Implementation of a Mobile Measuring Station For the Purpose of Measuring and Controlling the Greenhouse Application

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Abstract — This paper introduces the development of an intelligent agent, robot-sensor networks for greenhouse surveillance and monitoring of environment parameters. The goal is supervision, monitoring and remote sensing of territories. The primary task of the robot is to acquire data on the condition of the ecology system (working environment). The robot explores environment, collects all the necessary data and sends it to the main server for further processing via wireless sensor network.

Keywords – WSN, Sun SPOT, embedded system, PIC, Mobile robot, Greenhouse

Introduction

The paper deals with the implementation of mobile measuring station in greenhouse environment. It introduces a wireless sensor network that was used for the purpose of measuring and controlling the greenhouse application. Continuous advancements in wireless technology and miniaturization have made the deployment of sensor networks to monitor various aspects of the environment increasingly flexible. The function of a greenhouse is to create the optimal growing conditions for the full life of the plants. Using autonomous measuring systems helps to monitor all the necessary parameters for creating the optimal environment in the greenhouse. The robot equipped with sensors is capable of driving to the end and back along crop rows inside the greenhouse. Users can watch the on-line videos provided by the web cameras. With obstacles present in the unknown environment, the mobile robot reacts based on both the sensed information of the obstacles and the relative position of the target In moving towards the target and avoiding obstacles, the mobile robot changes its orientation. When the obstacle in an unknown environment is very close, the mobile robot slows down and rapidly changes its orientation. The navigation strategy is to come

as near to the target position as possible while avoiding collision with the obstacles in an unknown environment.

Routing Management of the WSN

Increasing computing and wireless communication capabilities will expand the role of the sensors from mere information dissemination to more demanding tasks as sensor fusion, classification, collaborative target tracking. This paper current provides comprehensive investigation of different routing schemes used in wireless sensor networks. routing protocols may be classified in to one of the ensuing three models :

- single hop model
- multi-hop model
- cluster-based hierarchical model.

Single hop is the simplest model to reach a base station or the sink node. however, This kind of single hop transmission is highly unrealistic in the real world. The multi-model supports the collaborative effort of several nodes within the sensor cloud. each sensor node has a radio range, which is referred to as the distance which the signal strength remains above the minimum usable level for that particular node to transmit and receive.

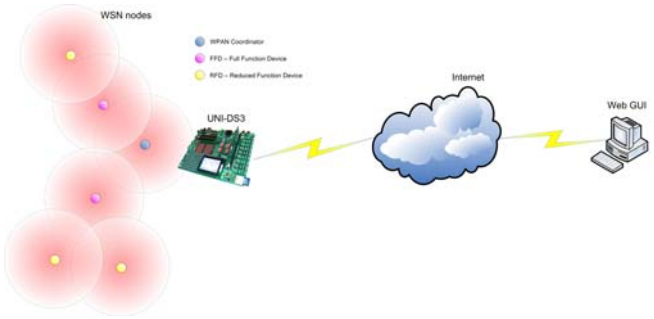

Figure 1. Schematic of the operational sensor network

In the cluster based model, the network is divided into clusters comprising of number amount of nodes. Cluster head, which is master node, within each respective cluster is responsible for routing the information to other cluster head.

Measuring Station

The Board Of Education is a complete, low-cost development platform equipped with the needed sensors for humidity, temperature, light, etc. The Boe-Bot is a great tool with which to get started with robotics.

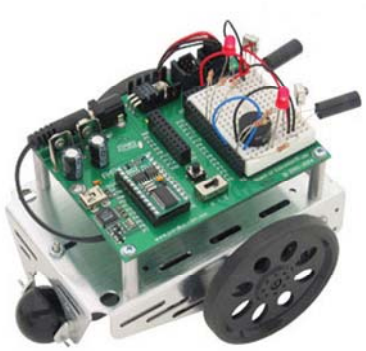

Figure 2. Assembled Boe-Bot

The SunSPOT WSN module makes it possible for the Boe-Bot robot's BASIC Stamp 2 microcontroller brain to communicate wirelessly with a web based user interface running on a nearby PC. The BASIC Stamp microcontroller runs a small PBASIC program that controls the Boe-Bot robot's servos and optionally monitors sensors while it communicates wirelessly with the web server.

Greenhouse Control Parameters

Water vapor inside the greenhouse is not one of the most important variables affecting the crop growth. However, the humidity control has a special interest, because high humidity may produce the appearance of diseases and decrease transpiration, and low humidity may cause hydric stress, closing the stomata, and thus reducing the photosynthesis due to a decrease in the CO_2 assimilation.

