"ROBO-WATERING SYSTEM BASED ON SOIL MOISTURE"

Rajendra Mogre, Shivshankar B C, Anil Jadhav, Digambar B

GURU NANAK DEV ENGINEERING COLLEGE BIDAR

ABSTRACT

This project work focuses on a smart sprinkler irrigation system that is less costly and any farmer used in farm division. In 21st century where automation is playing the most significant role in the life of human. Automation allows us to control appliances with automatic control. Automation gives comfort, increase efficiency as well as save time.

Our proposed system uses a robot with a single sprinkler and a water tank that moves throughout the field spraying water all over it. This technology could improve agriculture efficiency, promoting water conservation and reducing the environmental impacts. The objectives of this project are to avoid wastage of water and increase agriculture efficiency by using Arduino Uno based automatic plant watering system. Soil moisture sensor inserts in the soil to sense whether the soil is wet or dry. The control unit monitors the sensors and when moisture sensor senses dry condition the control circuit will switch on the motor for watering the soil and it will switch off the motor when the moisture sensor senses enough wetness of the soil at which one, two or three of the factors are in abnormal conditions. It is like a moving water tank that automatically moves all over the field spraying water through it. This robot is equipped with geo fencing sensors, so it will cover complete fields without needing any manual intervention.

1. INTRODUCTION

Irrigation is the agricultural process of applying controlled amounts of water to land to assist in the production of crops, as well as to grow landscape plants and lawns, where it may be known as watering.

Agriculture that does not use irrigation but instead relies only on direct rainfall is referred to as rain-fed. Irrigation has been a central feature of agriculture for over 5,000

DOI- 10.18486/ijcsnt.2021.10.02.05
ISSN: 2053-6283

years and has been developed independently by many cultures across the globe.

Irrigation helps to grow agricultural crops, maintain landscapes, and revegetate disturbed soils in dry areas and during periods of less than average rainfall. Irrigation also has other uses in crop production, including frost protection, suppressing weed growth in grain fields and preventing soil consolidation. Irrigation systems are also used for cooling livestock, dust suppression, disposal of sewage, and in mining. Irrigation is often studied together with drainage, which is the removal of surface and sub-surface water from a given location.

TYPES OF IRRIGATION SYSTEMS

There are a few techniques for water system. They differ in how the water is provided to the plants. The objective is to apply the water to the plants as consistently as could be expected under the circumstances, so each plant has the measure of water it needs neither an excessive amount nor little.

I. SURFACE IRRIGATION

Surface irrigation is the oldest form of irrigation techniques. In this technique, water is applied and distributed over the surface of soil by gravity, i.e., from an area of higher elevation to that of lower region to dampen and thereby infiltrate the soil. It is the most common form of irrigation throughout the world. This technique can be adopted after considering the following factors are which include the hydraulics of surface irrigation.

Classification of Surface Irrigation

Surface irrigation is classified as under:

1. Basin irrigation 2. Border irrigation 3. Furrow irrigation

BASIN IRRIGATION

Basin irrigation is the oldest, most common and the simplest form of surface irrigation. This technique of irrigation requires a leveled soil surface and a narrow ridge about 15 - 50 cm high on all sides of the field which serves as a basin. The irrigated land is generally divided into smaller areas surrounded by small levees (an embankment built to prevent the overflow of a river). Water is transported into each basin by pipes and siphons, or through the levee. Excess water is drained from the land with surface drains on the low contour levee.

Basin irrigation is suitable for crops such as maize, grains, cotton, or orchards where irrigation is used on moderate to slow intake soils and deep-rooted, closely spaced crops.

BORDER IRRIGATION

Another type of surface irrigation under surface is border irrigation. Border irrigation works on the principle of basin irrigation.

DOI- 10.18486/ijcsnt.2021.10.02.05
ISSN: 2053-6283

Here, water is transported to the land through wide borders. The area between borders is called a border strip, on which the crops grow, which may range from 3-30 m (10-100 feet) in width. For efficient border irrigation, the border surface should be leveled across its width, so the water can spread uniformly across it. Crops that are reactive to excessive water and soil that is too wet are not suitable to irrigate using this method.

