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Multifunction robot for reducing sensors count in greenhouse monitoring

Abstract:
Over the years, greenhouse systems have been utilized to regulate the ambient conditions of precious crops in an effort to increase agricultural productivity. The crucial elements of a typical greenhouse are the construction of a polyhouse, the placement of artificial lighting, the careful use of vents, watering methods, and the calculated application of insecticides and pesticides, among other things. Numerous factors are crucial for optimum plant development, including soil moisture, temperature, humidity, light intensity, greenhouse layout, and plant spacing. Various monitoring and control methods have been suggested and put into practice for automated greenhouses throughout the years. For parameter monitoring in different plots of a green house, a number of sensors are often needed in green house automation.The interface between these sensors and the monitoring device is crucial. In exchange for a fee, several wired and wireless sensor networking solutions are being tested. This paper focuses on adopting a robotic approach to reduce the sensor count in the automated greenhouse system. The need of multiple sensors is eliminated as the robot can move across the greenhouse to collect data at required locations.

Keywords: *greenhouse monitoring, temperature, humidity, soil moisture, light intensity, GSM,*

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I. Introduction

Although greenhouses are an excellent method to provide plants year-round, they are only as successful as the constantly changing weather. Planning ahead would not always be helpful since, despite our ability to anticipate the weather to a significant degree, the predictions are not always 100% right. Frost, dampness, and overheating are a few of the issues that might arise and harm the plants. Automated environmental control systems, such as those used to maintain a fish tank's required water temperature, can adapt to rapid, unforeseen changes. Less plants would be harmed if they could adapt to the changing weather. All greenhouses now in operation across the world include monitoring and control as a key component. It is vital to construct a measurement and control system in order to monitor the greenhouse environment parameters properly. The current study is primarily focused on developing a system for tracking various environmental and/or other factors in a predetermined remote location. We can identify the circumstances that are present at any given moment using a variety of sensors, and we may take action if any parameter or condition exceeds or falls below a pre-specified range. Additionally, by leveraging wireless technology, we are able to operate over a far larger region than we could have done with a conventional wire-based system.

A wireless sensor network (WSN) is a system consisting of a collection of nodes and a base station. A node is composed by a processor, local memory, sensors, radio and battery and a base station is responsible for receiving and processing data collected by the nodes [1]. The technological development in Wireless Sensor Networks made it possible to use in monitoring and control of greenhouse parameter in precision agriculture. In last decades there have been tremendous advancements in technology for agriculture and growth of final yield [2]. The use of computational systems and technology in agricultural applications has become viable, since the associated costs are decreasing [3]. In agricultural applications, monitoring and control are essential to support consumer requirements and to get productivity improvements. Two important branches of agriculture are precision agriculture and vegetable cultivation in greenhouses, in which the production management has to be more controlled, so that the values of a set of parameters have to be approximated to a value considered ideal [4]. Temperature, humidity, soil water contents, radiation and CO2 concentration are the major features that are monitored in greenhouses. Wireless sensor networks are applied in greenhouse control systems, providing a distributed and real time sensing, obtaining parameters values differences inside the greenhouse [5].

Wireless sensors and smart transducers are equipped with some micro-controllers for providing data processing and network management capability. IEEE 1451.5 standard is also suitable to integrate the wireless sensors with the special transducer to build wireless sensors with sensing, computing and communication capabilities. Intelligent sensors and actuators can be used to carry out various automatic functions. A

requirement for design of wireless sensor communications, including issues related to wireless sensor model, user requirements, data integrity, security and bandwidth all are well defined in this Standards [6].

Green house environment monitoring technology has continuously improved, and good greenhouse environment can improve crop quality, short the growth cycle and increase production, which have very important theoretical significance and value for study. Android based embedded system can closely monitor and control the climate parameters: humidity, temperature, soil moisture, light of a greenhouse on a regular basis [7].

Wireless sensor network technology, although under development, seems to be promising mainly because it allows real time data acquisition. However, for such agricultural application to be developed, some technological challenges should be resolved. A greenhouse is a controlled environment and does not require a lot of climatic parameters to be controlled. The use of this technology in large scale seems to be something for the near future. In this application, the great number of climatic parameters can be monitored using the sensors available. As a greenhouse is a relatively small and controlled environment, and energy is a limited resource, the possibility of replacing batteries or even resorting to a steady energy source adaptation is a constructive aspect [8].

