SMART IRRIGATION SYSTEM USING AGRIBOT

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Abstract

Traditional irrigation systems often waste a lot of water, without considering how many litres of water can be saved. Since water is directly irrigated to the land, plants under these conditions are subjected to high levels of stress and often have reduced appearance. The uncontrolled growth of the population is causing water management problems. The main reasons are that the population is growing rapidly, and automatic controls have not been able to keep up. There is worldwide water constraint where regulating shortage of water is becoming a critical problem. Such issues are typically observed in regions with a lack of water reserves and lesser economic development. Thus, the present paper provides a solution by designing a smart irrigation system based on Raspberry Pi 3 B+ to control a robot along with a moisture sensor. It also controls other sensors required to take care of the moisture content of land and to automate the irrigation process by turning on or off the pump using a relay without interference from the user.

Keywords. Smart irrigation system, irrigation automated robot, moisture sensing, irrigation control system, raspberry pi.

1. INTRODUCTION

Agriculture in the 21st Century is being digitally transformed quickly and products are being released in this domain as solutions for the latter problems. There is a rapid increase in the demand for food and agricultural stocks, cultivation process to improve yield, cost-effectiveness and quality of crops [1]-[2]. The agricultural products being produced with upcoming technologies like Internet of Things (IOT), Artificial Intelligence (AI) and Machine Learning (ML) [3]. Yield is a problem that needs to be solved, efficacious and increase production of land per unit area taken under deliberation. To overcome these problems, it is necessary to embrace new technologies. There are various benefits associated with the enactment of new technologies which include increased productivity, proper crop distribution, and crop pattern suggestion [4]. Moreover, proper utilization of resources such as automation and AI model are new solutions to technologies which create new types of fertilizers and manures [5].

2. AUTOMATIC PLANT WATERING SYSTEM USING PROTEUS

Watering is an important cultural practice in greenhouse operations, and it is one of the most labour-intensive tasks. Watering systems make it easier for plants to get water whenever required. The prime characteristic of watering is to understand the timing of water supply and quantity of water supply. The automatic plant watering system makes it easier for the gardener to work [6]-[7]. There are various types of automatic watering systems, including sprinkler systems, tube systems, and nozzle systems. This system uses an Arduino UNO board, which is equipped with an ATmega328 microcontroller. This type of irrigation system is designed to detect the moisture level of plants and provide water if necessary. It is generally utilized for caring plant of different sizes in the garden. The microcontroller has been programmed to irrigate the garden under the condition when moisture level in the land falls below 80%. This automation system was designed to help farmers. The system hopes that with this prototype, people will enjoy the joy of owning plants without the challenges associated with absence or forgetfulness.

2.1. Solution and methodology

Automation is the technology that allows a process to be carried out without the need for any specialized worker. The prime goal of this paper is to understand that how a worker can operate the automatic watering system with his own moderately available facility in a short duration and to assemble the required electronic as well as other components. Thus, an automatic watering system using various sensors has been developed and implemented in order to utilize it widely with profitable irrigation system. This system can be very helpful for human in their day to day work life, thereby minimizing their work time, hard work and cost. The present irrigation system employs relay, microcontroller, battery and DC motor along with the sensor technology. If the soil moisture level is low, the system will irrigate the plant. The ON / OFF switch will be based on the moisture level of the land. The proposed irrigation system can be easily monitored by a computer system. This computer system receives sensor readings and creates graphs to analyse the moisture level. Moreover, the present system can be automatically implemented for small-scale and large-scale gardens as well as green roofs, greenhouses and nurseries. It will save the cost, work time and reduce the loss of water. The automatic watering system will also assist the farmer by providing them with an alternate source of irrigation, solving irrigation planning problem.

Modelling of the automatic irrigation system when pump is ON and OFF is presented in Fig. 1 and Fig. 2 respectively. Working of this system is given in steps as follows:

- Change in moisture is simulated by changing resistance in potentiometer connected to the test pin of soil moisture sensor.
- Analog values are then calculated by Arduino
- After calculation, moisture percentage is displayed on the LCD display connected to the Arduino.
- There are two motors connected the Arduino: Watering motor, Tank motor
- If the moisture is less than 85% watering motor is turned ON.
- If moisture is more than 85% watering motor is turned OFF.

