IOT BASED SOLAR POWERED AGRIBOT FOR IRRIGATION AND FARM MONITORING

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Abstract—
India has always been an agriculture-dependent nation. This system proposes an advanced IOT based farming approach suited to Indian cultivation practices. This system focuses on smart irrigation as this model applies the IOT and Data Science technologies. It is an implementation of real-time analytics of the collected data which automates the entire farming process.The cloud system scraps the required data from the metrological center and compares it with the on-field data set. It also provides a Mobile application that helps the farmer to track the developments occurring throughout the field.The proposed system is highly efficient and economically feasible.The following objectives were accomplished with the above idea: To reduce human interference and encourage precision agriculture. To minimize water loss and to maximize the efficiency of water used. To charge battery incorporated in Agri-bot using solar panels. To enable remote farm monitoring system and ensure proper irrigation.

Keywords— IOT, Solar power, agriculture, Data Science, Sensors, components, Agri-bot, automation, irrigation, water, soil condition, micro controllers, mobile application, ploughing, seedling, watering.

An automatic irrigation system does the operation of a system without requiring manual involvement of persons. Every irrigation system such as drip, sprinkler and surface gets automated with the help of electronic appliances and detectors such as computer, timers, sensors and other mechanical devices.
85%)

EASE OF USE

1.1 Ditch Irrigation

Ditch Irrigation is rather traditional method, where ditches are dug out and seedlings are planted in rows. Siphon tubes are used to move the water from the main ditch to the canals.

1.2 Terraced Irrigation

This is a very labor-intensive method of irrigation where the land is cut into steps and supported by retaining walls. The flat areas are used for planting and the idea is that the water flows down each step watering each plot. This allows steep land to be used for planting crops.

1.3 Drip Irrigation

This is known as the most water efficient method of irrigation. Water drops right near the root zone of a plant in a drip- ping motion. If the system is installed properly, you can steadily reduce the loss of water through evaporation and runoff.

1.4 Statement of the Problem

The aim of this project is to build an automatic plant irrigation system that sense soil moisture using microcontroller.

The following are objectives of the studies:

- ✓ To reduce human interference and ensure proper irrigation
- ✓ To minimize water loss and to maximize the efficiency of water used
- ✓ To prevent over labour of the pumping machine and prevent it from getting bad or burned

The following aspects were considered in the choice of a design solution:

i. Installation costs;
ii. Water savings;
iii. Human intervention;
iv. Reliability;
v. Power consumption;
vi. Maintenance;
vii. Expandability.

1.5 Justification of the Work

The increasing world population has lead to exponential increase in food demand. This event has necessitated the need for more land to be cultivated. Due to change of weather patterns brought about by global warming, irrigation remains as the only reliable method of crops production. With more and more land now being under irrigation there is a need for optimal use of water.

Over the last few years knowledge in electronics and computation has been used to solve present day challenges. In the forefront of the electronics revolution has been the microcontroller. The microcontroller has been used together with various sensors to measure and control physical quantities like temperature, humidity, heat and light. By controlling these physical quantities using the microcontroller; automatic systems have been achieved.

Irrigation systems in crop production can and has also been automated. This solves the challenge brought about by the unreliability of climate changes thus need for water optimization. Automation of the soil moisture sensor irrigation systems is one of the most convenient, efficient and effective method of water optimization. The systems helps in saving water and thus more land can be brought under irrigation. Crops grown under controlled conditions tend to be healthier and thus give more yields. Controlled watering system results in reduction of fertilizer use and thus fertilizer costs go down.

1.6 Scope of the Study

This project involves the evolution of water in manually to watering automatically. The controlling of the automatic watering system is use in a house, institution or any organization with flowers planted for decoration. Sensor used to control the watering system is soil moisture sensor. Other than that, this system should also monitor the water level.

