supply solar electricity in places like business establishments and domestic setting. Each module gets the rating from its DC output power when put into standard testing prerequisites, and typically has a range from 100 to 365 watts. In order to be efficient, a module has to determine the area of that module provided the unchanged rated output – a 230-watt module with 8% efficiency will double the area compared to one with 16% efficiency for 230 watt module. A few solar panels have manifested their availability which exceeds 19% efficiency. A single solar module is capable of producing merely a certain degree of power; large number of installations is equipped with a set of modules. Typical for a photovoltaic system is to include a panel or a collection of solar modules, a solar inverter, and often accompanied by a battery or a solar tracker, followed by interconnecting wires. the current project intends to use a solar panel for to recharging battery. The solar panel would operate at 17 volts. But the employed battery would run at only 6 volt. That is why a regulator needs to be used to control the voltage level. In the project, the solar panel in use would have the following specification:
   - ✓ Operating Voltage Vmp 17.0V
   - ✓ Operating Current IMP 0.29V
   - ✓ Open Circuit Voltage Vcc 21.6V
   - ✓ Short Circuit Current Isc 0.34A
   - ✓ Max Power Pmax 5W

Figure 18 Solar Panel

2. **LM317T** (**Voltage** Regulator Circuit)**:** The LM317 has gained popularity linear voltage regulator since it can be easily adjusted. being an integrated circuit, the LM317T Voltage Regulator proves to be extremely handy in various energy applications that can be renewed. Its usefulness is evident in regulating current, like regulating the current in an array of LEDs. Similarly, in order to provide a fixed voltage output with stability, this is also a good choice. LM317T would be employed in the circuit to achieve a non-standard, or in other words voltage that would be best suit.

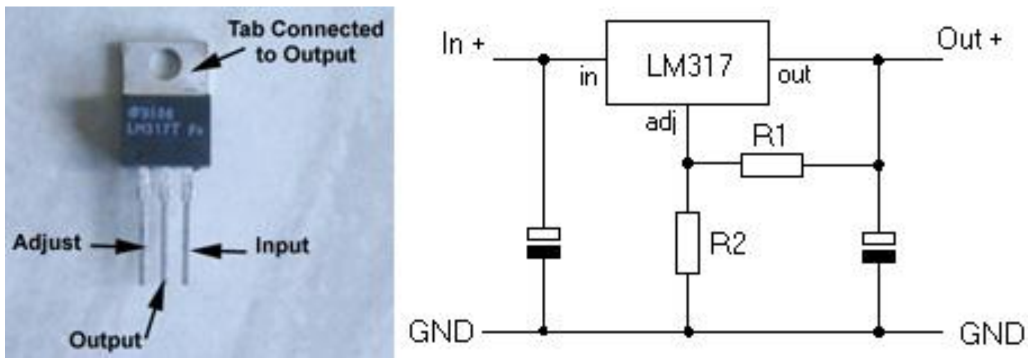


Figure 19 LM317T (Voltage Regulator Circuit)

3. 1N 4007 Normal Diode: The 1N4001 series or 1N4000 series belong to a genre of general-purpose silicon rectifier diodes which have gained popularity with 1.0 A (ampere) usually employed in AC adapters used in commonly found in appliances in domestic setting. Blocking voltage has variation in range of 50 and 1000 volts. This diode is constructed in an axial-lead DO-41 plastic package.1N4007 normal diode will be utilized with a view to a unidirectional current flow.

Figure 20 1N4007 (Normal Diode)

4. **BC548 Transistor** (switch): The BC548 belongs to a general-purpose NPN bipolar junction transistor frequently employed in Europe in their electronic equipment. It is notable that many a time in the initial stage, the kind of bipolar transistor a hobbyist comes across is more than seldom found in designs exhibited in hobby electronics magazines which require a general-purpose transistor. The BC548 is less expensive and availability is wide. BC548 transistor switch would be the tool for calculating current level – high or low.

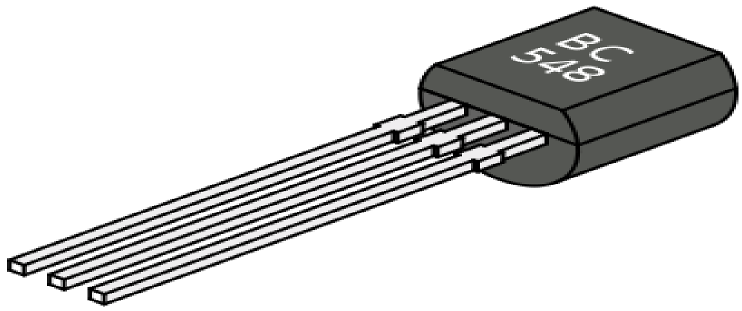


Figure 21 (BC548) Transistor switch

5. Resitors: Different kinds of reistors will be rquired for implementing this circuit.

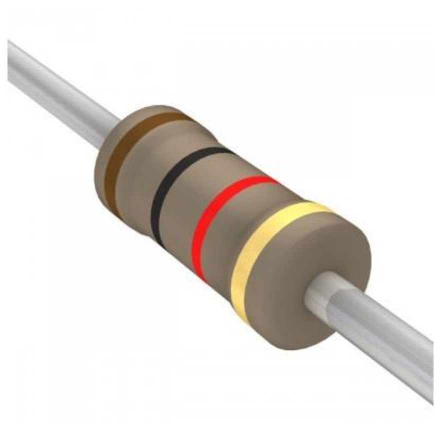


Figure 22 1k ohm 1/4w Resistor

Figure 23 10 ohm 1w Resistor

Figure 24 180 Ohm 1/4w Resistor

6. **Variable Resistor 1 mega**: In this circuit a variable resistor would be required to adjust the voltage originating from the solar panel. This resistor would be controlling the volatge and and would turn the voltage to provide a value around 6.8 volt for supplying purpose. since this is a variable resistor, the value can not be set to a fixed one.

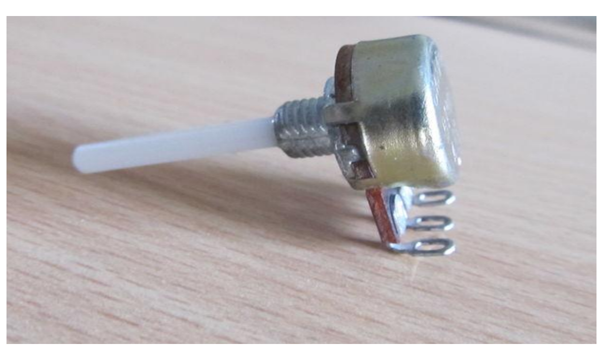


Figure 25 Variable Resistor 1 mega

7. **Zener Diode**: A Zener diode would allow current to be flowing from the anode end to the cathode terminal similar to a normal semiconductor diode, but it would also permit current to drift in the reversing direction when the Zener voltage is reached. Zener diodes are filled with a high concentration of p-n junction doping. Two types of zener diode are required in the system.