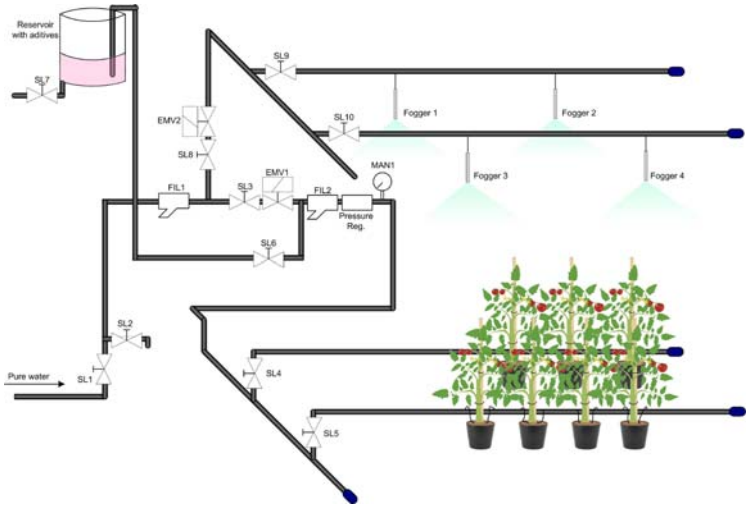

Figure 3. Humidity and irrigation system

There are two problems involved in the humidity control: (1) the greenhouse inside temperature and the relative humidity are inversely related when the greenhouse air not mixed with the external air, generally colder and drier (when one of them increases the other one decreases and vice versa); (2) the same actuators are used for controlling temperature and humidity. The temperature control has the main priority because it affects to the crop growth directly. In order to keep the humidity within a determined range, the temperature set-point can be changed based on the inside relative humidity value. Hence, the humidity controller acts as a set-point generator being able to change the temperature set-point in small ranges. The modification of the temperature set-point value depends on actual humidity level, selecting a maximum allowable modification for a specific kind of crop. A lower temperature set-point allows evacuating the humid air as a consequence of the exchange with the outside air because it is drier than the internal air. However, a higher set-point provokes that the ventilation remains closed for longer periods of time keeping the water vapour of air inside the greenhouse, and so increasing the humidity.

Plants grow under the influence of the PAR radiation (diurnal conditions), performing the photosynthesis process. Furthermore, temperature influences the speed of sugar production by photosynthesis, and thus radiation and temperature have to be in balance in the way that a higher radiation level corresponds to a higher temperature. Hence, under diurnal conditions, it is necessary to maintain the temperature in a high level, being optimal for the photosynthesis process. In nocturnal conditions, plants are not active (the crop does not grow); therefore it is not necessary to maintain such a high temperature.

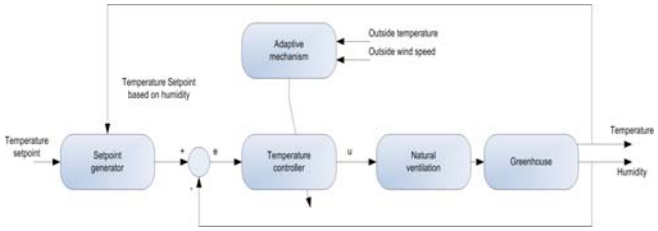

Figure 4. Temperature controller

On the other side, the nocturnal temperature control problem is the heating of the greenhouse (with temperatures lower than the nocturnal set-point) using heating systems to reach the nocturnal optimal temperature. The modification of the temperature set-point value depends on actual humidity level, selecting a maximum allowable modification for a specific kind of crop. A lower temperature set-point allows evacuating the humid air as a consequence of the exchange with the outside air because it is drier than the internal air.

Solution

Robotics has come a long way, especially for mobile robots. In the past, mobile robots were controlled by heavy, large, and expensive computer systems that could not be carried and had to be linked via cable or wireless devices. Today, however, we can build small mobile robots with numerous actuators and sensors that are controlled by inexpensive, small, and light embedded computer systems that are carried on-board the robot. Building and programming a robot is a combination of mechanics, electronics, and problem solving. What you're about to learn while doing the activities and projects in this text will be relevant to "real world" applications that use robotic control, the only difference being the size and sophistication. The mechanical principles, example program listings, and circuits you will use are very similar to, and sometimes the same as, industrial applications developed by engineers. In this project we have used SunSPOT-s to achieve remote control over a Boe-Bot. For this project we have used 2 SunSPOT-s from the kit (free range and base station module). SunSPOT's wireless protocol is Zigbee based protocol.