1.7 Significance of the Study

The continuous increasing demand of food requires the rapid improvement in food production technology. In a country like Nigeria, where the economy is mainly based on agriculture and the climatic conditions are isotropic, still we are not able to make full use of agricultural resources. The main reason is the lack of rains & scarcity of land reservoir water. The continuous extraction of water from earth is reducing the water level due to which lot of land is coming slowly in the zones of un-irrigated land. Another very important reason of this is due to unplanned use of water due to which a significant amount of water goes to waste. This problem can be rectified if we use microcontroller based automated irrigation system in which the irrigation will take place only when there will be acute requirement of water.

1.8 Advantages of the System

i. **Saves water**- Studies show that drip irrigation systems use 30-50%lesswaterthan convention a watering methods, such as sprinklers.
ii. **Improves growth**- smaller amounts of water applied over a longer amount of time provide ideal growing conditions. Drip irrigation extends watering times for plants, and prevents soil erosion and nutrient runoff. Also, because the flow is continuous, water penetrates deeply into the soil to get well down into the root zone.
iii. **Discourages weeds**- Water is only delivered where it's needed.
iv. **Saves time**- Setting and moving sprinklers are not required. A timer delay as per environment can be added to the system for automatic watering.
v. **Helps control fungal diseases**, which grow quickly under moist conditions. Also, wet foliage can spread disease.
vi. **Adaptable**- A drip irrigation system can be modified easily to adjust to the changing need sofa garden or lawn.
vii. **Simplest Method**- Start by drawing a map of your garden and yard, showing the location of plantings. Measure the distances required for lengths of hose or plastic tubing to reach the desired areas.

1.8.1 Others Advantages

✓ Highly sensitive
✓ Works according to the soil condition
✓ Fit and Forget system
✓ Low cost and reliable circuit
✓ Complete elimination of manpower
✓ Canhandleheavyloadsupto7A
✓ System can be switched into manual mode when ever required

1.8.2 Area of Application

- Roof Gardens
- Lawns
- Agriculture Lands
- HomeGardens

1.9 Motivation

The increasing demand of the food supplies requires a rapid improvement in food production technology. In many countries where agriculture plays an important part in shaping up the economy and the climatic conditions are isotropic, but still we are not able to make full use of agricultural resources. One of the main reasons is the lack of rains & scarcity of land reservoir water. Extraction of water at regular intervals from earth is reducing the water level as a result of which the zones of un-irrigated land are gradually increasing.

Also, the unplanned use of water inadvertently results in wastage of water. In an Automated Irrigation System using ATMega328, the most significant advantage is that water is supplied only when the moisture in soil goes below a pre-set threshold value. This saves us a lot of water. In recent times, the farmers have been using irrigation technique through the manual control in which the farmers irrigate the land at regular intervals by turning the water-pump on/off when required. This process sometimes consumes more water and sometimes the water supply to the land is delayed due to which the crops dry out. Water deficiency deteriorates plants growth before visible wilting occurs. In addition to this slowed growth rate, lighter weight fruit follows water deficiency.

This problem can be perfectly rectified if we use Automated Irrigation System in which the irrigation will take place only when there will be intense requirement of water, as suggested by the moisture in the soil.

1.10 Outline

This study comprises of five different chapters arranged sequentially. Chapter one gives a brief history of the various forms of locks and their technological advancements. Chapter two explains the operating principles of the various stages involved in the digital combination lock using microcontroller. In chapter three, the design and implementation of the whole project work is discussed fully. Chapter four presents the results and discussions drawn from tests performed on the system, while lastly; Chapter five gives a conclusion and recommendation on the entire work.

2.1 Automatic Irrigation System

An automatic irrigation system does the work quite efficiently and with a positive impact on the place where it is installed. Once it is installed in the agricultural field, the water distribution to crops and nurseries becomes easy and doesn't require any human support to perform the operations permanently. Sometimes automatic irrigation can also be performed by using mechanical appliances such as clay pots or bottle irrigation system. It's very hard to implement irrigation systems because they are very expensive and complex in their design. By taking some basic points into considerations from experts' support, we have implemented some projects on automatic irrigation system by using different technologies.