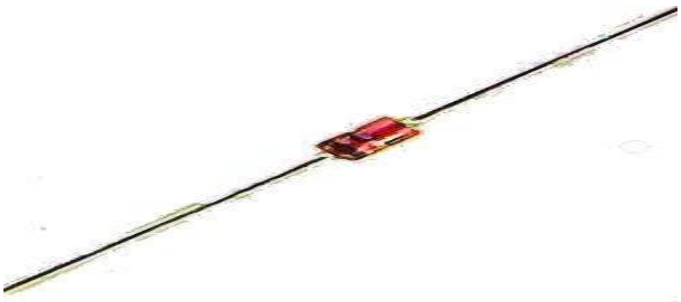


Figure 26 1N4734 Zener dioide

Figure 27 Zener 3.3V

8. A Wooden Frame: Finally, a wooden frame is required for housing compenents in a decent way and also to ensure safe movement of the components.

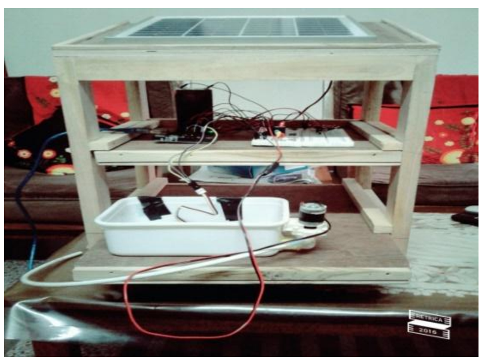
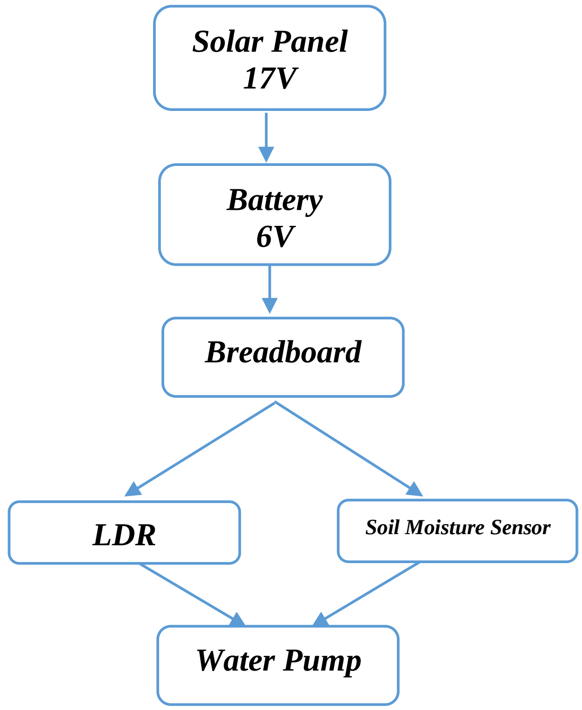


Figure 28 A Wooden Frame

3.3: System Flow Chart



3.4: Implementation

In order to carry out this mammoth task, this project had to rely on all the hardware and software components outlined in the Design phase. The description is given below:

Breadboard:

Two breadboards had to be bought – one for housing the circuit for Arduino based system, and the other one for converting sunlight into electrical energy. Both of the breadboards had the typical construction – positive (indicated by red) and negative (marked by blue) columns on both ends and in between were the columns for letting inputs for different components, namely the columns indicating a, b, c, d,e in one segment and columns f,g,h,i,j in other segments.

Arduino Uno system:

There are different types of Arduino based system but for this particular initiative, Arduino Uno was the perfect choice. The hardware section of the Arduino Uno has a number of built-in circuits and components, which had no need to tinker with. However, the main purpose of using this system was to capitalize the various Pins that had to be connected to the different electrical components. The Arduino system – in question – has a number of pins for indicating output signals.

Connection to the Arduino circuit Breadboard:

Output from Arduino System to o the Breadboard:

Pin 13 is connected to the Red LED of the LDR (Light Dependent Resistor)

Pin 12 is connected to the Yellow LED of the LDR.

Pin 11 is connected to the Green LED of the LDR.

Pin 10 is connected to the Red LED of the Soil Moisture Sensor.

Pin 09 is connected to the Yellow LED of the Soil Moisture Sensor.

Pin 08 is connected to the Green LED of the Soil Moisture Sensor.

Pin 07 is connected to the Relay, which either turns 'On' or 'Off' the circuit – acting as a Switch.

Pin 06 is being utilized as the supplier of 5V since the pin indicating the original 5V became unusable because of a broken pin got stuck inside the hole.

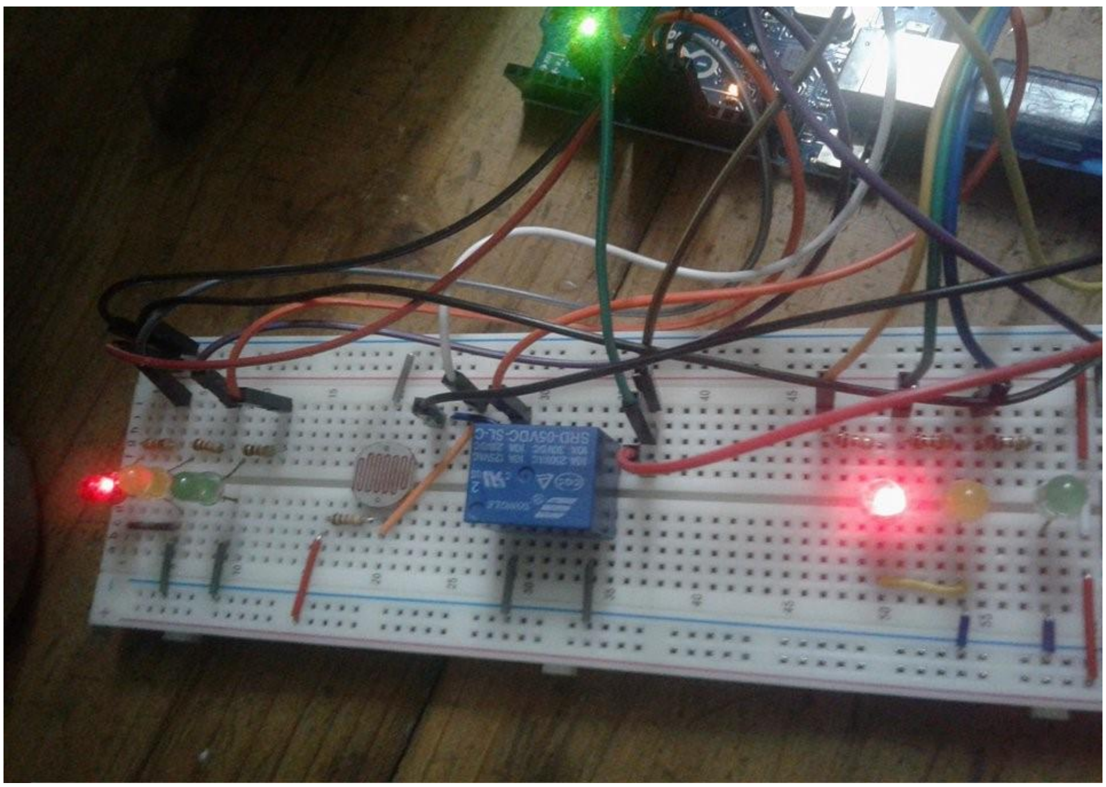


Figure 29 Pin connection in breadboard

Input into Arduino System from Breadboard and Soil Moisture Sensor:

Pin $V_{in\ gets}$ positive power connection from Breadboard's one of 'J' column pin-hole beside Relay Switch.

GND – Immediately after V_{in} pin - is connected to the Soil Moisture Sensor's GND indicating end.

GND – the next one – is connected to the Negative power supply of the Breadboard.

5V pin is damaged and unusable as stated earlier.

3.3V pin is attached to Soil Moisture Sensor, which sends the voltage signal into Arduino from its V_{cc} end.

Analog input into Arduino System:

A1 – Analog input – 1 - pin is connected to the Soil Moisture Sensor's Signal end.

A2 – Analog input – 2 – pin is connected to the column J, row 26 hole of the Breadboard – through a white wire – getting the input signal from LDR (whether it is dark or illuminated).

USB port connection:

Universal Serial Bus port in the Arduino hardware facilitates the USB Data Cable connection to the Computer, where programming on values (input-output) could be displayed.

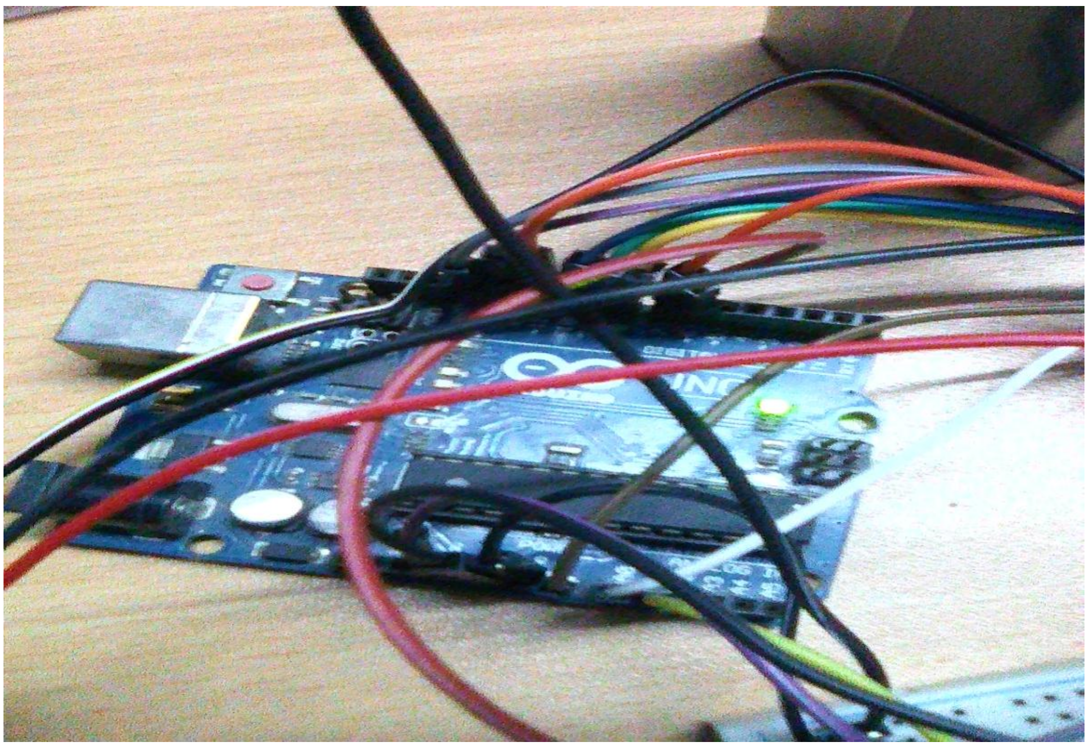


Figure 30 Arduino Uno connection

Arduino Uno Software section:

The code-file for Arduino has been saved as 'Waterpump.ino'. Below given are snapshots of the code and their short details.

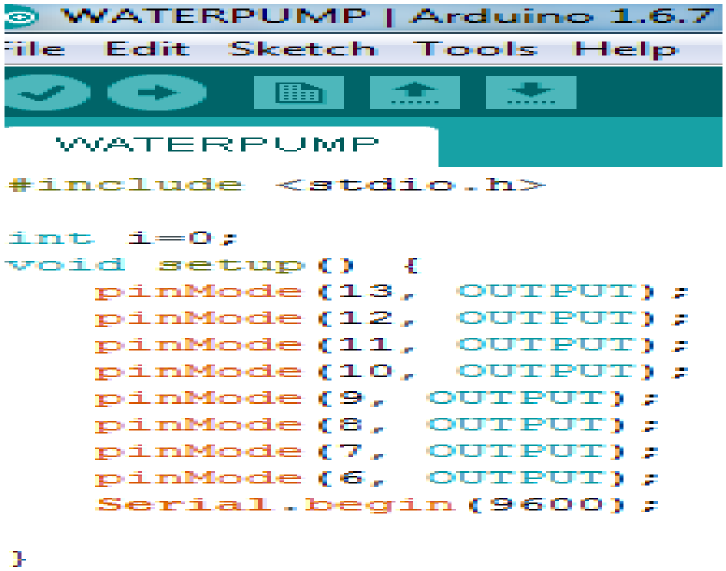


Figure 31 Water Pump code

The above figure includes the header file (stdio.h) as similar to C programs; declares and initializes the counter variable ‘i’ equals to zero; then the function (void) ‘setup’ is declared to assign pin numbers (with the keyword ‘pinmode’) of Arduino Uno circuit in order to calculate the values obtained by them. The command ‘Serial.begin’ initializes the program execution in Serial mode (since other modes are also available).

```
void loop() {

   int sensorValue = analogRead(A2);
   int moisturesensor = analogRead(A1);
Serial.print("LDR:");
Serial.print(sensorValue);
Serial.print("       Moisture:");
Serial.print(moisturesensor);
Serial.print('\n');
   delay(1000);
   digitalWrite(13, LOW);
   digitalWrite(12, LOW);
   digitalWrite(11, LOW);
   digitalWrite(10, LOW);
   digitalWrite(9, LOW);
   digitalWrite(8, LOW);
    digitalWrite(6,HIGH);
   if(sensorValue<650)
   { digitalWrite(11, HIGH);}

   if(sensorValue>=650&&sensorValue<=950)
   { digitalWrite(12, HIGH);}

   if(sensorValue>950)
   { digitalWrite(13, HIGH);}
```

Figure 32 Arduino Code 1st part

Then the program enters into another function named 'loop' (as void type). It declares an integer variable 'sensor value' and assigns the value 'analogread 'function's parameter value of 'A2'. So the value from LDR is put into that variable. Then comes another variable – of integer type-named 'moisturesensor' which gets the 'A1' parameter value of the function 'analogread'.

