I.J. Engineering and Manufacturing, **2019, 6, 14-23**
Published Online November 2019 in MECS (http://www.mecs-press.net)
DOI: 10.5815/ijem.2019.06.02

Available online at http://www.mecs-press.net/ijem

Automated Roof Top Plant Growth Monitoring System in Urban Areas

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Received: 29 July 2019; Accepted: 15 October 2019; Published: 08 November 2019

Abstract

Innovation is progressing at a quick pace so it is required to utilize it in an each fields to have the coveted and appropriate yield. Present day's robots are winding up plainly more well-known and are progressively depend upon embrace schedule, regularly dull errands which are costly to do utilizing generously compensated labor. Because of the expanded populace and urbanization less space found for cultivating particularly in urban regions. There is a need of self-creating of slightest individual prerequisites. To fulfill ordinary demand in green vegetables and love towards their indoor and outside plants can be expert through urban rooftop gardening. This paper clarifies essential assignments of checking and detailing the development status of plants in urban rooftop gardening. We execute the customary checking of plants development. Height of the plant is one of the parameter to decide the growth of the plant. The tallness of the plant is more than the predetermined typical height in the program; robot shows that as overgrown, if there is no development discovered robot will show that as vacant slot. For identifying the development of the plant we utilize Sharp GP2D12 sensor, three white line sensors of ATMEGA 2560 FIREBIRD V to take after the arena of cultivation slots.

Index Terms: Roof top gardening; Robot; Sensor; Height.

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1. Introduction

Due to the increased population and urbanization less space is found for gardening specifically in urban areas. Urban greenery and gardening are necessary to achieve social, economic sustainability for the buildings in urban cities. Malnutrition amongst children and adults is a serious problem. In vegetable cultivation with less fertilizers and good monitoring better yield can be obtained.

The environmental conditions greatly affect the plant growth process. The parameters of the environment such as Carbon Dioxide, moisture, temperature, light, etc. are the input parameters for the development of plant. Farmer is required to have the knowledge of these factors for the mentoring of the plant growth. Height is the one of the output parameters of the plant to decide its health status. The necessary actions to help the plant growth like supplying of water, fertilizers etc. can be taken using suitable mechanism. The plant requirement for its growth and continuous monitoring helps the plant growth. In this presented work robot helps with continuous monitoring of the plants growth status.

The tasks done that are dull, delicate and dangerous for people can be substituted by robot. In specific the tasks that are repetitive in nature can be efficiently performed by programming of the robot. ATMEGA 2560 FIREBIRD V mobile robot provides hardware, software platform with its innovative architecture [1] to design various applications of the robot in real world environment without any human intervention.

2. Literature Survey

Here, Madhumitha A and Sanjeeve Kumar S [1] have proposed ZigBee Based Monitoring System for Intelligent Green Roof Ecosystems have stated the Green roofs were primarily constructed aiming to provide valuable ecosystem services for both humans and the urban environment. Monitoring them undergoes the various challenges which includes the collecting of related data from the sensors and incorporating how irrigation process is handled in the field along with the management of all collected sensory data and interpretation of the same. Their proposed ZigBee based monitoring systems is based on automated fuzzy system which monitors, controls the shading and irrigation process. The paper also presents a basic design and implementation of Wireless Sensor Networks using ZigBee technology with the IEEE 802.15.4 compatible transceiver. Further a simple circuit for water irrigation controlling is presented.The system consists of local station and base station which is equipped with the ZigBee transceiver. The location station consists of various sensors and Arduino microcontroller. This microcontroller reads and frames the readings and it is forwarded to the base station via ZigBee network.