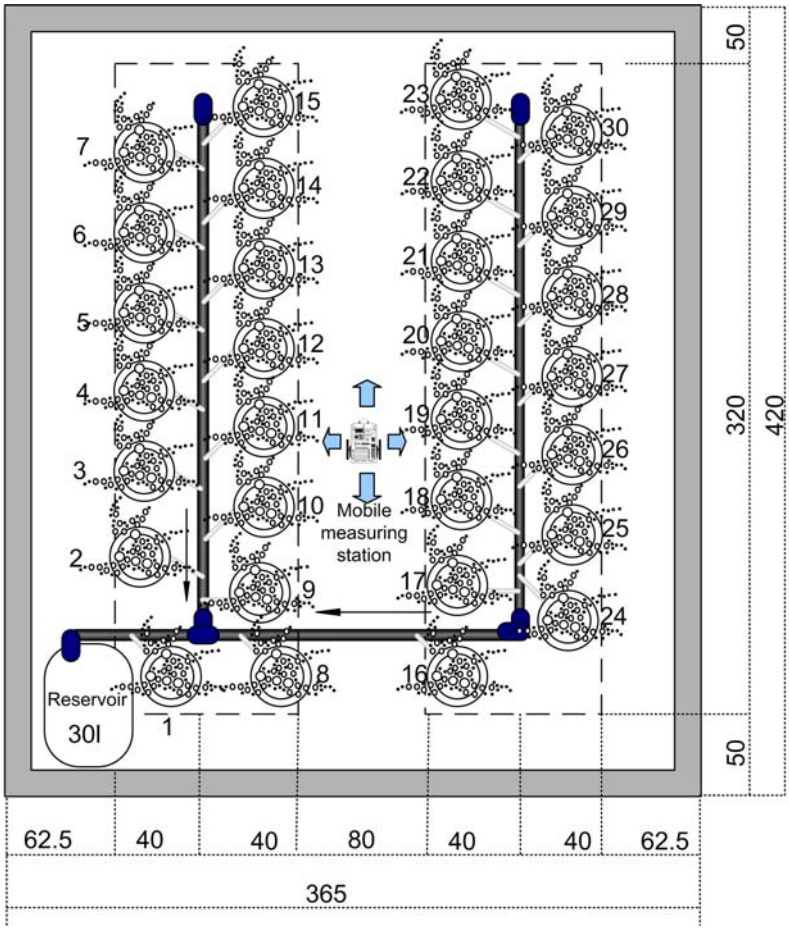

Figure 5. Greenhouse top view with the mobile measuring station

The Hardware basically centers around Sun SPOT and DC Motors controlled by Basic Stamp. The Sun SPOT base station will send data to Sun SPOT on the mobile measuring station which will drive the Basic Stamp controller to DC IO pins. The microcontroller will drive the Motors which will run the measuring station.

Conclusion

The applications for WSNs are many and varied. They are used in commercial and industrial applications to monitor data that would be difficult or expensive to

monitor using wired sensors. They could be deployed in wilderness areas, where they would remain for many years (monitoring some environmental variable) without the need to recharge/replace their power supplies. They could form a perimeter about a property and monitor the progression of intruders (passing information from one node to the next). There are a many uses for WSNs.

Figure 6. Crops in greenhouse

Typical applications of WSNs include monitoring, tracking, and controlling. Some of the specific applications are habitat monitoring, object tracking, nuclear reactor controlling, fire detection, traffic monitoring, etc. In a typical application, a WSN is scattered in a region where it is meant to collect data through its sensor node. The WSN-based controller has allowed a considerable decrease in the number of changes in the control action and made possible a study of the compromise between quantity of transmission and control performance. The limit of the level crossing sampling has presented a great influence on the event based control performance where, for the greenhouse climate control problem, the system has provided promising results. Motion control of mobile robots is a very important research field today, because mobile robots are a very interesting subject both in scientific research and practical applications. In this paper the object of the remote control is the Boe-Bot. The vehicle has two driving wheels and the angular velocities of the two wheels are independently controlled. When the vehicle is moving towards the target and the sensors detect an obstacle, an avoiding strategy is necessary. The host system connects to the mobile robot with the SunSPOT module. A remote control program has been implemented.

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