Automated greenhouse monitoring system consists of various sensors, namely soil moisture, temperature and light. These sensors sense various parameters temperature, soil moisture and light intensity and are then sent to the controller and control action taken by comparing with preset values. Thus, agricultural greenhouse monitoring system eliminates risk of greenhouse not being maintained at specific environmental conditions due to human error and labor cost can be reduced and it is eco-friendly [9].

II. System Development

Figure 1 shows the block diagram of greenhouse monitoring robot. The functioning of this robot is divided into two parts as data acquisition unit and motor wheeling unit. The data acquisition unit is equipped with soil moisture sensor (Capacitive type), light intensity sensor (BH1750), temperature & humidity sensor (DHT11), a servo motor and GSM module. The soil moisture sensor is attached to the servo mechanism through which the sensor is inserted in the soil when measurements are taken. The data sensed by these sensors is communicated to the end user via SMS through the GSM module. The wheeling unit as shown in figure 2 is a line following architecture. It moves the robot throughout the green house on a predetermined track. The robot structure is included with infrared sensor which assist it for follow a line thus making it line follower robot. It is recommended to create such a line path with previously marked strategic point along the path at which the data of environmental parameters is to be gathered. At every such marked point robot takes pause and sends the data of all the sensors at the particular point and then moves forward to gather the data of next marked point. Thus, during this movement, sensors fitted on the robot only moves and hence it eliminates the need of multiple sensors for each plot in the greenhouse.