A base station is embedded with fuzzy logic DSS framework is designed for the irrigation process. Before irrigation process the system monitors the status of rain using acoustic sensor. After that irrigation process is designed through the fuzzy controller system for automatic water valve ON/OFF which makes it cost-effective. The developed system helps in easy customization of the design according to our needs and provide scientific basis for water-saving irrigation. The results of the system shows that it can quickly and precisely calculate the amount of water depending on the plant needs. Several preliminary results of measurement reveal the reliability and effectiveness of the system which uses the fuzzy logic algorithm which is simulated using MATLAB fuzzy logic toolbox. Two different fuzzy controller systems are inbounded in two different places. Fuzzy controller for shading process is programmed in base station and hardware model of the proposed system using off shelf components. The simulation result as shown in fig 9, shows the shading process for the controller placed in base station. Ten different inputs are selected to test the twelve rules. For an input rain type of 0.125 and input time of 2.5, the simulation gave the output of 0.336 matches and conforms to the weight of 0.336, turns the irrigation process.

Bandri Manoj et.al [2] proposed Urban Rooftop Farm Monitoring System (URFMS) using WSN. Urban rooftop gardening has gained importance due to rise in concrete jungle at faster phase, thereby leaving smaller room for urban citizens to cultivate/grow their interest and requirements. The day to day demand in green vegetables and love towards their indoor and outdoor plants can be achieved through urban rooftop gardening. This demands lot of care and precise monitoring systems for their healthy vegetation. A wireless sensor network model for precise monitoring of urban rooftop gardening was proposed.

This model include monitoring the environmental factors that affect the health of the plantation like light, temperature, humidity and water content in the soil. The monitoring system will indicate the necessary actions to be taken up so that the plantation remains healthy. A typical example can be the moisture level in the soil going below the threshold value will trigger the water sprinklers. The real time implementation of the proposed monitoring system is also carried out by generating a test bed to perform the preliminary studies and results have been discussed in the paper.

A simulation model has been generated in this regard to carry out further studies on energy efficiency, low latency and better monitoring, the results are discussed. In their work they have implemented a hardware setup for monitoring environmental parameters using wireless sensor networks. They have used ZigBee radios for communication purpose.

A complete model for urban farm monitoring and the model is also simulated in NS2. They implemented the model using less communication overhead thus increasing the lifetime of the network employed for monitoring. The future can be extending the simulated model into real time implementation as well as developing a novel data integration mechanism.

Gayatri Sakya and Ankit Gautam [3] have proposed Smart Agriculture System using Ad-hoc networking among Firebird V Bots. The wireless sensors are deployed in the fields for automatic controlling of the process. The smart agriculture systems effectively provides irrigation to specific area with the help of wide range of controlling applications such as temperature, moisture etc. Which replaces the traditional agriculture techniques.

Anusha P and Dr. Shobha K R [4] used Wireless Sensor Network to implement Precision Agriculture. WSN provides cost effective technology which improves production and enhance agriculture yield. The Automated Intelligent Wireless Irrigation System using LITE mote provides efficient water management which yields more profit with lower cost. This system provides advantage of flexible networking used for monitoring equipment, easy installation, and reliable nodes with high capacity.

Rohit Kelkar et.al [10] proposed Automation of Library System Using Firebird V. White Line Follower is put between Book Shelvesto avoid human errors and locating books in library efficiently. A prototype of Autonomous Robot Fire Bird V is used to automate the book issuing process in library. User will provide information of the book required to the robot. The robot processes the data and finds the appropriate book hence forth reducing human work. Firebird V will follow black line to locate the books in library. It will deliver the book whose input was given to it.

Firebird V will detect the white line on which it is moving using the white line sensors. It will detect the obstacles using proximity sensors and infrared sensors depending upon the range of obstacle, A robotic arm is used with Firebird V. The robotic arm will be used to pick the books. It is a robotic manipulator which is programmable, with similar functions like a human arm. The details of the hardware peripherals connected to ATmega 2560 to design the robot working model are referred from [5,6,7,8].

Pre scaling the timers:

As you may be aware the clock frequency of Atmega 2560 is 14.745600 MHz and the counter/Timer will increment by 1 for each clock pulse. Consider that the timer/counter is 16 bit, therefore maximum possible count value will be 65535 (starting from 0). The time period for each clock pulse is 1/14.745600 MHz is 0.0678 µsecs.