In this article, we are describing about three types of irrigation systems that work automatically and each system is an advancement of the previous one as we go from first system to the next, and so on. The automatic irrigation system on sensing soil moisture project is intended for the development of an irrigation system that switches submersible pumps on or off by using relays to perform this action on sensing the moisture content of the soil.

Soil electrical conductivity is simply measured using two metal conductors spaced apart in the soil except that dissolved salts greatly alter the water conductivity and can confound the measurements. An inexpensive fix is to embed conductors in a porous gypsum block which releases calcium and sulphate ions to swamp the soil background level of ions. The water absorbed by the block is correlated with soil water potential over the range -60 to -600 kPa providing a tertiary indicator for use in medium to heavy soils. Non-dissolving granular matrix sensors are now available with a more exacting specification for the range 0 to -200 kPa and use internal calibration methods to offset variations due to solutes and temperature.

Methods for exploiting soil dielectric properties actually measure proxy variables that more or less include a component due to the soil electrical conductivity and are thus inherently sensitive to variations in soil salinity and temperature as well as water. Measurements are also affected by soil bulk density and the proportion of bound and free water determined by the soil type. Nevertheless, good accuracy and precision can be achieved under specific conditions and some sensor types have become widely adopted for scientific work.

2.2 Functional Description of Sensor

1. For conversion of change in resistance to change in voltage, the sensor is connected with a 200kΩ resistor in series to form a potential divider arrangement.
2. It gives a voltage output corresponding to the conductivity of the soil. The conductivity of soil varies depending upon the amount of moisture present in it. It increases with increase in the water content of the soil. **The higher the water contents of the blocks, the lower the electrical resistance**.

3. The voltage output is taken from the output terminal of this circuit. The moisture sensor is immersed into the specimen soil whose moisture content is under test.

The soil was examined under three conditions:

1. Dry condition:

The sensor is placed in the soil under dry conditions and embedded up to a fair depth of the soil. In dry condition, as there is no conduction path between the two copper leads the sensor gives a high resistance value (nearly 700 kΩ). The voltage output of the potential divider in this case ranges from 2.2 V to lower optimum level (3 V).

2. Optimum condition:

When water is added to the soil, it percolates through the successive layers of it and spreads across the layers of soil due to capillary force. This increases the moisture content of the soil. Thus a conductive path is established between the two copper leads. This leads to a decrease in resistance of sensor. The optimum condition of the soil can be set manually depending on the type of soil.

3. Excess wet condition:

With the increase in water content beyond the optimum level, there is drastic increase in the conductivity of the soil and the sensor resistance is further decreased to around 50kΩ. The voltage output of the potential divider in this case ranges from upper optimum level 5V to 10V.

In general, conversions from raw sensor readings to volumetric moisture content or water potential using secondary or tertiary methods tend to be sensor or soil specific, affected or precluded at high salinity levels and dependent on temperature. Research-grade instruments typically have laboratory measured accuracy worse than +/- 4% when relying on factory settings or as good as +/- 1% when calibrated for the specific soil. Sensors based on the TDR method seem to require least calibration but may be unsuitable for soils with very high salinity or clay content. There are no comparable laboratory specifications for granular matrix sensors, possibly because they are technically more difficult to calibrate, their response times are relatively slow and the output is hysteretic for wetting and drying curves.

Soil dielectric measurement is the method of choice for most research studies where expertise is available for calibration, installation and interpretation, but scope for cost reduction through sensor multiplexing is limited due to the possibility of stray capacitances. A lower manufacturing cost is possible through development of application specific integrated circuits (ASICS), though this requires a high level of investment. Multiple sensors are required to provide a depth profile and cover a representative area, but this cost can be minimized through use of a computer model to extend the measurements in a predictive way. Thus, by using the moisture sensors, the over-riding factor will be reliable, cost- effective sensors and electronic systems for accessing and interpreting the data.