After that, the program goes for some printing, i.e., displaying the names of the variable/input of the system – namely, LDR and MoistureSensor values, through the calling of the function

‘Serial.print’. In order to specify the maximum value range of the inputs/outputs, a function named ‘delay’ with a value of ‘1000’ has been declared.

Next, a function named ‘digitalWrite’ was called to allocate the high/low values for the different pin numbers of the Arduino system. In this regard, pin numbers 13-08 were assigned the initial values of ‘LOW’.

The code section follows an ‘if-then-else’ loop at that time. here –

When the sensorvalue (LDR) is less than 650, the 11^{th} pin will get an output of ‘HIGH’. The Green LED of LDR will blink and would indicate that there is enough sunlight, meaning waterpump would remain stopped.

sensorvalue (LDR) going beyond 650 but not exceeding 950 would push - 12^{th} pin - Yellow LED blinked and would mean that waterpum p will keep on functioning once started but would go for a total halt if there is sunlight- indicated by Grenen LED.

When the value would exceed 950, the 13^{th} pin will be set to ‘HIGH’. It will trigger the Red LED to be blinked. This will notify the user that tthere is no light or total darkness is prevailing at that moment. As a consequence, the pump will start to function – pumping water – instantly with full swing.

```
 if(moisturesensor<50)
{ digitalWrite(10, HIGH);}

if(moisturesensor>=50&&moisturesensor<=350)
{ digitalWrite(9, HIGH);}

if(moisturesensor>350)
{ digitalWrite(8, HIGH);}

if(sensorValue>950)
{ if(moisturesensor<350)
    { digitalWrite(7, HIGH);
    }


}
```

Figure 33 Arduino Code 2nd part

For the pins numbered 10-08, the coding is done in the following way.

When the moisturesensor value is less than 50, the 10th pin will get an output of ‘HIGH’. The Red LED of Moisture Sensor will blink and would indicate that the soil is totally dry and needs water immediately which will prompt the pump to start working.

Moisturesensor value going beyond 50 but not exceeding 350 would push - 09th pin - Yellow LED blinked and would mean that water pump will keep on functioning once started but would go for a total halt if there is some wetness in the soil but still the soil needs water - indicated by Red LED.

When the value would exceed 350, the 08th pin will be set to ‘HIGH’. It will trigger the Green LED to be blinked. This will notify the user that the soil is saturated with water and hence the pump needs to be kicked off.

```
if(moisturesensor>350)
 {digitalWrite(7,LOW);}
if(sensorValue<650)
 {digitalWrite(7,LOW);}
}
```

Figure 34 Relay Code

Another ‘if’ block is set there to decide when the Relay would be on ‘On/Off’ switching mode. It runs on the logic that when the moisturesensor value goes over 350, the 7th pin would be set to ‘LOW’ – indicating that the pump should go to a halt. The same scheme is applicable for a sensorValue of less than 650.

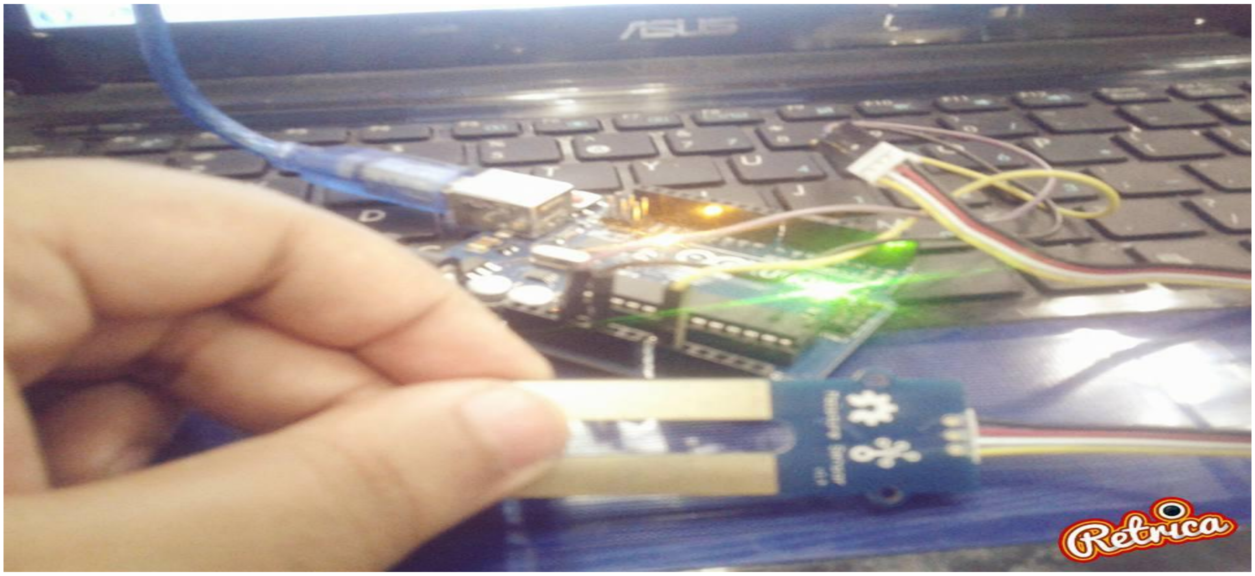


Figure 35 Arduino Uno System with Soil Moisture Sensor

<u>Arduino Based Circuit Breadboard:</u>

This Breadboard accommodates one Relay Switch, one LDR, 6 LEDs, 7 resistors, a great many wires - both male to male and male to female, jumper wires and 2 wires for connecting the battery (6V). The Relay (switch, colored Blue – shaped like a square) switch is housed in the middle (Columns d,e – f,g ; Rows 29-35) of the board. It functions at a specific value of 5V – to be 'ON' to provide power to the battery.