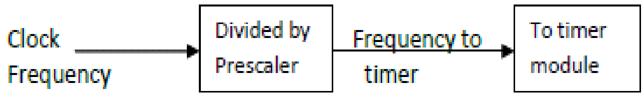

Fig 1.Setting clock frequency using pre-scalar values

Maximum delay that can be generated will be 65536 X 0.0678 µs = 4.44 milliseconds. Hence, we need a pre-scalar to divide this clock frequency by 8/64/256/1024 to generate greater delay. As shown below in fig 1.

Black line sensing logic

Three white line sensor threshold values are adjusted to make the robot to follow the black line in the arena. From line sensors for black line sensing Potentiometer is adjusted to have similar readings on all three sensors for a particular surface. Consider the value of all three sensors on white surface is similar (±5) and is named as 'W'. The value of all three sensors on black surface is similar (±20) and is named as 'B'. Now the threshold value will be ((W+B)/2)-(B/3). The logic of the black line sensor is explained below:

-Setting the pre-scalar for suitable clock source to ADC.
-Selecting the required reference voltage.
-Selecting the channel to sample.
-Selection of the trigger source for starting the conversion process.
-Choosing left adjusted or right adjusted mode according to the application requirement.

3. ROOF TOP MONITORING SYSTEM

According In this project we are designing the roof top plantation growth monitoring autonomous robot which will sense the status of the plant in real time. For this, we are analyzing the growth of the plant by taking height as a parameter.

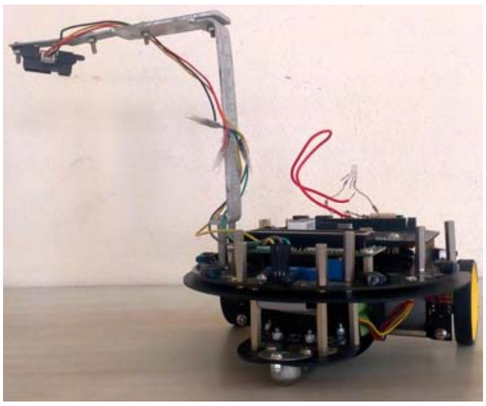

Fig 2. FIREBIRD V Robot with Mechanical support with sensor mounted on top to detect plant growth

The working model of our project is shown in fig.2. This project uses the fire bird v robot that uses ATMEGA 2560 as master controller, ATMEGA 8 as slave controller, IR, mechanical support and other accessories. Our project uses Firebird v robot to move on the field. The mechanical support along with Sharp sensors is used for detecting the plant growth. AVR ATMEL STUDIO 6.0 software is used along with AVR boot loader. The AVR studio is used for writing the code. Computer and robot are interfaced using AVR boot loader which also burn's the code.
Specifications of the processor:

1) Power Requirements:
   Supply Voltage 12 V

2) General:
   - Operating Frequency: 14.74 GHz
   - Arena size: 213cm x182cm
   - Plants Size:
     - Green: Over grown plant: 6cmx6cmx12cm
     - Blue: Healthy Plant: 6cmx6cmx8cm
     - Red: Stunted plant: 6cmx6cmx4cm
     -

3) Operating Temperature -40 to 85° C (industrial).

The proposed system prototype was implemented by selecting an arena. Arena arrangement used in this project is shown in the fig 3. It consists of plants, black line to run the robot in forward direction. Mechanical support with arm is used having sharp sensors mounted on robot to monitor the growth of the plant and RGB LED is also used to indicate which plant is detected. Arena has entry point 'IN' and exit point 'OUT' for the traversal of robot. Arena consists four different growth statuses of the plants. Table 1 represents the conventions used to represent all four statuses of the plants.