FURROW IRRIGATION

Under furrow irrigation, water is transported from open ditches or pipes through small channels, or furrows, along with the land. The water flowing through the channel, penetrates the soil, thus irrigating crops. According to furrow direction and level, they can be classified into level furrow (lengthwise leveled furrows), contour furrow (furrows curved to fit field topography), graded furrow (straight channels down the field slope).

Furrow irrigation is suitable for crops that are reactive to very wet soil and excessive water over the stem. Though furrow irrigation does not require special farm equipment and can minimize irrigation costs, furrow irrigation does have certain disadvantages. Such as labor-intensive technique, high probability of accumulation of salts in the furrows, furrow surface needs to be leveled. It requires experience on the part of the farmer to divide water into each furrow and to maintain the correct flow.

DRIP IRRIGATION

Drip irrigation is the most efficient water and nutrient delivery system for growing crops. It transports water and nutrients directly to the plant's roots zone, in the right amounts, so that the plant gets exactly what is needed, to grow optimally. Drip irrigation enables farmers to produce higher yields while saving water as well as fertilizers.

Commonly used in orchards, vineyards and high-value vegetable crops, drip irrigation systems consist of a network of tubes that have small holes or emitters. They can be placed above or below the soil's surface and slowly drip water into the soil over prolonged periods.

In drip irrigation, water and nutrients are transported across the land in pipes called 'dripper lines' also known as 'drippers'. Each dripper emits drops containing water and fertilizers, resulting in the uniform application of water and nutrients directly to the plants, across the entire land.

Advantages of Drip Irrigation

- Soluble fertilizers and chemicals can be used

DOI- 10.18486/ijcsnt.2021.10.02.05
ISSN: 2053-6283

- Minimized fertilizer and nutrient loss due to localized application and reduced leaching
- Field levelling is not a priority thereby reducing labour
- Allows use of recycled non-potable water
- Reduces soil erosion
- Helps tackle the problem of excessive weed growth
- Uniform distribution of water as water is controlled by nozzle
- Not a labour intensive technique thereby reduces labour cost
- Regulated supply of water because of valves and drippers
- Plants remain dry thereby reduces the risk of diseases
- Reduces energy cost as this technique uses lower pressure in comparison to other types of irrigation.

Disadvantages of Drip Irrigation

- High initial cost
- The longevity of the tubes can be compromised due to exposure to sunlight
- Proper filtration of water is of utmost importance to avoid blockage
- Proper education of farmers is a must as avoid excess water as well as inadequate water supply
- The users need to plan drip tape winding, disposal, recycle and reuse
- If the system is installed improperly, it could lead to wastage of water time and effort but most importantly, it will lead to poor harvest
- Study of subjects like land topography, soil, water requirement as per crop type, etc. is a must for this system to provide optimal results
- In lighter soil subsurface, drip may be unable to wet the soil surface for germination. Therefore, careful consideration of the installation depth is of prime importance.

SPRINKLER IRRIGATION

In the sprinkler irrigation system, water is supplied by overhead high-pressure sprinklers or guns from one or more central locations within the field or from sprinklers on a moving platform. In other words, this system allows the application of water under high pressure with the help of a pump. It releases water similar to rainfall through small sprinklers placed in the pipes. Sprinkler irrigation is suited for most row, field and tree crops and water can be sprayed over or under the crop canopy.

Advantages of Sprinkler Irrigation

i. Eliminates water conveyance channels, thereby reducing conveyance loss.
ii. Suitable in all types of soil except heavy clay.
iii. Saves water up to 30% - 50 %.
iv. Suitable for irrigation where the plant population per unit area is very high.
v. Helps to increase yield.
vi. Suitable for undulating land.

DOI- 10.18486/ijcsnt.2021.10.02.05
ISSN: 2053-6283

vii. Saves land as no bunds required.
viii. Soluble fertilizers and chemical use are possible.
ix. Provides frost protection & helps in alteration of micro climate.
x. Reduces labour cost.

Disadvantages of Sprinkler Irrigation

i. High initial cost
ii. Requires constant energy
iii. Poor application efficiency under high wind and temperature
iv. Leaf burning due to high salinity of water in temperature higher than 95°F
v. Uneconomical in cases where land is already levelled and developed
vi. Loss of water due to evaporation.