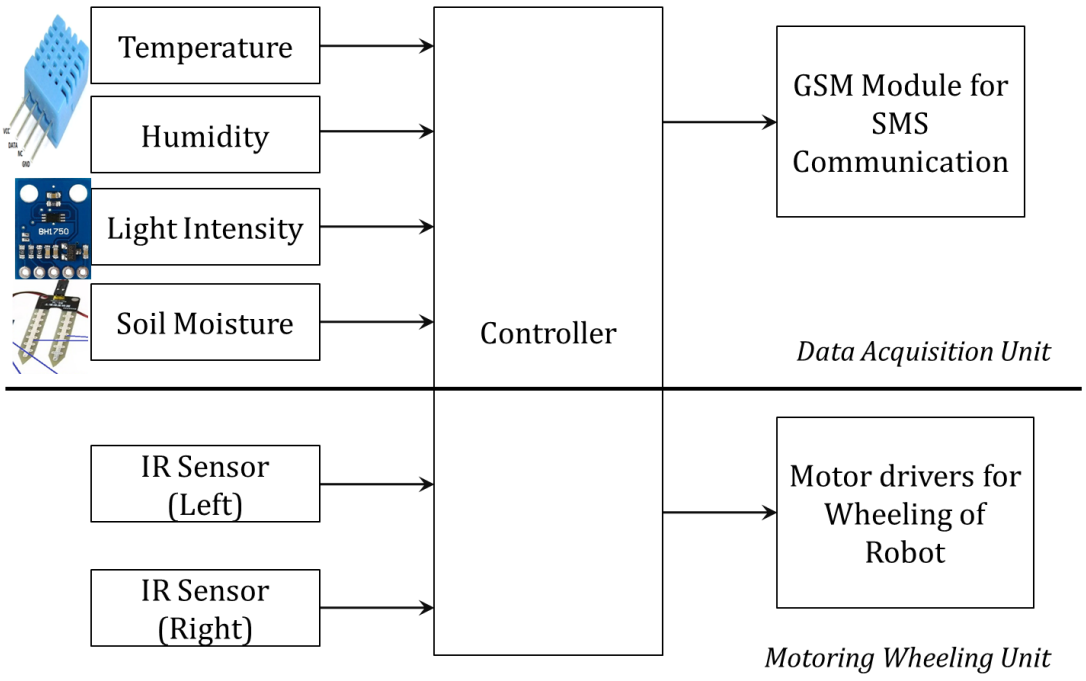

Figure 1: Block Diagram of Green House Monitoring Robot

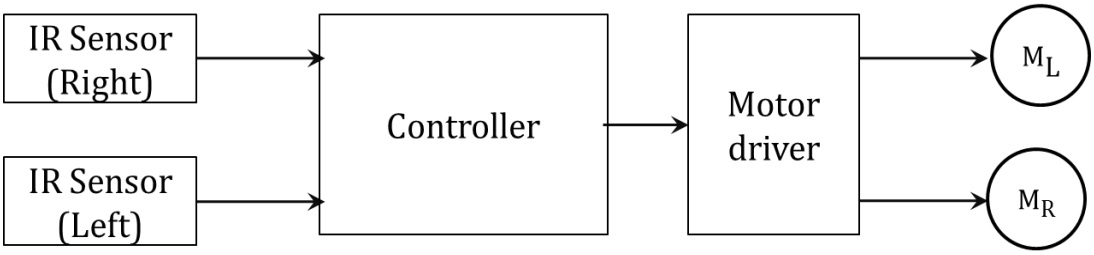

Figure 2: Wheeling unit of greenhouse monitoring robot

III. Results and Discussion

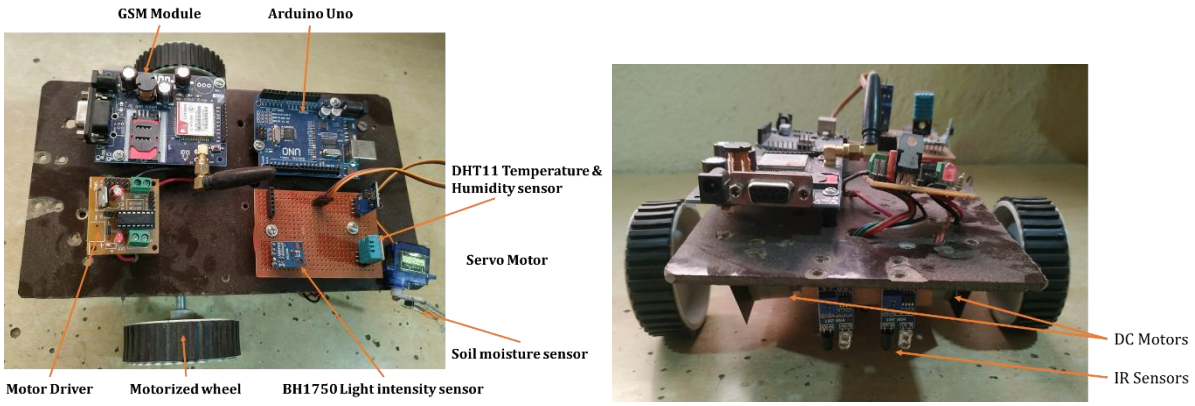

Figure 4: Photographs of developed greenhouse monitoring robot

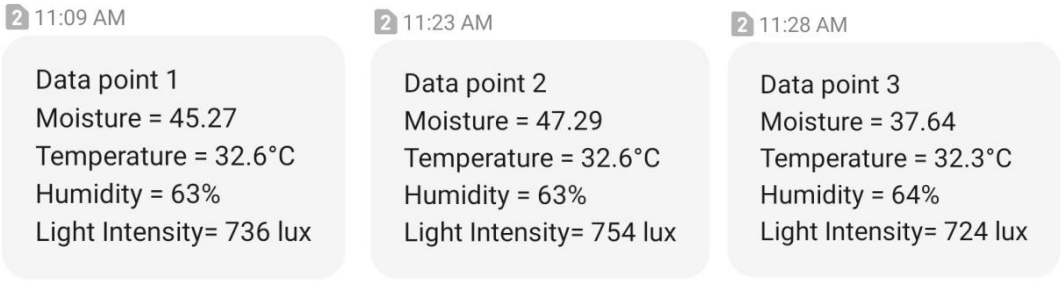

Figure 4: screenshots of SMS Received by the user

The photograph of developed greenhouse monitoring robot is shown in Figure 4. Figure 4 shows the message sent by the robot at previously marked strategic point as read at the user mobile screen. Also, for smooth operation of the robot and overall monitoring of the green house, the necessary path for the robot to traverse through the green house was created over which robot traversed smoothly.

IV. Conclusion

The monitoring with robot is effective way to reduce number of sensor required for green house monitoring and automation systems. This serves to be a compact and cost effective solution for complex wired and wireless sensor networks. For implementation of this robot certain reforms are essential in conventional green house for making a permanent track for traverse of the robot and marking of data collection point with RFID tags or a parallel system.

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