- When water level in tank is less than 65% tank motor is turned ON and when it is more than 65% tank motor is turned OFF.
- Whenever any of the two motor is turned ON or OFF alert message with moisture level is sent to the smartphone/cell phone.

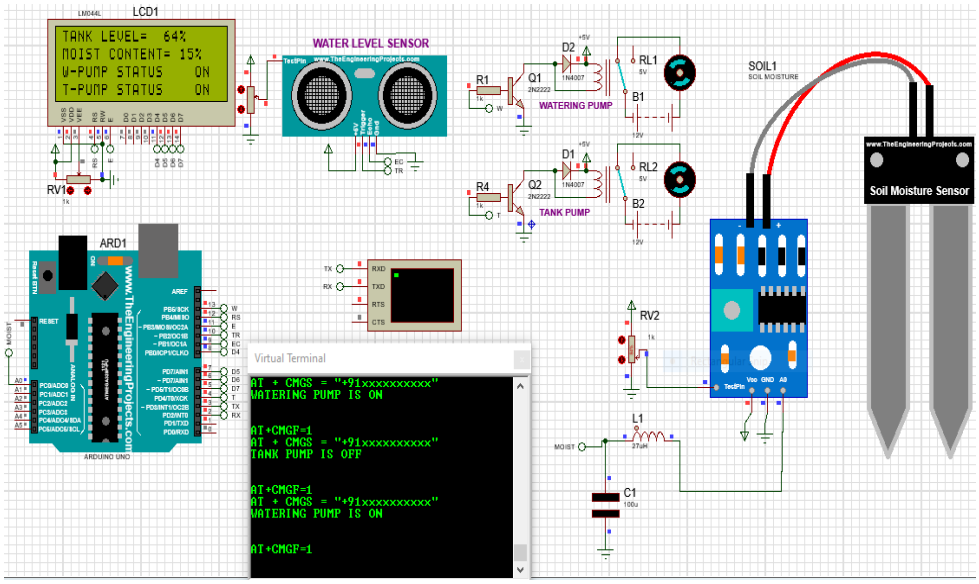

Fig. 1. Modelling the automatic irrigation system when pump is ON.

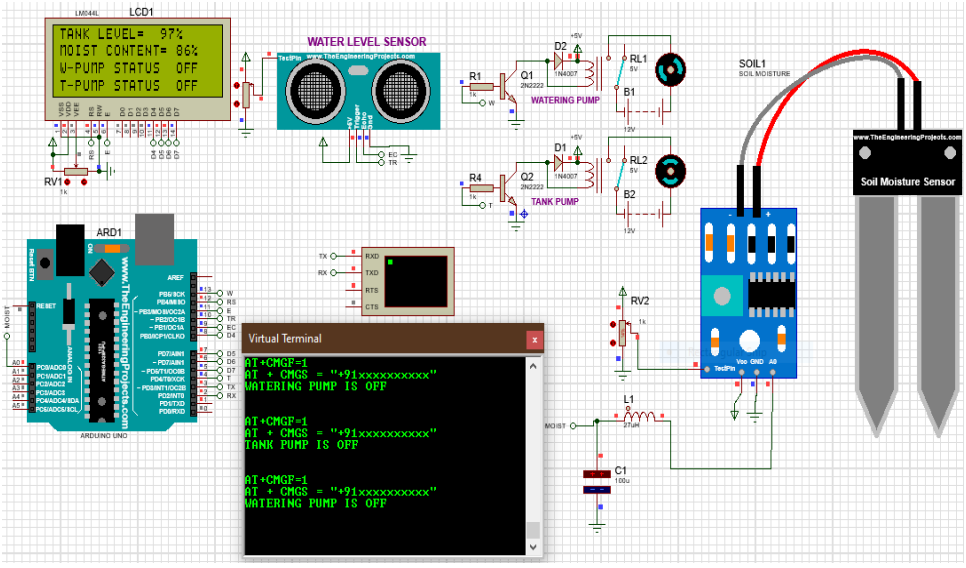

Fig. 2. Modelling the automatic irrigation system when pump is OFF.

