Ag (ro)^{2}bot :Automated Intelligent Farm Care for Greenhouse

K. Shayether S. Pavithrakini A. M. Aslam Sujah U. L. M. Rijah Gayana Feranando

ABSTRACT
In the modern world, people are adopting to new technologies to improve their lifestyles. Human Computer Interaction is a popular topic nowadays. Ag(ro)^{2}bot is a farm care system for green house which incorporates Human Computer Interaction. The main Objective of the research is to enhance the activities of a Green house. Therefore an automated intelligent farm care system for Green house was developed. The system has automatic intelligence to care Greenhouse according to the atmospheric condition. Soil moisture sensor, humidity & temperature sensor and IR sensor are used to track the conditions. These sensors are attached with Arduino UNO which controls the overall system. A technology called line following is used to move Ag(ro)^{2}bot within the Green house. The Automated intelligent farm care for Green house System (Ag(ro)^{2}bot) result increased and efficient productivity by minimizing wastage, time, effort and farmer's health issues.

Keywords
Arduino, Sensors, Intelligent, Moisture, humidity, temperature s.

1. INTRODUCTION
Sri Lanka is an agriculture based country. Sri Lanka produces more than 900,000 metric tons of fruit and vegetables annually and exports both fresh and processed varieties to many destinations in the world. Now a days Greenhouse have very popular and have gotten higher demand in Sri Lanka. Greenhouses are used extensively by botanists, commercial plant growers, and dedicated gardeners. Particularly in cool climates, greenhouses are useful for growing and propagating plants because they both allow sunlight to enter and prevent heat from escaping. The transparent covering of the greenhouse allows visible light to enter unhindered, where it warms the interior as it is absorbed by the material within. The transparent covering also prevents the heat from leaving by reflecting the energy back into the interior and preventing outside winds from carrying it away.

In Sri Lankan agriculture field, they have introduced new technology to irrigate crops, farmlands and home gardens to increase productivity and healthy growth of plants. Which is implemented through Drip, Sprinkler, Spray and Pop-up systems. The greenhouse is at an early stage of technical development. Green house Maintain Labor cost is very higher than other agricultural fields. Because Greenhouse each plant must need full attention.Due to use of modern machinery, labor requirement is minimized. The labor cost is reduced by using modern irrigation system. There are more advantages by cultivating plants that can be mechanized. It is important to consider labor requirement factor that should be given the priority when selecting such varieties.

Overcome the issues on the existing systems Ag(ro)^{2}bot is aimed to develop greenhouse support systems without a labor. This system makes the intelligent system that automatically adjusts the quantity of water, based on sensor data. This system also enables to fertilize the greenhouse without a greenhouse owner which is more helpful to reduce the problem which can cause effect to the owners' health. The main activity can be controlled by mobile Application.

Through this robot this process will ultimately minimize the issue of high workload of the labor and provide a solution through automating the greenhouse system and the fertilization process as well. So, that think this automated farm care system will be a useful one with the least effort, lower labor cost and most efficient process. This will be a useful and effective system which can be implemented for greenhouses in Sri Lanka.

This paper discusses background, methodology, Result and Discussion, Conclusion and Future work

2. BACKGROUND
In modern society all the people are adapting to the new technologies as everyday technology develops. During the last 10-15 years, a large number of research projects have focused on developing in this way, the highest level of the technology adaptation is an artificial intelligent system.

In earlier of 1990s Aurora robot langue. Aurora robot is the very first greenhouse managed robot.

It is fully controlled by remote. It is substituted for human work force. Aurora can go only one direction and it can turn into one

A successful demonstration for local greenhouse owners and the media took place in March 1995. When the Aurora work in greenhouse one operator must need nearby Aurora.

Aurora navigates autonomously through a greenhouse corridor using only the information provided by the ultrasonic sensors. The program introduced through Aurora is a keypad consisted of a loop of instructions so that the robot sprayed a greenhouse while navigating through all its corridors. In these tests, Aurora repeatedly detected the same environmental landmarks specified in the task (corridor, turning point and wall), accomplishing the mission independently of the robot is a precise starting position or the exact path followed. Aurora robot can maintain only small size of greenhouse [1] [2].