TYPES OF SPRINKLER IRRIGATION SYSTEMS

1. Center Pivot irrigation

Center pivot irrigation is a technique of irrigation where the crops are watered with sprinklers through an equipment that rotates around a pivot. This method is also called water wheel or circle irrigation.

2. Lateral move irrigation

In lateral move irrigation, the water is distributed through a series of pipes and sets of sprinklers. It is to be noted that Centre Pivot systems are anchored at one end and rotate around a fixed central point whereas Lateral systems are not anchored, and both ends of the machine move at a constant speed up and down a paddock.

3. Sub-irrigation

Sub-irrigation is an irrigation practice used in areas with relatively high-water tables or where the water table can be artificially raised to allow the soil to be moistened from below the root zone through a system of pumping stations, canals, weirs, gates and ditches.

Technical Challenges in Current Irrigation System

Irrigation schemes involve solving numerous engineering and economic problems while minimizing negative environmental consequences. Such problems include:

- Competition for surface water rights.
- Over drafting (depletion) of underground aquifers. In the mid-20th century, the advent of diesel and electric motors led to systems that could pump groundwater out of major aquifers faster than drainage basins could refill them. This can lead to permanent loss of aquifer capacity, decreased water quality, ground subsidence, and other problems. The

DOI- 10.18486/ijcsnt.2021.10.02.05
ISSN: 2053-6283

future of food production in such areas as the North China Plain, the Punjab region in India and Pakistan, and the Great Plains of the US is threatened by this phenomenon.

- Ground subsidence (e.g. New Orleans, Louisiana)
- Under irrigation or irrigation giving only just enough water for the plant (e.g. in drip line irrigation) gives poor soil salinity control which leads to increased soil salinity with consequent buildup of toxic salts on soil surface in areas with high evaporation. This requires either leaching to remove these salts and a method of drainage to carry the salts away. When using drip lines, the leaching is best done regularly at certain intervals (with only a slight excess of water), so that the salt is flushed back under the plant's roots.
- Drainage front instability, also known as viscous fingering, where an unstable drainage front results in a pattern of fingers and viscous entrapped saturated zones.
- Over irrigation because of poor distribution uniformity or management wastes water, chemicals, and may lead to water pollution.
- Deep drainage (from over-irrigation) may result in rising water tables which in some instances will lead to problems of irrigation salinity requiring water table control by some form of subsurface land drainage.
- Irrigation with saline or high-sodium water may damage soil structure owing to the formation of alkaline soil.
- Clogging of filters: algae can clog filters, drip installations, and nozzles. Chlorination, algaecide, UV and ultrasonic methods can be used for algae control in irrigation systems.
- Assisting smallholders in sustainably and collectively managing irrigation technology and changes in technology.
- Complications in accurately measuring irrigation performance which changes over time and space using measures such as productivity, efficiency, equity and adequacy

LITERATURE SURVEY

There is a lot of research paper that have worked automatic sprinkler system using Arduino.

Subhash Ghosh represents “smart drip irrigation system using the cloud, Android and data mining”[1]. They are used in

DOI- 10.18486/ijcsnt.2021.10.02.05
ISSN: 2053-6283

Microcontroller based programming and also used with an application using the concept of cloud and data mining moisture sensor says the reading from the farm and web application is easy to handle the farmer in the 16 Cloud Computing are used sensor change the data and send the reading to microcontroller and microcontrollers and the farm these readings Display Android phone for PC also the mobile is connected to the database through the cloud.

Abhinav Rajpal [2] "Microcontroller based Automatic irrigation system with Moisture Sensors". The system used provides a reading of the temperature of the atmosphere along with the humidity contained in the soil. Arduino receives the signal of the moisture sensors this is achieved by the two stiffs is also connected to a microcontroller to display soil and water pump status by using a too stiff metallic rod inserted into the field this is the sensing arrangement for the system.