2.3 ATmega328P Features:

i. 28-pin AVR Microcontroller
ii. Flash Program Memory: 32 Kbytes
iii. EEPROM Data Memory: 1 Kbytes
iv. SRAM Data Memory: 2 Kbytes
v. I/O Pins: 23
vi. Timers: Two 8-bit / One 16-bit
vii. A/D Converter: 10-bit Six Channel
viii. PWM: Six Channels
ix. RTC: Yes, with Separate Oscillator
x. MSSP: SPI and I^2C Master and Slave Support
xi. USART: Yes
xii. External Oscillator: up to 20MHz

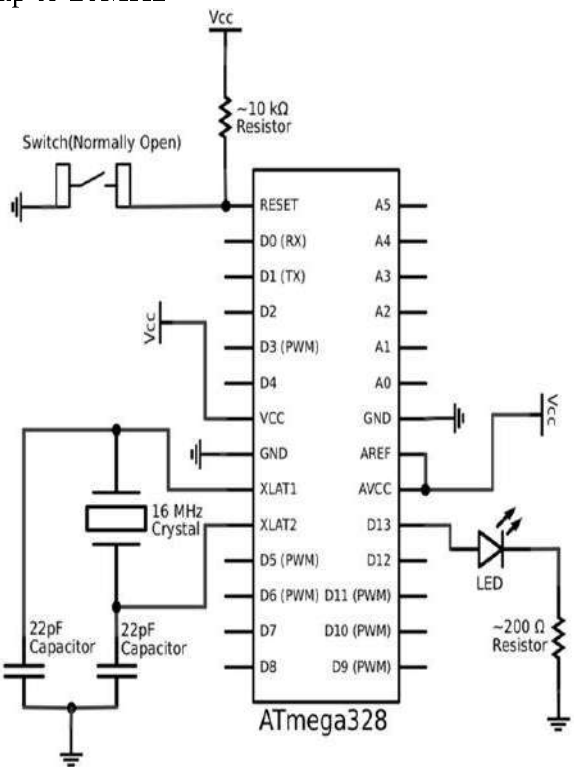

Figure 1 ATMEGA 328 (Pin Configuration)

2.4 Water Pump

The water pump is used to artificially supply water for a particular task. It can be electronically controlled by interfacing it to a microcontroller. It can be triggered ON/OFF by sending signals as required. The process of artificially supplying water is known as pumping. There are many varieties of water pumps used. This project employs the use of a small water pump which is connected to a H-Bridge.

ISSN: 0972-2750
Vol-11 Issue-01 No.01: Dec 2021

Figure 2 Water Pump

The pumping of water is a basic and practical technique, far more practical than scooping it up with one's hands or lifting it in a hand-held bucket. This is true whether the water is drawn from a fresh source, moved to a needed location, purified, or used for irrigation, washing, or sewage treatment, or for evacuating water from an undesirable location. Regardless of the outcome, the energy required to pump water is an extremely demanding component of water consumption. All other processes depend or benefit either from water descending from a higher elevation or some pressurized plumbing system.

2.5 Transistor

A transistor is a semiconductor device used to amplify and switch electronic signals and electrical power. It is the modern miniature semiconductor equivalent of the harmonic value and was invented in 1947 by Bardeen, shocking at USA. Transistors are packaged as separate and discrete-component. There are two basic types of transistors, the bipolar junction transistor (BJT) and Field Effect transistor (FET)

It is composed of semiconductor material with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals changes the current flowing through another pair of terminals. Because the controlled (output) power can be higher than the controlling (input) power, a transistor can amplify a signal.