In last of 1990s Fit robot langue. it is fully controlled by a remote. Two navigation techniques have been tested in a real environment using the mobile robot Fit robot. The first of the experiments was following a straight corridor which had to the left and to the right plants. Afterwards, a new test was realized. In this test the robot left a corridor, turned and later returned to another corridor.

Fit robot has a rubber tracked system, which takes the advantages of differential drive vehicles and also provides a larger contact surface with the soft ground of the greenhouses, making it more robust and stable This robot has a mass of 756 kg (with the phytosanitary tank full) and it has appropriated dimensions (0.7 x 1.5 m) to the corridors of the greenhouses. It is driven by a powerful 20HP gasoline engine. Fit robot can maintain large scale of the green house. But one operator need to operator fit robot [1] [2] [8].

Then introducing mobile robot. This mobile robot can spraying and irrigation in the greenhouse [3][2][1]

Then in greenhouse environment get a wireless line tracking robot. It is a very first wireless robot fully controlled by software. Its design for harvesting fruits .It is only doing the harvesting. When the power supply is given, the robot moves

Over the black line by continually sensing the black and white colors. When the RFID reader detects the RFID tag, the

Mobility of the robot is stopped and the operation of the arm to pick the object starts. Once the object is picked, again the robot moves over the black line and on sensing the other RFID tag, the robot stops and drops the object. This operation continues. Wireless tracking robots which can be controlled with wireless technology from the remote and this robot follows the line and move to the desired location and perform pick and place operation of the item .These Robots can be deployed in vital locations and also used for military for a rescue mission. These robots can communicate with adhoc network and can perform better operation [4] [1].

Then many harvesting based robots are introduced into greenhouse environment. In harvesting purpose its design specific harvesting purpose such as, picking robot that can recognize sweet peppers, cut it and put into the container as a farmer. This system consist of recognition technology, moving technology. For these functions, this picking robot has an image positioning system with a parallel stereo vision, a positioning system to follow sweet pepper by visual feedback control, and a cutting devise [5] [4] in a green house environment in this time period robots used ultra-lights for finding the illnesses of plants. These robots can harvest and spraying [6] [3] [1].

Thereafter KLT robot used in greenhouses. This is a robot is first visual capturing wireless robot. In this robot visual odometer was developed for an autonomous greenhouse sprayer to estimate vehicle translation and rotation relative to the world coordinate system during navigation. Digital images were taken from a CCD camera mounted on the robot. 7 x 7 pixel features were selected in the image using the KLT algorithm Features were tracked from image to image by finding the best 7 x 7 pixel match of the feature within a 25 x 25 pixel search box. By analyzing the movement of these features, vehicle rotation and translation were estimated. Five features were tracked with the odometer. Tests were run to verify the visual odometer accuracy during translation, rotation, and on various surfaces [7] [3].

Introducing visual capturing technology in green house robots its makes a huge change in greenhouse environments. The robot used image processing techniques for identifying the illness of plants [9]. Then there have used color images techniques for capturing plant in a green house [10] [9].

Middle of the 2000 years GSM modem used in a greenhouse environment. Many parameter measurements are required to monitor and control for better quality and productivity of plants. But to get the desired results there are some very important factors which come into play like Temperature, Humidity, Light and Water, which are necessary for a better plant growth. GSM (Global System for Mobile communication) is a digital mobile telephone system that is widely used in Europe and other parts of the world. They take the temperature, co_2 level, the humidity level in the greenhouse. Send these details on to alert alarm as a greenhouse owner's phone. The owner can set standard values. All the results are sent to the phone as a message at the same time the GSM result directly get it in their computers. [13] [14] robot sends spraying, irrigation details to owners phone through the GSM module [12] [13]

They're after introducing the GSM Module worked in real time processing. They used this system and by using sensors observed greenhouse for 24 hours and take most of the readings like temperature, soil wetness and light intensity. At the same time measure the process, update the process and control.[14] in real time processing robot take picture of illness plant and sent it to owners phone and sprayed, watered the plant [11] [7]The green house owner to receive all the updates through the message by using GPS modem

Thereafter used Zigbee protocol this protocol helps with wireless communication between nodes. In this protocol used JN-5139 micro-processor. And also they use embedded zkos operating system. In this operating system all the configurations and GPRS based remote data forwarded in real time through the sort message service

"A monitor System for Vegetable greenhouse based on wireless" come with a wireless sensor network prototype with the 2 part framework. Arm processor embedded sink node. They installed collecting and transferring data wirelessly to a remote PC using message. In another part of the framework they manage the database running on remote PC get same result [15] [16].