In the research by the Chandan Kumar Sahu and Pramitee Behra [3], the authors present a prototype for full automation accessing of irrigation motor where Prototype includes numbers of sensor placed in different directions of the farm field. Each sensor is integrated with a wireless networking device and the data received by the "ATMEGA-328" microcontroller, which is an ARDUINO-UNO development board. The RASPBERRY-Pi is used to send messages through internet correspondence to the microcontroller process. The objectives of this paper were to control the water motor automatically and select the direction of the flow of water in a pipe with the help of soil moisture sensor. The information, which is considered as the operation of the motor and direction of water of the farm field, is finally sent to the user using mobile message and e-mail account.

In another research by P. Archana and R. Priya [4], the authors proposed a technique in which the humidity and soil moisture sensors are placed in the root zone of the plant. Based on the sensed values, the microcontroller is used to control the supply of water to the field. However, their system does not intimate the farmer about the field status.

In the paper by Sonali D. Gainwar and Dinesh V. Rojatkar [5], the authors proposed a fully automated system in which soil parameters such as pH, humidity, moisture and temperature are measured for getting a high yield from the soil. In this system, the motor pump switches ON/OFF as per the level of moisture in the soil.

However, the current field status is not intimated to the farmer.

S. M. Wange et al., [6] (2018) Presented the "Automatic Water Springler System" is powered by solar energy. The solar energy is absorbed by the solar panel and the energy is stored as electricity in the battery. The battery gives power to the dc motor.

Constantinous Marios Angelopolos et al., [7] (2011) Presented the "A Smart System for Garden Watering Using Wireless Sensor Networks" this system is powered by EC-5 soil sensor shouldered on a Telos B mote. The sensor motes were programmed in Tiny OS. Java Application is used for data collection for the system

Devutt et al., [8] (2017) Presented the Plant Watering Robot "Plant O Bot" this robot is in manual operating system mode and finds any flower pot then its ultrasonic sensors help to find the height of flower pot and the robot adjusts the nozzle and gives 200-400ml of water depending upon the size of pot.

Hema N et al., [9] (2012) Presented the "Plant Watering Autonomous Mobile Robot" this fully automated watering system which uses wireless communication to communicate between the mobile robot and the sensing module. This gardening robot is completely portable and is equipped with Radio Frequency Identification module, a microcontroller, an on-board water reservoir and an attached water pump.

Saeid Jafari et al., [10] (2013) presented the "Towards an Automated Guided Vehicle (AGV) in Sprinkler" the study to propose and develop an automatic guide vehicle (AGV) with the capability to change sprinklers timely and on appropriate positions for sprinkler irrigation classic method. The designed AGV is simulated on computer environment and the results show acceptable outcomes.

Kevin Sikorski [11] "A Robotic Plant Care System" (2003) presented the project was created with the intention to demonstrate Combining robotics with ubiquitous computing. Whenever a plant's condition, such as the moisture content of its soil, would fall out of an acceptable range, the computer could active a robot in the lab. This robot would then locate the plant, water it, and recharge the sensor. Then the robot would automatically return to its maintenance bay, where it would recharge itself, and refill its water supply.

Ayumi Kawakami et al., [12] (2014) "Potpet: Pet-like Flowerpot Robot" that helps users grow plants more effectively and

DOI- 10.18486/ijcsnt.2021.10.02.05
ISSN: 2053-6283

enjoyably. Pot Pet acts autonomously like pets: it automatically moves to sunny places or approaches people when it requires water. Basically, Pot Pet consists of a “real” plant, several sensors to detect plant status, a robot with wheels for mobility, and a microcontroller to control the above devices.

Joaquín Gutiérrez, Juan Francisco et al.[13] explained that temperature sensors, soil moisture sensor placed in root zone of plant and gateway unit handles the information about sensor and carry data to a web application. One algorithm was developed for measure threshold values of temperature sensor and soil moisture sensor that was programmed into a microcontroller to control water quantity. For power photovoltaic panel was used. Another fact like cellular-Internet interface used that allowed for data inspection and irrigation scheduling to be programmed through a web page. The automatic system was tested for 142 days and save 92% compared with traditional watering system. Three replicas of the automated system have been used successfully in other places for 1 year and 6months. Because of its energy autonomy and low cost, the system has the potential to be useful in water limited geographically isolated area.