3. IRRIGATION SYSTEM USING AGRIBOT

Water wastage is not of consideration in traditional irrigation systems. Water is irrigated directly into the land, plants undergoing increasing stress from variation in soil moisture, therefore plant appearances are reduced. Without proper control or automation of the control of this system, results in improper water control system. The major reason for these inhibitions is the growth of population which is increasing at an exponential rate.

Global water crisis is a problem that is emerging at present, thereby managing shortage of water has become a serious issue. This growth is prevalent in the countries in which there is scarcity of water and are economically backward, which is a very serious problem in the sector of agricultural sector. So, the present paper designed a smart irrigation system based on Raspberry Pi 3 B+ controlling a robot along with moisture sensor and other required sensors. It automate the process of watering and taking care of the moisture content in the soil by sensing the moisture level and turn ON/OFF the pump using relay without the involvement of worker.

3.1. Comparison of integration system with existing work

The automatic plant watering system in the previous project work presented a robot which can perform various irrigation tasks with the integration of Artificial Intelligence, Machine Learning, and Internet of Things. Sending and receiving data on the cloud and collecting these substantial data using sensors on-board, such as water level, soil moisture and obstacle detector sensors, overall building a smart agribot.

The problem with making a smart robot which incorporates the use of Artificial Intelligence, Machine Learning and Internet of Things is that the usage of RAM and processes will be very high and a microcontroller like Arduino is not designed to handle such heavy process and memory consuming tasks. Thus the better solution is to switch to the Raspberry Pi based automatic watering system.

The Raspberry Pi based proposed system overcomes the problem that was posed due to newer technologies and so it provides a really good solution. Hence a different and more passive approach has been incorporated, and the usage of a Raspberry Pi provides a wide range of utilities that one can use and provide a solution to our problem statement.

3.2. Proposed irrigation system

The present paper uses a Raspberry Pi 3 B+ since it has a very good selection of utilities in terms of using it for an Artificial Intelligence, Machine Learning, and Internet of Things Applications. The automatic irrigation system has been assembled on a synthetic chassis with a board, which can fit the processor and other required components. This system employs the following components: single shaft DC motors (4 Nos.), tires with treads (4 Nos.), battery pack (Li-ion), Micro-SD card, Wi-Fi module, moisture sensor and ultrasonic sensor. The software used for the system are Proteus software, Python, Octave, and Android App for Wi-Fi control.

The overall block diagram of the proposed irrigation system is shown in Fig. 3. The Raspberry Pi is programmed by using a Micro-SD card in which the program is encoded. The Wi-Fi module and the Battery Pack is connected to the Raspberry Pi via connectors. The four single-shaft DC motors are connected to a power supply via H-bridge connector. The Raspberry Pi controls the H-Bridge along with the input from the sensors and the Wi-

Fi module relays information from the Mobile App, which is used to control the latter. This therefore helps in the movement of automatic robot.

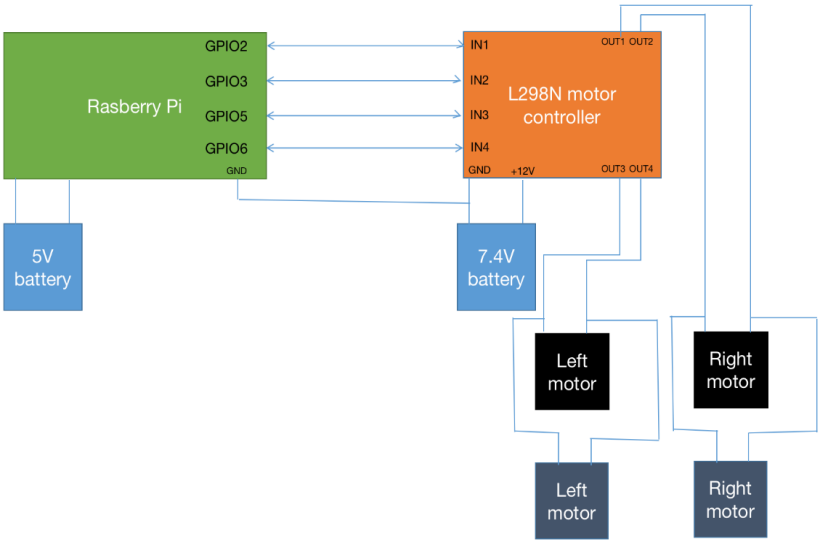

Fig. 3. Block diagram of the automatic irrigation system.