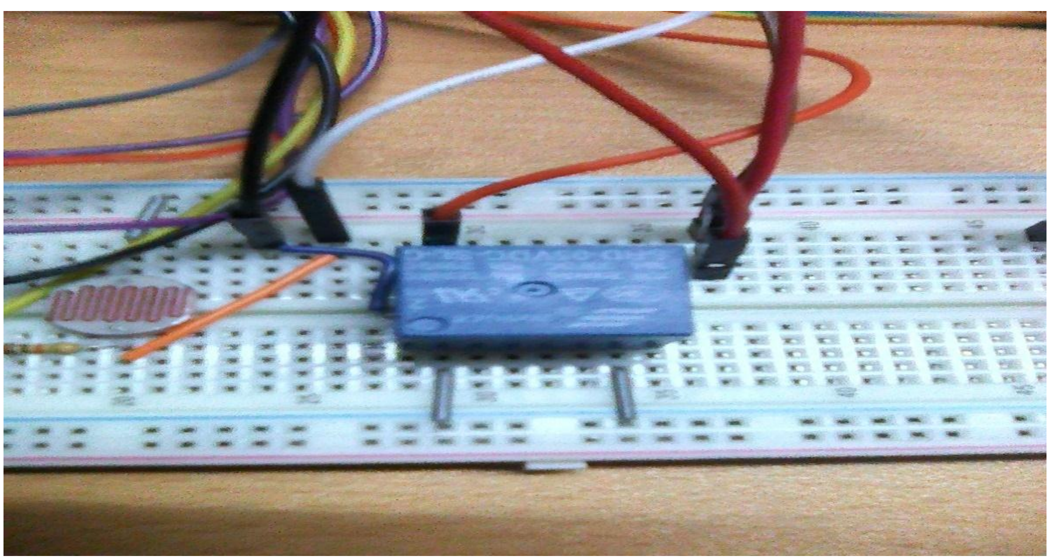


Figure 36 Relay Switch on breadboard

LDR: on the right to Relay (Columns d,e – f,g; Rows 19-21) – functions at the presence and absence of light. It gets to work at the value of 3.7V and the remaining 1.3V is taken care of by a resistor.

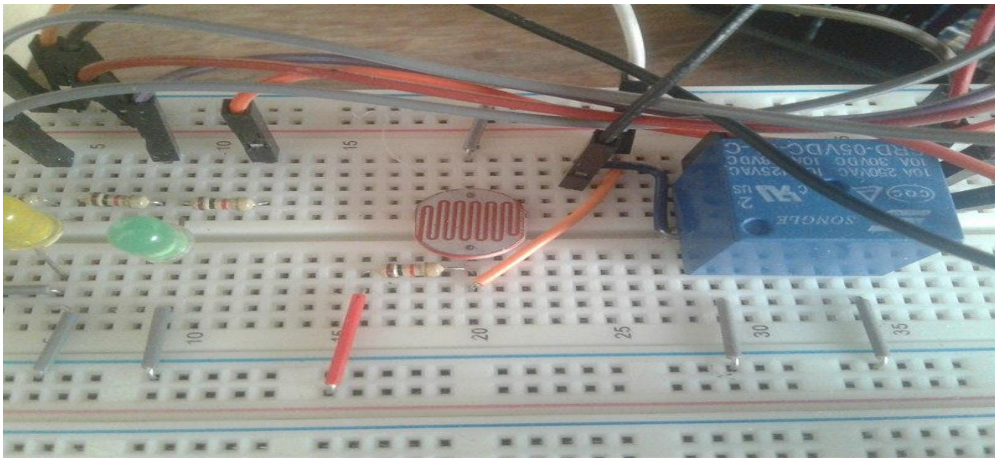


Figure 37 LDR on breadboard (Light Dependent Resistor)

LED: 6 in number - are associated with LDR and Moisture Sensor, as stated earlier. For both components, LEDs are colored in Green, Yellow, and Red. Each of them operates at 3.7V.

There are 7 resistors attached with the Breadboard – 6 for the 6 LEDs and the other one for the LDR. All the resistors function at 1.3V.

Jumper wires are inserted in the board for shorting the positive and negative ends of the power system.

Breadboard to convert the solar power into electrical power:

This breadboard accommodates 2 diodes, 1 voltage regulator, 1 variable resistor, 1 transistor, 2 Zener diodes, and 3 resistors.

The positive end of solar charge – after getting the input from the solar panel – with the wire at column, at row 43 – gets through the diode D1 IN 4007 – located at the breadboard's Column 'g', Rows 43-47.

Voltage Regulator: LM 317T - gets the positive charge input from the D1 IN 4007 diodes. this regulator controls the voltage flow of the solar panel - to 6V, where the solar panel can provide up to 17V. It is attached to a variable resistor as well as to both a diode and a resistor at its output end.

Variable resistor: Its 2 pins are inserted at column 53 and 55 at row e while the opposite pin is located at column 54, row f. this resistor would aid the voltage regulator in controlling the voltage flow within the circuit as we need 6 volts from a 17volt solar panel source.

The transistor: BC548 – has its pins located at columns 55, 56, 57 and at row h. this setting facilitates in calculating the current flow – how high or low the value is.

Zener diode: 2 in number were used to since a single 7.5 volt such diode was not available and the duo provided values of 3.3volts each. One of the Zener diode is located at column a row 57 and 42 while the other one is at column c, row 40 and column g, row 35. Both will be working in tandem to maintain the 6v value for the circuit.

Diodes: One of them is at column g, row 47 and 43; the other one at row i, column 48 and 40. Resistors – the 180ohm is located at column j, row 57 and column I, row 48; 1kohm at column b, row 57 and column f, row 56; 10ohm resistor is housed at column i, row 40 and 35.

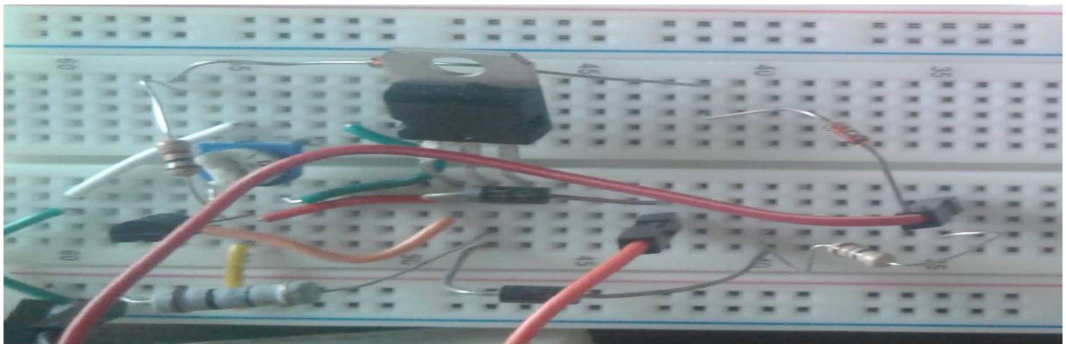


Figure 38 Solar Panel Circuit

Water pump: It is attached at the bottom of one end of a large plastic box that can contain 3.9 liter of water made from Bengal Plastics – one of the leading brands in Bangladesh, a narrow 24 inches (36 centimeters) long pipe with 1 cm radius is connected for flowing water to soil.