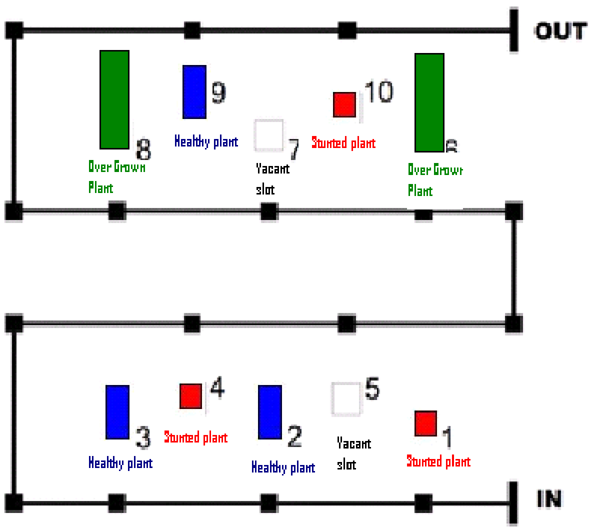

Fig 3. Arena of plant growth monitoring system

Table 1. Conventions of growth status

Cultivation slots	Growth status	Color
1,4,10	Stunted	Red
5,7	Vacant	White
2,3,9	Healthy	Blue
8,11	Overgrowth	Green

The Challenges faced during our implementation

- Alignment of the BOT.
- Sharp sensors are very sensitive.
- The wheels could not be rotated by precise amounts.

3.1 Flow of Work:

This module is a wireless method of measuring plant growth. Sharp sensors mounted on the top of the robot measure the height of plant and sensors send the message to the robot regarding the height. If the height is less than the normal height sensor send the message as stunted plant, if the height is greater than the normal height sensor send the message as plant is overgrown suppose if the height is matches with the normal height sensor detect that plant as healthy plant and on the arena if any slot is empty the height of the plant is measured as 0 that means no plant is grown on that slot.

After monitoring the status of the plant growth summary will be displayed on the 16x2 LCD displays which are located on the robot. In this on LCD we display how many plants are overgrown, how many stunted plants, how many plants are healthy and how many plants are not at all grown.

The working flow is shown in the fig 4. In general the plants cultivated in garden are of smaller size which range from 0.5 feet to 2 feet. But we are simulating our monitoring system for a particular type of plant. By study we find the normal height of the plant and assign that value as ‘x’ in our logic. The robot while tracing the path compares the readings of the IR sensor to x value and accordingly takes the decision.

4. Experimental results

The robot is made completely autonomous. It does not receive any extraneous input. The maximum time taken by the robot to trace complete arena is 2 minutes. The robot traverses the arena; detect the growth status of the Plants in each Cultivation Slot. Indicate the growth status by turning ON the appropriate Light Emitting Diode (LED), Red, Blue or Green.

LED remains ON until the robot reaches the next Cultivation Slot. The robot sounds a buzzer for each vacant slot. The buzzer is ON for 500ms. After reaching the OUT position, the robot displays the Cultivation Slot numbers along with growth status of the plants in those slots and indicates the absence of a plant if any, on the LCD screen. Refer to Fig. 5 below.