Thomas J. Jackson, fellow et al.[14] proposed a model of automatic irrigation system which is based on Controller and solar power was used only for source of power supply. Various sensor are placed in rice field. Sensors sense water level regularly and give the information to farmer through cellular phone. Farmer controls the motor using cellular phone without going in rice or paddy field. If the water level reaches at danger level, automatically motor will be stop without conformation of farmer.

Samysadeky, Ayoub al-Hamadiy et al [15] described that soil moisture content has been detected using a technique that is called acoustic based and it was developed. The main propose of this technique is development for measure level of soil moisture in real time method. The technique based on relationship between speed of sound and the degree of saturation with water in soils. This experiment found that the speed of sound decreases with the moisture content following, depending on the kind of soil.

IiaUddin, S.M. Taslim Reza, Qadernewaz, Jamal Uddin et al [16] explained the automatic system based on ARM (Advanced RISC Machine) and for communication GSM (Global System for Mobile

DOI- 10.18486/ijcsnt.2021.10.02.05
ISSN: 2053-6283

communication) technology was used. Irrigation system provides foe adequate irrigation in particular area which is real time. Soil moisture sensor placed in root zone in paddy field and sense water level. The system was set up using ARM7TDMI core and GSM. GSM is an important part of these this system. System communicates using GSM. GSM operate through SMS and is a link between ARM processor and centralized unit. This system detects climate condition and field condition in real time. This information send to user in the form of SMS and GSM modem is controlled with the help of standard set of AT (Attention) commands. These commands are used to control majority of the functions of GSM model.

Ms.Sweta S. Patil, Prof. Mrs. A.V. Malvijay [17] explained automatic irrigation technique irrigated using wireless sensor network i.e. Zig-bee and internet technology. The idea was developed by improve irrigation system and reduced cost of irrigation water level. Sensors are placed in farm and sense continuously and collect the information. This information stored at center monitor and also passes to more data collection interface and then broadcast to the wireless sensor node. Using this information system was control automatically using internet.

In the paper by G. Parameswaran and K. Sivaprasath [18], the authors proposed a smart drip irrigation system using IOT in which humidity, temperature and pH sensors are used. Irrigation status is updated to the server or localhost using a personal computer. However, the farmer can't access the field condition without internet.

PROBLEM STATEMENT

In our increasingly busy lifestyle we often forget or forget to water our plants as a result due to lack of proper care the plants do not grow properly and ultimately die. Another problem that occurs is improper watering of plants, often we put more water than required and if drainage is not proper they will be damaged and not grow properly.

Irrigation systems require large piping setups along with many sprinklers to achieve proper irrigation. This system has many problems associated with it. It requires expensive piping as well as sprinkler costs along with high powered motors to drive water through such long pipes. There is always a chance of leakages that may cause oversupply of water to an area and under

DOI- 10.18486/ijcsnt.2021.10.02.05
ISSN: 2053-6283

supply in another leading to plantation loss. Also, this will incur heavy repairing costs.

Referring to all above mentioned aspects, a concept of automated irrigation is introduced. Here is a simple project more useful in watering plants automatically without any human interference. Sensor-based irrigation system is based on soil moisture sensor that will measure the level of moisture in the soil and propel the signal to the Arduino and accordingly it will irrigate the crops. If designed and coded properly, the automatic irrigation systems can be very cost effective. Automatic irrigation systems can be designed in such a way that gives the required amount of water in a targeted area, and which will promote water conservation too.

OBJECTIVES

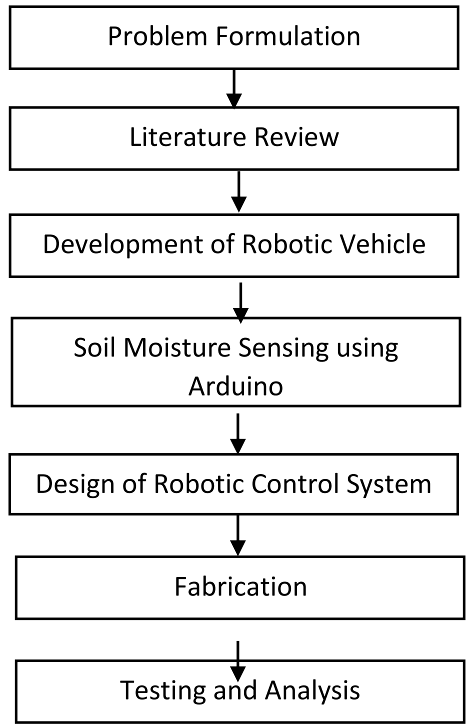
The objectives of this project work are as follows:

- To make the process of plant watering automatic and minimize human intervention in irrigation purposes.
-
- To design a watering system that waters the field uniformly up to the required level.
- To implement a successful soil sensing system using Arduino.
- To determine if watering is required for the plants based on the information obtained from monitoring the soil water content.
- To supply exact (or approximate) amount of water required for the plants and discontinue the water supply when the required amount has been delivered to the plants.
- To establish an autonomous navigation system in a four wheeled robot that traverses the field.
- To incorporate the above systems to a single compact robotic mobile platform.
- To achieve the above goals at minimum cost.
- To save water and promote water conservation.
- To overcome environmental issues in irrigation like over drafting, ground subsidence etc.

DOI- 10.18486/ijcsnt.2021.10.02.05
ISSN: 2053-6283

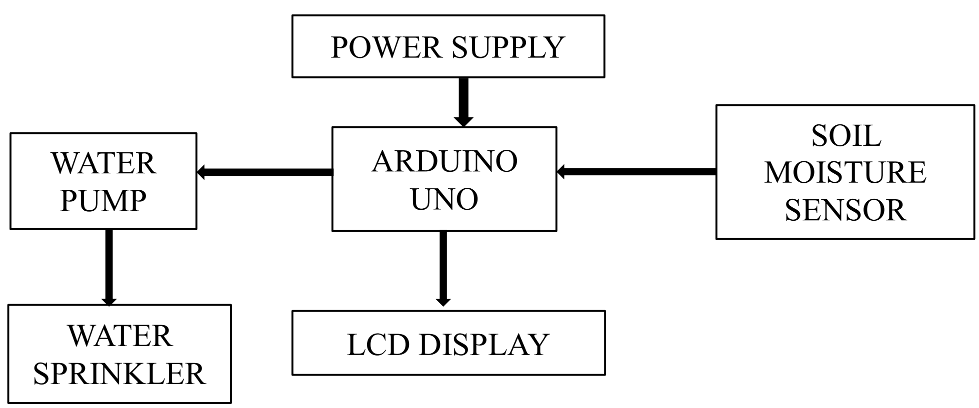
METHODOLOGY

The proposed methodology of the project work is presented in the flowchart given below:



There are two functional components in this system. These are Robotic vehicle and a Soil Moisture Sensing system.

A block diagram of an automatic watering system is shown below:



DOI- 10.18486/ijcsnt.2021.10.02.05
ISSN: 2053-6283

COST ESTIMATION

Components	**Price(in Rupees)**
Arduino Uno R3 Cable	1000
Breadboard	400
L293D Motor Shield	600
DC Geared Motor Wheels x2	600
Cart Wheels x2	500
Servo Motors x2	400
Ultrasonic Sensor	500
Soil Moisture Sensor	500
IR Proximity Sensor x2	500
HC-06 Bluetooth Module	750
DC Submersible Pump	1800
Water Sprinkler	600
Power bank	1000
LCD Display	400
USB Converter Cable	900
Jumper Wires	400
Plastic Tubes	300
Fabrication	2000
Others	1500
Total (Estimated)	**14,650**

REFERENCES

[1]. Subhash Ghosh, Sumaiya they, Kanchana wani, Kunal mahatre, “smart drip irrigation system using the cloud, Android and data mining”. 2016 IEEE International Conference on Advances in Electronics, Communication and Computer Technology (ICAECCT) Rajarshi Shahu College of Engineering, Pune India. Dec 2-3, 2016

[2]. Abhinav Rajpal, Sumit Jain, Nistha Khare and Anil Kumar Shukla, “Microcontroller based Automatic Irrigation System with Moisture Sensors”, Proceedings of the International Conference