The working of the proposed automatic irrigation system is provided in steps as follows:

- The Battery powering both the Raspberry Pi and the motor driver are powered on and connected.
- The server receiving signal for controlling the Raspberry Pi and Motor Driver is started on a laptop.
- The mobile is connected to the laptop via Bluetooth and The Raspberry Pi is connected via the Wi-Fi module through wireless interface.
- Similarly, the moisture sensor is being actuated by lead screw mechanism along with a DC Motor with the help of a motor driver and the signal from the Raspberry Pi from the mobile phone.
- Also designed is a motor pump control using a node MCU which is again wirelessly controlled through cloud methods.
- The mobile provides signal to the Robot for movement or other instructions and the Raspberry Pi executes the same.
- Signals to run program on-board as well can be given.
- All the devices and sensors are further being programmed to be controlled solely via the Raspberry Pi without any external interface.
- This will establish an IOT network which will be completely automated.

4. RESULT AND DISCUSSION

The hardware model of automatic irrigation system is shown in Fig. 4 and the model used to measure soil moisture levels in dry and wet conditions is shown in Fig. 5. The robot consisted of the Raspberry Pi B+ Model and the other components such as the single-shaft motors, battery packs, H-bridge, WI-FI module, lead-screw mechanism, node MCU etc. A mobile app and an OS on the Raspberry Pi used as software and backend model for this project.

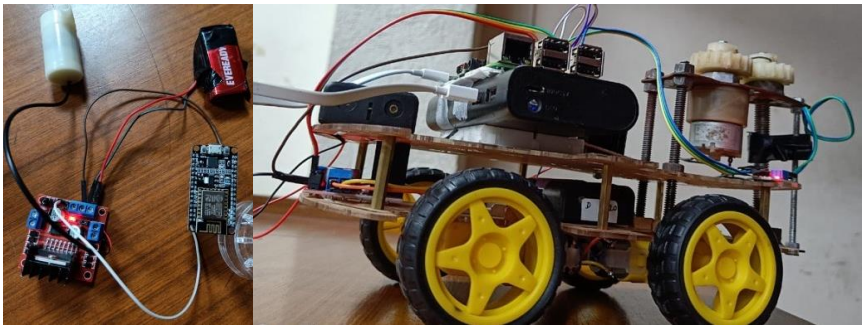

Fig. 4. Hardware model of automatic irrigation system.

The connections for the Robot were made on a breadboard using jumper wires along with all the above mentioned components. The Raspberry Pi B+ model was installed with an OS and connected to the mobile app through a laptop server. The commands were given to the Robot through wireless mode. The movement of the Robot was verified in Front, Back and Yaw Directions following which a lead-screw mechanism powering and mechanising the sensor to take readings of moisture level and send it to the cloud. Thus allowing the Robot to be used with Artificial Intelligence and Internet of Things.

Fig. 5. Hardware model used to measure soil moisture levels in dry and wet conditions.

Firstly the Arduino is connected with the moisture sensor fitted in a lead-screw mechanism driven by a 9 V DC Motor through a Motor Driver. The mechanism allows the sensor to enter the soil and sense the moisture content. These values are analog values, which are taken from the sensor and since the Pi does not have Analog to Digital converter, we have to make use of Arduino to take the input of the moisture value. Moisture values from the Arduino are sent to Raspberry Pi using serial communication. For collection of cloud data, an open source website called ThingSpeak.com has been used. There are two API keys that allow us to read or write data. Moisture values from the Raspberry Pi are sent to Thing-Speak could using the write key API. Then the data is stored on a channel in ThingSpeak.com. The module that is used to interface between cloud and the motor pumps is the ESP8266. The ESP8266 module reads API key and then it reads the relevant data from the cloud. The module will also compare moisture values received from the clouds with reference values to determine if the water has to be released through the pump control setup**.** If the value is high then the motor will be left turned OFF, otherwise if it is low then the motor is signalled to be turned ON. Data collected in database in wet and dry conditions through thingspeak.com is shown in Fig. 6.