3. METHODOLOGY

Section 3 discusses about the selected methodology used to develop the research project and how the implementation took place in accordance with each phase in the Software Development Life Cycle (SDLC) process.

3.1 Planning

The planning phase is the most critical and important step in the SDLC. As the starting point of the project life cycle research problem was found. There for as a solution to the stated research problem a robot was proposed. In this phase the team identified the project value and divided the work for members. Budget is calculated and the technology is chosen. For this the team did feasibility studies in technology and economics.

3.2 Analysis

In this phase, developers gathered sufficient data as primary and secondary data which will help identifying the problem existing and enhancing the solution. Primary data were gathered through interviews. Secondary data were gathered via the literature review done related to previous researches similar to "Ag(ro)^{2}bot" In order to gather the requirements. Then the gathered information analyzed for their ambiguities, inconsistencies and incompleteness. Those are completely eliminated before started working on other phases. With all the analyzed factors "Ag(ro)^{2}bot" was developed with a combination of software and hardware components.

3.3 Design

Initially the overall design was started with the High level diagram. Figure1 represents the high level diagram of the system

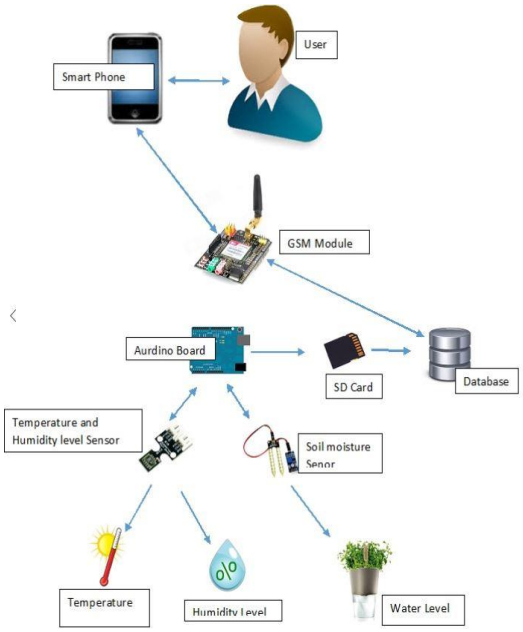

Figure 1High level Diagram

In the design phase the initial design was planned. The sketch of the robot was designed, how the hardware components are placed and how it will be connected to software. All the main functionalities such as line following, sensor fixing, taking reading, sending the readings were finalized also the android application design was planned. The application design contains what are the readings to be placed on the screen, proper navigation. Finally the integration between the hardware and software was planned. As the last step Arduino IDE (Integrated Development Environment) is finalized to develop the hardware programming and android studio is finalized to develop the android application.

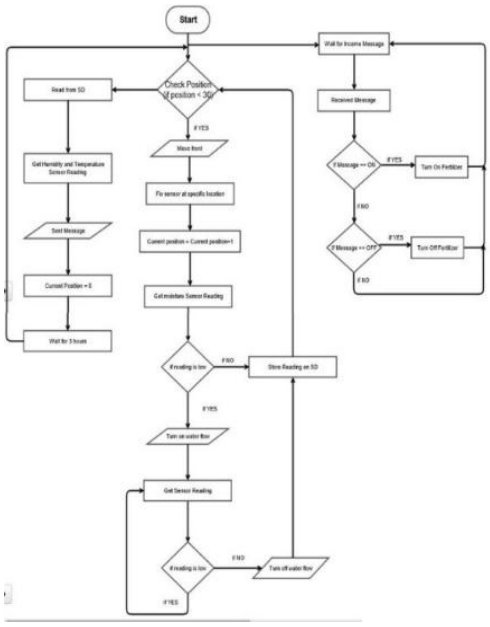

Figure 2 Flow Chart

The Figure2 flow chart explains the major functionalities and the workflow of the robot "Ag (ro) ^{2}bot"