DOI- 10.18486/ijcsnt.2021.10.02.05
ISSN: 2053-6283

on Science and Engineering, 2011, pp. 94-96

[3] C. Kumar Sahu and P. Behera, "A low cost smart irrigation control system", Proc. of 2015 2nd International Conference on Electronics and Communication Systems (ICECS), Coimbatore, 26-17 Feb. 2015, pp. 1146-1152. Doi: 10.1109/ECS.2015.7124763

[4] P. Archana and R. Priya, "Design and Implementation of Automatic Plant Watering System", International Journal of Advanced Engineering and Global technology, Vol. 04, Issue 01, Jan. 2016, pp. 1567-1570. Retrieved from http://ijaegt.com/wpcontent/uploads/2016/01/409692-pp-15671570-Archana.pdf

[5] S. D. Gainwar and D. V. Rojatkar, "Soil Parameters Monitoring with Automatic Irrigation System", International Journal of Science, Engineering and Technology Research (IJSETR), Vol. 04, Issue 11, Nov. 2015.

[6] S. M. Wange, Sanket Garudkar, Akshay Pendurkar, Prashant Roopdas, Pranav Bhandari "Automatic Water Springler System," International Research Journal of Engineering and Technology, Volume 5, no. 6, June2018.

[7] Constantinos Marios Angelopoulos, Sotiris Nikoletseas, Georgios Constantinos Theofanopoulos, "A Smart System for Garden Watering using Wireless Sensor Networks", MobiWac '11 Proceedings of the 9th ACM international symposium on Mobility management and wireless access Pages 167- 170 ACM New York, NY, USA, 2011.

[8] Devdutt, Ishlok Vashistha, Vimlesh Singh, Priyanka Bansal, Abhiruchi Passi Plant Watering Robot "PLANT O BOT," International Journal of Computer Science and Mobile Computing, Vol. 6, Issue. 4, April 2017, pg. 3.

[9] Saeid Jafari, Reza Vatankhah Barenji, and Majid Hashemipour "Towards an Automated Guided Vehicle (AGV)" in Sprinkler Irrigation," International Journal of Environmental Science and Development, Vol. 4, No. 5, October 2013. [26] Kevin Sikorski, "Thesis- A Robotic PlantCare System", University of Washington, Intel Research, 2003.

[10] Ayumi Kawakami, Koji Tsukada, Keisuke Kambara and Itiro Siio, "PotPet: Pet-like Flowerpot Robot", Tangible and Embedded Interaction 2011, Pages 263-264 ACM New York, NY, USA, 2011.

[11]. Joaquin Gutierrez, Juan Francisco Villa-Medina, Alejandra Nieto-Garibay, and Miguel Angel Porta- Gándara "Automated

DOI- 10.18486/ijcsnt.2021.10.02.05
ISSN: 2053-6283

Irrigation System Using a Wireless Sensor Network and GPRS module” Ieee 2013.

[12]. Thomas J. Jackson, fellow, Ieee, Michael H. Cosh, Rajatbindlish, senior member, Ieee, Patric J. Starks, David D. Bosch, mark Seyfried, David C. Goodrich, Mary Susan Moran, senior member, Ieee, and Jinyang Du ,”Validation of Advanced Microwave Scanning Radiometer Soil Moisture Products”, Ieee 2010 .

[13]. Samysadeky, Ayoub al-Hamadiy, Bernd Michaelisy, Usama Sayedz, ”An Acoustic Method for Soil Moisture Measurement”, ieee 2004.

[14]. Iia Uddin, S.M. Taslim Reza, Qadernewaz, Jamal Uddin, Touhidul Islam, and JongMyonkim,”Automated Irrigation System Using Solar Power” ©2012 Ieee.

[15]. Ms. Sweta S. Patil, Prof. Mrs. A.V. Malvijay, ”Review for Arm Based Agriculture Field Monitoring System”, International journal of scientific and research publications, volume 4, issue 2, February 2014.

[16] G. Parameswaran and K. Sivaprasath, “Arduino Based Smart Drip Irrigation System Using Internet of Things” International Journal of Engineering Science and Computing, Vol. 6, Issue 5, May 2016, pp. 5518-5521. Doi: 10.4010/2016.1348

DOI- 10.18486/ijcsnt.2021.10.02.05
ISSN: 2053-6283