Figure 39 Water Pump with pipe

Wooden frame: The frame contains 2 shorter legs – 14 inches long – in front and 2 hind legs – 16 inches each. It has 3 wooden surface – the bottom one 14 inches long, the top 2 12 inches each. The top one is sloped from behind towards front at an angle of 45 degrees. The bottom 2 surface can be pulled out. The wood used was – Mehogoni, Kerosine, Shegun, hardboard.

Figure 40 Wooden Frame Structure

3.4 Breakdown of Cost

- Arduino Uno - 850 tk
- Moisture Sensor – 450 tk
- Breadboard – 400 tk
- LED – 200 tk
- Resistors – 100 tk
- Relay –100 tk
- LDR – 70 tk
- Cables – 200 tk
- Solar Panel- 600 tk
- Voltage Regulator Circuit- 30 tk
- Diodes- 28 tk
- Transistor Switch- 22 tk
- Multimeter- 750 tk
- Wooden Frame- 1800 tk

Total – 5500 tk

Chapter 4: Results and Discussion

4.1 Water Need Calculation

The water need calculation of crops is the amount of water that is required to meet the evapotranspiration rate so that crops may thrive. The evapotranspiration rate is the amount of water that is lost to the atmosphere through the leaves of the plant, as well as the soil surface.

Evapotranspiration (ET) is the sum of evaporation and plant transpiration from the Earth's land and ocean surface to the atmosphere. Evaporation accounts for the movement of water to the air from sources such as the soil, canopy interception, and water bodies. Transpiration accounts for the movement of water within a plant and the subsequent loss of water as vapor through stomata in its leaves. The crop water need always refers to a crop grown under optimal conditions, i.e. a uniform crop, actively growing, completely shading the ground, free of diseases, and favorable soil conditions (including fertility and water). The crop thus reaches its full production potential under the given environment. The crop water need mainly depends on the climate, crop type and growth stage of the crop.

In order to estimate the water requirement of a crop we first need to measure the evapotranspiration rate. The reference rate, ET0, is the estimate of the amount of water that is used by a well-watered grass surface that is roughly 8 to 15 centimeters in height. Once ET0 is known, the water requirement of the crop can be calculated. There are few methods that can be used to measure or predict the evapotranspiration rate of crops:

1. Evaporation pan: In this method, pan is filled with water and the loss of water from the pan is measured. Provided that there is no rainfall, the evaporation rate, which is recorded as millimeters per day, is quite easy to measure. This method of measurement takes into account wind, temperature, radiation and humidity, which are the same factors that affect crop transpiration rate.

However, there are a few factors that prevent this recording from being entirely accurate. For one, the solar radiation results in heat storage in the pan. This can lead to increased reading of the evaporation rates at night, when transpiration usually does not occur. In addition, temperature and humidity levels above the pan surface will vary from what would naturally occur.

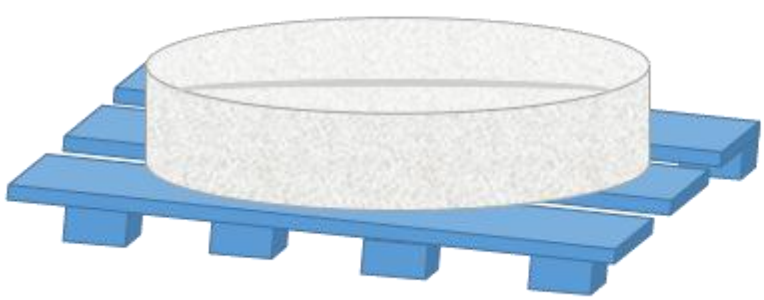


Figure 41 Evaporation Pan

In this method, different kinds of pans are used to measure the water requirements of crops, with Kp representing the pan coefficient, according to the kind of pan, solar radiation, wind, humidity and the surroundings.
ETO = K pan × E pan

2. The Penman-Monteith Equation: The reference rate, ET0, is calculated using the Penman Equation, which takes into account the climatic parameters of temperature, solar radiation, wind speed and humidity.
A variation of this equation, published by the FAO is:

$$ET_o = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T+273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34 u_2)}$$

Where
ETo reference evapotranspiration [mm day-1],
Rn net radiation at the crop surface [MJ m-2 day-1],
G soil heat flux density [MJ m-2 day-1],
T air temperature at 2 m height [°C],
u2 wind speed at 2 m height [m s-1],
es saturation vapour pressure [kPa],
ea actual vapour pressure [kPa],
es - ea saturation vapour pressure deficit [kPa],
D slope vapour pressure curve [kPa °C-1],
g psychrometric constant [kPa °C-1].

ET0 represents the maximum, or potential, evapotranspiration rate that can occur. However, the water requirement of the crop is usually less than ET0, as there are factors of the crop itself that have to be taken into account.
These include the growth stage of the plant, the leaf coverage that provides shade to the ground, and other particulars of the crops that make them vary from each other. With these factors taken into account, ET0 is converted into ETc, through the crop-specific coefficient, Kc.
ETc represents the evapotranspiration rate of the crop under standard conditions (no stress conditions).
When calculating ETc, one must identify the growth stages of the crop, their duration and select the proper Kc coefficient that need to be used.
ETc = Kc*ET0.

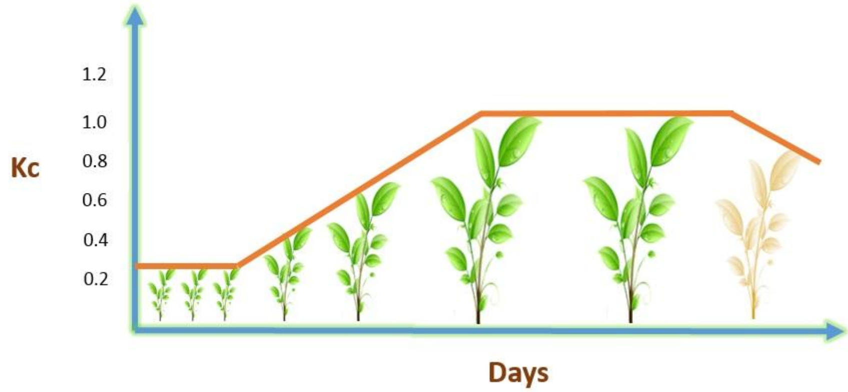


Figure 42 Kc Calculation

Climatic effects are incorporated into ET0, while the effect of the crop characteristics is incorporated into Kc.