3.4 Implementation

The goal was to implement a system correctly, efficiently, and quickly. With the quick design a working model of the product is implemented. Android Studio used for android application implementation and the hardware programming done through Arduino IDE. As the very first step the robot was implemented to move all around the farm. Added IR sensors and implemented the robot to follow the line and it reached the correct position where the plants are kept. When the robot reaches the plant by reading Black values in both IR sensors, it fixed the moisture sensor into the plant for this a servo motor and soil moisture sensor is used. The robot can identify whether a plant needs water or not using sensor readings, it implemented to flow the water according to the sensor reading. To achieve this used water flow controller is used. If the water level is lower then it should flow water else it should unfix the sensor and move the front to the next planet. Likewise the robot is implemented to check all the plants in his path. When last plant is reached it checked the humidity and

temperature. All readings and sent to the developers, mobile through SMS. Data is pushed to web server from the developer's mobile phone. An Android application is built to view the details in the webserver.

3.5 Testing

Ag(ro)^{2}bot was tested using two testing methods. In unit testing each and every function tested individually. First checked for following the line correctly, likewise the robot tested for all the functionalities stated in the figure 2 flow chart. In integration testing, whole robot and android application were tested along with all functionalities to make sure that the whole system works without any error.

4. FIGURES/CAPTIONS

The Ag(ro)^2 bot is developed as Robot and It connects to Android Application Through Webserver. Interfaces related to the functionalities in both the Robot and the android application are described in this section

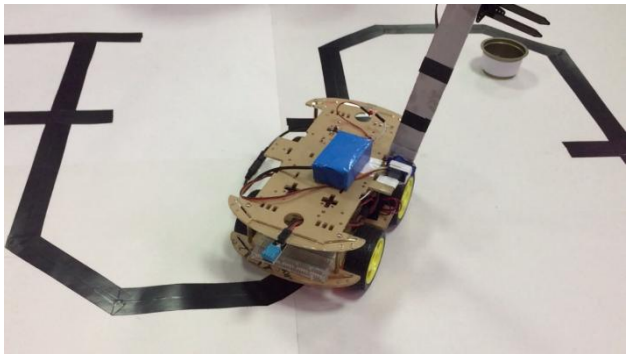

Figure 3 Fixing Sensor

The above Figure 3 represents Ag(ro)^2 bot fix the sensor. It must fix the sensor in each and every plant in the Greenhouse and get the soil moisture reading.

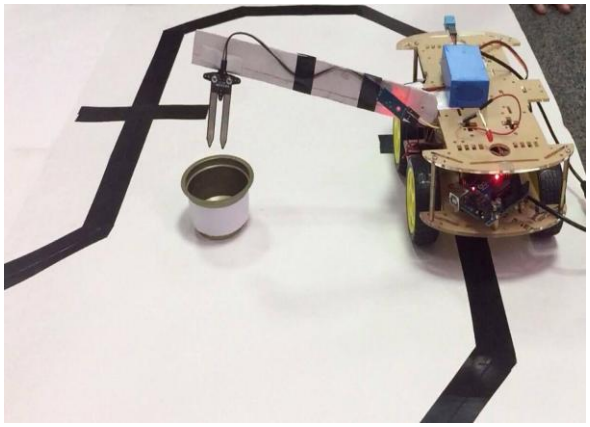

Figure 4 Ag(ro)2bot Moving

The above Figure 4 represents Ag (Rio) ^{2} but move the Black and White Path. Ag(ro)^{2}bot have IR sensor. So It Identify black and white surface and moved.

Figure 5 Mobile App Main Page

The Figure 5 represents Ag(ro)^{2} bot Android Application Main Menu. In this place Greenhouse owner can select which page they want to see.

Figure 6 Mobile App Watering Details

The Figure 6 represents Ag(ro)^{2} bot Android Application "Plant watering information" Menu. In this place Greenhouse owner can view the watering details in every 3hours.

Figure 7 Mobile App Greenhouse details

The Figure6 represents Ag(ro)^{2} bot Android Application Greenhouse information page. In this place Greenhouse owner can view the Greenhouse temperature and humidity level in every 3hours.

Figure 8Mobile App Alert Message

The Figure 8 represents Ag(ro)^2 bot Android Application Alert Message page. In this place Greenhouse owner can get Fertilizing alert message in every 3 months.