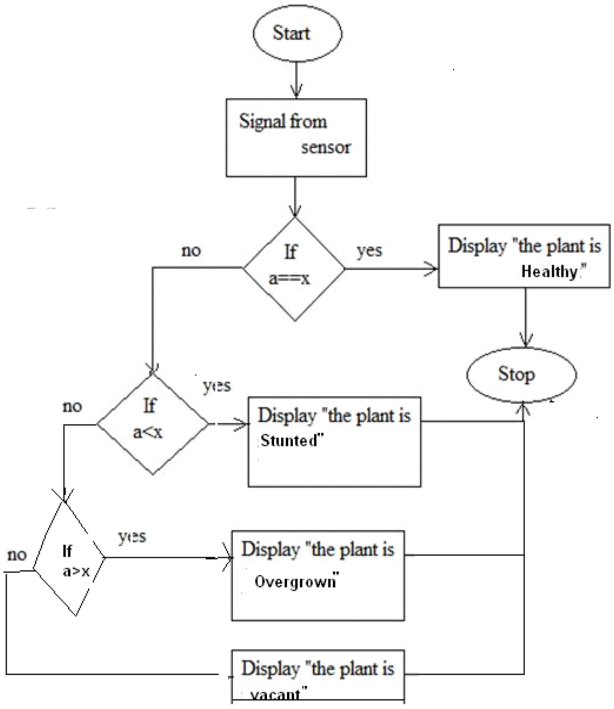

Fig 4. Flow chart of the working model

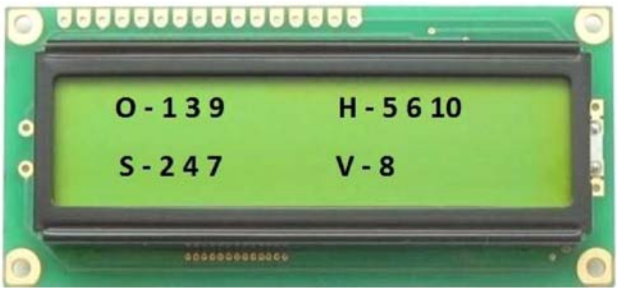

Fig.5 Results on Firebird V LCD

Figure 4 illustrates the LCD display when the robot completes the task correctly. O – Overgrown, H – Healthy, S- Stunted and V – Vacant. If there are no plants of a particular growth status O, H or S, then that growth status is does not displayed on the LCD. Similarly if there are no Vacant Slots, then it does not display on the LCD.

At the same time, the robot sounds a continuous buzzer to indicate END of the task. Buzzer sound for more than 5 seconds will be considered as continuous buzzer. The example arena shown in Fig. 5 illustrates the display format.

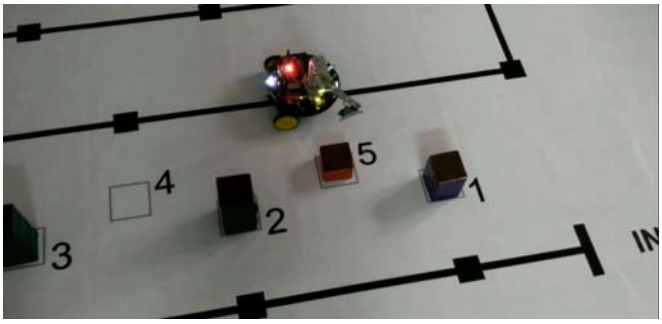

Fig 6. Black Line following Firebird V

With reference to Fig 6 – In Cultivation Slot numbers 2, 4 and 7, the growth status of the plants is stunted; Cultivation Slot numbers 5, 6 and 10 have plants that are Healthy. Cultivation Slot numbers 1, 3 and 9 have over grown plants; while Cultivation Slot number 8 is Vacant.

5. Conclusion

In this paper we tried to present a novel method for plant growth monitoring which is robot based. To our knowledge this is the new concept of employing software for the plant growth. Using the blank line follower the path for the plant placement is made. The Robot follows the same and based on sensor reading a decision about plant growth is made and the same is displayed for the user.

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Sujata Bhavikatti completed B.E in Electronics and Communication Engineering from S D M College of engineering and Technology, Dharwad, Karnataka, India and MTech in VLSI and Embedded System Design from BVBCET, Hubli. She has published several national and international journal and conference papers. Her areas of interest are image processing, VLSI and robotics.

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Shailaja S. Mudengudi completed her B. E in electronics and communication engineering from Visvesvaraya Technological University Belgaum, India and M.Tech in Digital Electronics and Communication from Visvesvaraya Technological University Belgaum, India. Presently, she is working as Assistant Professor in Department of Electronics and Communication Engineering, Tontadarya College of Engineering, Gadag, Karnataka India. She has published 1 international conference paper and 1 international journal paper. Her areas of interest are wireless networks, MANET's, VANET's and sensor networks.

How to cite this paper: Sujata Bhavikatti, Sadanand P, Mukta Patil, Pradeep Vibhuti, Shailaja S.Mudengudi. "Automated Roof Top Plant Growth Monitoring System in Urban Areas", International Journal of Engineering and Manufacturing(IJEM), Vol.9, No.6, pp.14-23, 2019. DOI: 10.5815/ijem.2019.06.02