From the project in study, the type of transistor used belongs to the class of bipolar junction transistor. Bipolar transistor consists of three pieces of semiconductor material Sandwiched together known as base, collector and emitter. It is known as a three-terminal device. The Bipolar junction transistor (BJT) can be sub-grouped into:

NPN is one of the two types of bipolar transistors,
Carrying such currents requires a large junction area so that the forward resistance of the diode is kept as low as possible. Even so the diode is likely to get quite warm. The black resin case helps dissipate the heat.

The resistance to current in the reverse direction (when the diode is "off") must be high, and the insulation offered by the depletion layer between the P and N layers extremely good to avoid the possibility of "reverse breakdown", where the insulation of the diode fails due to the high reverse voltage across the junction.

Figure 3 Hardware Setup

Figure 4 Operation of the Hardware setup showing soil wet condition and status of the pump in OFF condition

3. Discussion

In this design, not all benchmark elements have been fully studied and tested. This was mostly due to time constraints. However, the following observations were made:

i. The installation of the automated irrigation system is very simple. No technician is required. An installation manual should be provided to the user as well as a chart of the water needs of common houseplants and a list of compatible soil types. The pipe network should also be easy to set up. A tank and a compatible pipe may be included or recommended by the manufacturer. More elaborate work may be required to connect the valve to the water mains.

ii. Water savings have not been studied for the system as a whole. Nevertheless, the performance of the geo textile and of the moisture probe has been demonstrated by previous experiments in real agricultural contexts.

iii. An experiment showed that it is difficult to maintain a constant soil moisture level with only human feedback. In the short periods over which this system has been tested, virtually no human intervention was required. The user must only verify that the system is operational and that the water tank, if used, is not empty. On the other hand, there is no way to inform the user of emergencies such as overflow, empty tank, component failure, etc.

iv. Further testing should be done in a real home or greenhouse environment to assess the reliability and durability of the system. These tests should also be prolonged to determine the significance of the savings in water and labour. Furthermore, all measurements and tests were done on a very limited collection of plants of a single species. Different plants have different water requirements and are unequally resistant to deficiencies in the water supply.

v. All the components were selected to achieve some degree of power efficiency. All the electronic components consume less than 400mW on a constant basis. The probe consumes a maximum of 41mW, but only for one minute per 5:20-hour duty cycle; in average, it should require less than a milliwatt. The valve is the element that uses the most power (8.41W maximum, 26mW average). On average, the whole system should require less than 450mW of electricity with peak consumption of less than 8.9 W.

vi. Regular maintenance of the irrigation system is not required, except to refill the water tank (if used), to clean the geotextile, pipes and valve, and to replace parts when broken. Most replacement components can be found in an electronic shop or a hardware store.

4.CONCLUSION AND FUTURE SCOPE

4.1 Conclusions

The "Design of Solar Powered Smart Agri-bot for Irrigation and Farming" has been designed and tested successfully. It has been developed by integrated features of all the hardware components used. Presence of every module has been reasoned out and placed carefully, thus contributing to the best working of the unit. The basic concept of a Agri-bot is to replace manual operations in conventional agriculture with robot in a representative part of the lawn and allowing the sensor to "sense" if there is sufficient moisture in the soil for the grass. If there is sufficient moisture, then the sensor will prevent the sprinkler system from activating and applying water. However, if it senses that the soil is dry, it allows irrigation to take place.

The Microcontroller based irrigation system monitors and controls all the activities of drip irrigation system efficiently. This system saves water because the water is directly fed to the root and the quality of the crop gets improved. It also helps in time saving, removal of human error in adjusting available soil moisture levels and to maximize their net profits.

4.2 Future Scope

To improve on the effectiveness and efficiency of the system the following recommendations can be put into considerations:

i. Cost effective techniques to overcome the limitation of requiring a soil specific calibration should be employed.
ii. The system can be integrated with temperature and humidity sensors to monitor the weather conditions in the farm.
iii. The design is still in a proto type stage. More tests need to be conducted before the efficiency, durability, and reliability can be demonstrated. Additionally, many improvement scan be made to make the system more versatile, customizable, and user-friendly.

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