4.2 Solar Panel Rating

The Formula which is used here is to charge the battery

$$P = IV$$

$$\text{Here, } P = 5W$$

$$V = 17V$$

$$I = P/V$$

$$= 5/17$$

$$= 0.29A$$

The battery is charged with 0.29A per second

Maximum time needed to charge the battery fully = (4.5*60*60)/ (0.29*60*60) = 15.517h

This is the solar panel rating.

4.3 Water Pump Rating

Volume of water container= 3.9L

Time needed for emptying the whole water container=95 seconds

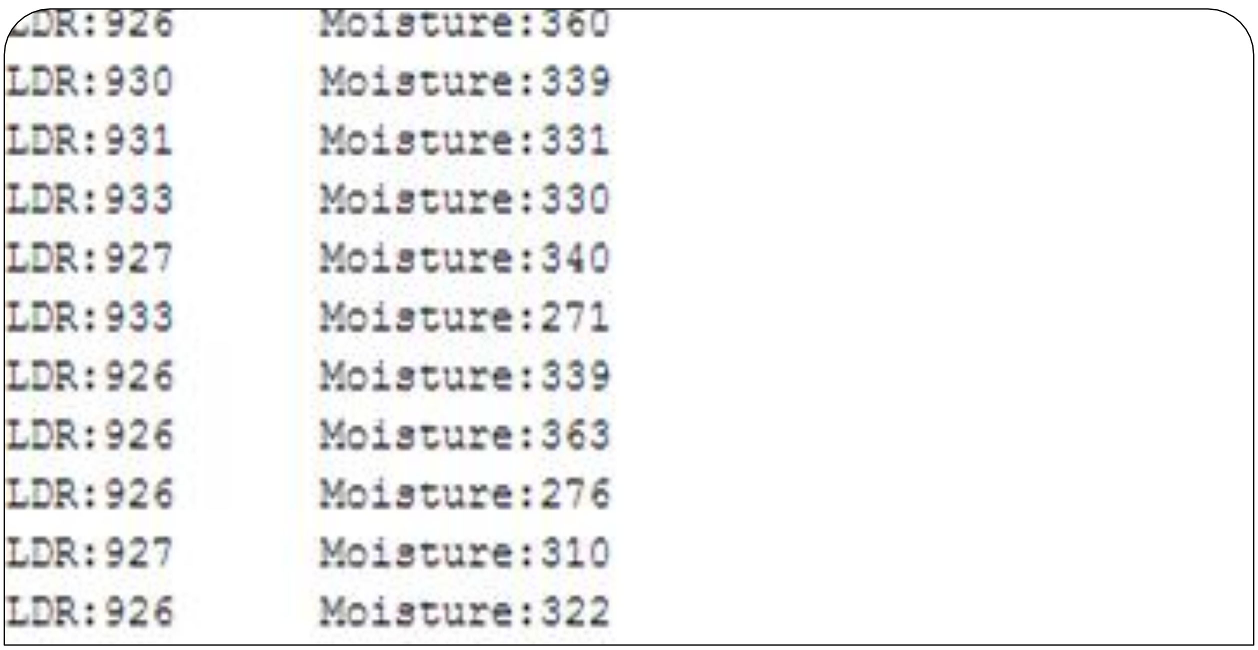
Maximum time for pumping with battery until charge completely depleted

= 300 minutes (18000 sec)

Total amount of water pumped during this time = (3.9 * 18000) / 95 {(L * S) / S}

= 739 L (approx.)

HENCE, pumping rate of the pump = (3.9*3600)/95= 147.79L/H



```
LDR:926        Moisture:360
LDR:930        Moisture:339
LDR:931        Moisture:331
LDR:933        Moisture:330
LDR:927        Moisture:340
LDR:933        Moisture:271
LDR:926        Moisture:339
LDR:926        Moisture:363
LDR:926        Moisture:276
LDR:927        Moisture:310
LDR:926        Moisture:322
```

Figure 43 LDR and moisture sensor values

Chapter 5: Design impacts

As with every system, our one also exerts influence on different aspects of life. This impacts range from environmental, economic too social, health, cultural and so on. Below we highlight various facets of the impacts our system is associated with.

5.1 Environmental Impact

Through the use of solar driven irrigation system, environmental risks can be reduced; the side effect of applying fertilizer and pesticides can be minimized, soil erosion could be prevented. Through irrigation, water is drawn from groundwater, rivers, and lakes or even from flow on overland, and then is distributed over a region. Hydrological, or direct, impacts of providing water this way include drop in downstream river current, rise in evaporation in the places of irrigation, heightened mark in the water table since groundwater recharge in the place is enhanced and flow surge in the irrigated fields. In the same way, irrigation is associated with having an immediate consequence on the allocation of moisture to the atmospheric domain, thus induction in the atmospheric volatilities and helping to grow downwind rainfall, along with a situation where the atmospheric circulation is modified, causing delivery of rain to dissimilar downwind expanses. Intensifications or declines in irrigation are a key area of concern in this project. A great number of environmental advocates are of the conviction that energy systems utilizing natural resources, like water, solar or wind to generate power produce little carbon dioxide emissions once they are installed and hence have zero contribution to climate changing extravaganza. On top of that, unlike the nuclear and oil industry, almost all of the renewable energy systems are not part of the destructive forces presenting hazardous byproducts and waste which can immensely put an ecosystem in peril.

5.2 Economic impact

In various ways, the utilization of solar energy can help to stimulate the economy of the areas in question. Improvement occurs with crop production at a low cost in relative term, efficiency in yield of crop achieved in a short time interval and makes way for competition with contenders in the market. With such irrigation scheme, farms with availability of training and various forms of support enter a highly integrated system within the crop-based systems of rice, vegetables, and other crops where livestock, poultry, and ponds are also members of the domain. Human beings' capability for extracting and utilizing fossil fuels has been the driving force for technological and industrial advancement that has propelled unparalleled socioeconomic opulence in many areas of the globe. Although proponents of non-renewable energy systems claim that fossil fuels remain to be much more economically viable than renewable energy sources, environmental activists and establishments such as the United Nations point out that sustainable energy can also have constructive economic bearings. The price of renewable energy sources is not as susceptible to market vacillations as oil or natural gas; solar or wind-powered systems are proficient in delivering energy to emerging or less reachable areas, which may not possess the financial options or setup to exploit fossil fuels. Also, manufacturing solar energy entails frugality compared to burning fossil fuels - the traditional approach adopted for generation of electricity. Besides, specialists envisage that growing venture in renewable energy systems will continue to contribute to creating thousands of jobs globally. It is a fact that cities or organizations going for building and operating solar energy installations often aids in creating abundant jobs. For instance, workers are required for planning the project, developing and implementing the project, building the solar energy plant, managing the equipment and operating the facility. Thus, a good number of new jobs can be created for workers due to the using of solar energy amenities for generating electricity within the zone, and this would, consequently, assist in reduction of the unemployment rate within the region. With growing number of people in a position to find earning opportunity as a consequence of the rising higher figure for job being created by the progress and functioning of solar energy panels, greater number of individuals would be able to expend money for the contribution to the nation's economic drive. Be it businesses or the domestic setting, decision to use solar energy to provide electricity powering the electrical devices there, electric bills could be substantially slashed when compared with the exploitation of energy obtained from fossil fuels. Over a prolonged duration, the financial saving of inexpensive electric bills can become quite substantial, which can enable households and businesses to contribute to the economy by injecting more cash. And important issue is the fact that oil plays a major role in determining the global powers' role in international politics. The price of oil impacts the balance of world economy and power. People pay a higher tax to sustain the oil-based economy and governments become more concerned about maintaining their respective political interest, which may sometimes lead to wars terrorism and many hidden conflicts. If dependence of oil and fossil fuel can be minimized by relying more on solar power, the world would be free from many vices. It is a major gain for the global humanity, who are at times torn apart by the race to dominance in the world stage by the superpowers.