5. DISCUSSION

Human Computer Interaction Technology very well recognized prominent place in the World. In this Ag(ro)^{2}bot, it was started following the line. When it reached the plant then it was stopped. So the position of the plants was identified here to fix the sensors. Then the sensors were fixed into the plant with the support of servo motor. Sensor readings were sent to the Arduino. When the sensor readings were higher than optimal level, then it unfixed the sensor and it moved to the next plant. When the reading was lower than the optimal level, water was passed through the water flow controller. When the value of sensor reading reaches the optimum level, then the flow of water was stopped. Then it unfixed the sensors and moved to the next plant.

Until it reaches the final plant, it did the same procedure mentioned above. When the system reached the final position (initial position). It reads the temperature and humidity values of the Greenhouse environment, then it send a message with the details of the sensor readings to the web server.

a. Interview was conducted to get an Interview from Greenhouse Owner Greenhouse information.

b. Data gathered through the Interview was analyzed to what are the critical works in the greenhouse and how to reduce those critical levels.

In order to gain a highly reliable system, the following technologies and software were used.

a. Assume Sensors give accurate readings of the soil, water level, temperature and humidity level of Greenhouse

b. Used Webserver (JSon) to get details from Ag(ro)^{2}bot and pass to Android Application On timely Manner

c. Android studio was used as the IDE to develop the android application.

d. Rearrange-able layout library was used to give user friendly interfaces to the users.

6. CONCLUSION

Sri Lanka is still a developing their Agriculture techniques to improve the productivity. This Ag(ro)2bot are hoping to provide some benefits to the Greenhouse owners to maintain their Greenhouse easily. There is no doubt that Sri Lankan Greenhouse owners are still having a trouble in Greenhouse management.

Ag(ro) 2bot can check the plant water level, if plants need water it can watering. And it checks Greenhouse temperature, humidity level, all details saved. So it is very easy to reduce owners' workload.

Ag(ro)2bot send reminding message for Greenhouse owner in every 3 months for fertilizing the Greenhouse. In the mobile application in every 3 hours it updates Greenhouse temperature and humidity level and plant watering level. All records display in clear view and save it. This is aimed to fulfill all the objectives of this Ag (ro)2bot and hope our research would be of benefit on a local level. Hope that this study will be helpful for the researchers who are interested in the automated system and will develop similar models or to develop the same device further and use this concept with other hi-tech automation projects.

During the development of the project the following are the limitations are figured out:

a. Greenhouse Owner should use smart phones with adequate processing power.

b. All the functionalities of the "Ag(ro)2bot"- Automated intelligent farm care system for Greenhouse system should always be available.

c. Lithium battery life.

d. Ag(ro)2bot only detect the black and white path.

e. Temperature and humidity sensor should have taken accurate readings.

f. Aurdino UNO have a limited number of pins. So dived them is most critical stuff.

g. More than 12V voltage Aurdino will burn.

Ag(ro)2bot- Automated Intelligent Farm Care System for Greenhouse have some limitation but when did some works and overcome those issues.

a. Greenhouse owner charge the Ag(ro)^{2}bot in every two days. So we can maintain that battery life.

b. IR sensor only detects the black and white path. So we draw the black path in the greenhouse and set the pots. So Ag(ro)^{2}bot easily move around the Greenhouse environment.

c. In every month, check the sensors clean the sensor. So we can get accurate output from those sensors.

d. Use those kind of techniques and get more benefits from Ag(ro)2bot.

7. FUTURE WORK

Sri Lanka is now showing a rapid development in IT industry and Agriculture industry, with these developments everyday activities are getting automated. It makes people depend on technology instead of other people. In this current trend our

project Ag (ro) 2bot would be a great step into Agriculture industry. It expects the future to provide the following:

- Ag(ro)^{2}bot will fertilize the greenhouse.
- It will identify the plant disease and capture that plant and send it to a mobile phone owner.
- It will identify the plant disease and inform owner what the illness is having.

8. ACKNOWLEDGMENT

The project team of Ag(ro)^{2}bot would like to declare our honest sense of gratitude to our institution - Sri Lanka Institute of Information Technology (SLIIT). We are acutely beholden whose help, stimulating suggestions, knowledge, experience and encouragement helped us in all the times of study and analysis of the project in the pre and post research period. Also very special thanks to Mr. Yasas Jayaweera for their endless support given at times of difficulty as well as to our seniors and the lecture panel. The completion of this undertaking could not have been possible without the participation and assistance of so many people whose names may not all be enumerated

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