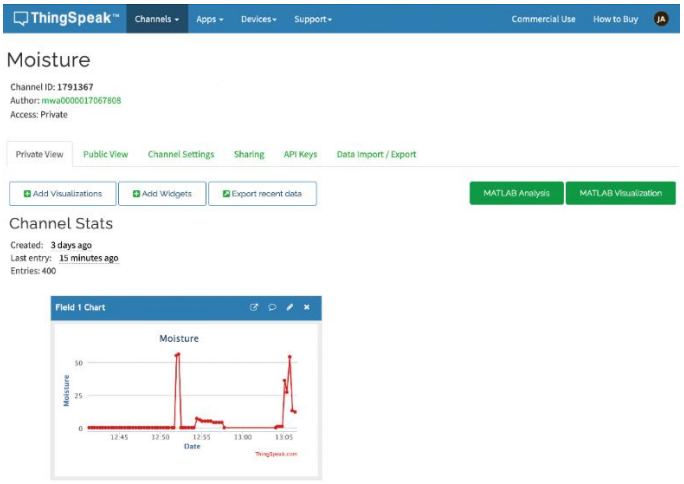

Fig. 6. Data collected in database in wet and dry conditions through thingspeak.com

5. CONCLUSIONS

An autonomous bot including the hardware and software models is designed in this paper. The agri-bot was used to measure various levels of moisture in the soil which is dry wet and semi-wet soil. The sensors and the robot were inserted in the explained mediums and relevant results discussed in the previous section were obtained. The website named thing-speak.com was used to obtain the data and provide insights on the results and values of moisture using API keys to read and write the same. Using this data, we can build a database for further analysis. Future scope for building AI algorithms based on this database model is possible. Different considerations were made to keep the model sustainable and green for the environment. Over all the work reached completion and plenty of improvements and additions are also being planned for the same.

6. REFERENCES

[1] Emiko Fukase, Will Martin, "Economic growth, convergence, and world food demand and supply", World Development, Volume 132, 2020.

[2] Adam M. Komarek, Shahnila Dunston, Dolapo Enahoro, H. Charles J. Godfray, Mario Herrero, Daniel Mason-D'Croz, Karl M. Rich, Peter Scarborough, Marco Springmann, Timothy B. Sulser, Keith Wiebe, Dirk Willenbockel, "Income, consumer preferences, and the future of livestock-derived food demand", Global Environmental Change, Volume 70, 2021.

[3] A. Subeesh, C.R. Mehta, "Automation and digitization of agriculture using artificial intelligence and internet of things", Artificial Intelligence in Agriculture, Volume 5, 2021, Pages 278-291.

[4] Victor Galaz, Miguel A. Centeno, Peter W. Callahan, Amar Causevic, Thayer Patterson, Irina Brass, Seth Baum, Darryl Farber, Joern Fischer, David Garcia, Timon McPhearson, Daniel Jimenez, Brian King, Paul Larcey, Karen Levy, "Artificial intelligence, systemic risks, and sustainability", Technology in Society, Volume 67, 2021.

[5] Jinha Jung, Murilo Maeda, Anjin Chang, Mahendra Bhandari, Akash Ashapure, Juan Landivar-Bowles, "The potential of remote sensing and artificial intelligence as tools to improve the resilience of agriculture production systems", Current Opinion in Biotechnology, Volume 70, 2021, Pages 15-22.

[6] Prabhakar Mishra, G.P. Khare, "Water controlling by soil moisture", Materials Today: Proceedings, 2021.

[7] Hari Kishan Kondaveeti, Nandeesh Kumar Kumaravelu, Sunny Dayal Vanambathina, Sudha Ellison Mathe, Suseela Vappangi, "A systematic literature review on prototyping with Arduino: Applications, challenges, advantages, and limitations", Computer Science Review, Volume 40, 2021.

Biographies

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