5.3 Health

When energy is generated from solar panels, emission of polluting particles into the air are very little; hence, solar energy becomes relatively cleaner a source of energy compared with the fossil fuel derived energy. Regions adopting the use of solar energy to power the infrastructure would thus be blessed with a pure quality of air in the atmosphere, which would in consequence can ensure the inhabitants and working people in the vicinity to enjoy a sound and stable health. Furthermore, studies have pointed out, with a little argument, that fossil fuels are burnt, it contributes to global warming phenomenon. However, since emission of hazardous elements into the air from solar panels amount to very insignificant in figure, solar energy has less damaging impact on the atmospheric degradation or global warming exacerbation – marked by events such as rising of sea levels and storms being intense in recent times.

5.4 Social Impact

1. COMFORT: The user of a solar powered pump based irrigation system has to spend very little time for overseeing the pump's activity since it starts and stops automatically. So being freed from the anxiety, he/she can devote more time to him/her and lead a comfortable social life.
2. CONSERVATION: such a person becomes a conscious citizen by contributing to the conservation of natural resources and pollution free environment.
3. SAFETY: no tension of oil spill or obnoxious gases from the solar pump ensures safety for all unlike that from fossil fuel.
4. SUSTAINABILITY: it is always comforting to know that this energy is practically infinite.
5. HEALTH: in a pollution free surrounding, individuals can enjoy a healthy life which would make them socially more engaging to community works.
6. WEALTH: being cost-effective, solar schemes would eventually lead to greater saving of money and brighten up households' financial outlook.

Due to the varying economic and environmental impacts of renewable energy systems, the increased use of sustainable power will likely have significant social consequences too. For example, the widespread use of renewable energy systems may lead to increasing or decreasing employment rates in certain regions, depending on their industrial base and whether they are completely reliant on fossil fuels. Other social impacts could include increased consumer choice regarding a household's energy supplier; changing political relations internationally as certain nations end their reliance on others for energy; and expected improvements in health, as more and more citizens are no longer exposed to hazardous wastes and emissions associated with fossil fuels.

Chapter 6: Future work

Although the present system is a major improvement compared to the previous attempts at addressing irrigation obstacles, some of the issues are there which can be polished or fine-tuned in future to attain the optimum goal in agriculture through irrigation. One of the key areas of concern in this regard is the volumetric water control issue. It becomes a consideration since uniformity in distribution, principally when irrigating surface, turns out to be an essential part in attaining precise water applications. This is because performance of sprinkler and drip irrigation systems turns out to be robustly reliant on the qualitative aspect of design and materials chosen. Inadequacy in management and presence of variability in pressure are other principal sources of poor performance of such potentially proficient approaches. Moreover, restricting flow in delivery in surface irrigation systems originating from rotation, preset deliveries and discharges from unfamiliar sources are the main limiting factors in initiating exact field applications and irrigation arrangement in such systems. Another important facet of the topic is how the field is evaluated for irrigation performance since it is a crucial means to enhance managerial issues and introducing irrigation methods into schedule. Irrigation scheduling simulation models ought to provide proper focus to the kind of irrigation and pointing out the difference in schedules in connection to the irrigation approach adopted. Besides, producing programmers for field assessment onsite is pertinent in order to improve both irrigation scheduling as well as methods for applying water. For introducing a better customizable water supply for surface system, farming individuals need the opportunity to exercise regulation of water flow destination channels. By modernizing supply system, along with fine-tuned scheduling scheme, where considered are the particular requirements and constraints attribute by field irrigation scheme. Lastly, it will be a revolutionary approach if the solar panel installed on the field can be made rotatory – if it can move according to the direction of the sun on the sky.

Chapter 7: Conclusion

Bangladesh, being blessed with the rich fertile soil and the apparent lack of industrialization finds itself under obligation to put its best efforts for having a high yield in crop production. Although the increasing population baffles as well as thwarts all the ongoing initiatives for both the government and private sector individuals, the deficiency in applying the up-to-date technology or failing to orientate the farmers to smarter farming mechanism is a reality impossible to overlook or deny. The discussion herein has clearly demonstrated the role of irrigation in determining the optimum output from the agriculture. The uneven rain distribution throughout the year, coupled with the high demand of water for many crops during the dry season is a reality we have to deal with. Rather than cursing the nature, the best approach would be to employ the blessing of innovation where our proposed system can be a milestone. It will take a considerable timeframe to enable farmers free from the clutches of the political manipulation of economic system. The farmers – even the better-off ones - find a larger share of their profits being eaten up by fossil fuel that power up the pumps for irrigation. Apart from the environmental pollution and health impacts, the economic strain caused by the huge amount of money spent on fossil fuel is a serious matter of concern. The dependence on sunlight-practically an infinite source of energy – would be a major turning point for the farmers as this is the very element that enhances the thirst of water during dry season and now harnessing that power for lifting water from the subsurface level actually compensates the damage triggered by this natural force. Although the charging time of the solar panel suggested by our system may seem a little lengthy in modern day standard, by employing larger solar panels and batteries with high wattage along with the powerful pump – though our miniature pump can already let approximately 700 liter of water flow into the soil and it is an enviable amount by any standard – can ensure a huge yield in crop production under the setting. Apart from the pump, solar panel and battery, the rest of the components are not going to put any stress on even the poorest of farmers and again, the cost is just one-time investment. Most of the components are durable and if farmers can go for co-operative approach, they will be thriving for unprecedented economic progress and may no longer be reliant on others for loan since the cost of fossil fuel compels them to be manipulated by the opportunity seekers in the rural areas.

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