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Arduino Based Pest Control Using Real Time Environmental Monitoring Sensors

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Abstract

This paper strives to develop a robot capable of performing operation of dispensing pest control agents, obstacle avoidance for self-guidance on the field without any user interference and create a sterile environment for the optimum growth of the crops in a real time monitored closed environment.

Keywords:*Agricultural engineering, Crops, Microcontrollers, Intelligent robots, Recycling, Vegetation, Water conservation*

1. Introduction

1.1 Robot in agriculture- Agrobot

The robot utilises a pump for dispensing the pest control agent. The pest control agent is preferably a liquid which can be sprayed on the plants. The obstacle avoidance setup consists of an Ultra sonic Distance measuring transducer sensor and L293D Arduino motor drive controller. The robot is manually switched on or off using a Bluetooth module placed on the robot which is paired with a Bluetooth enabled Cell phone carried by the user.

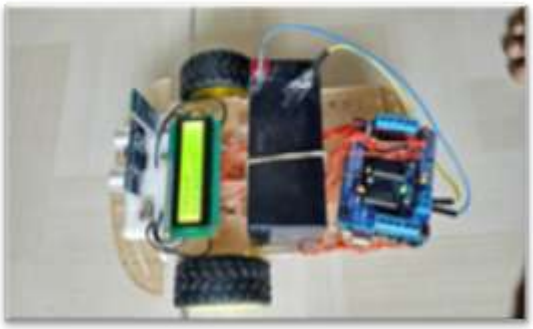

Figure 1 Robot

1.2 Vertical farming

The Farming environment show cased in this paper is called Vertical Farming. The Vertical Farming is the advanced level of agricultural technology where this has to be practised when there is unavailability of land and other requirements for the perfect structure of farming, this is the new way or approach in the advanced level. Vertical Farming utilises Hydroponic and the Aeroponic methods for efficient growth of the plants. Hydroponics is a subset of hydroculture, the method of growing plants without soil, using mineral nutrient solutions in a water solvent. Terrestrial plants are grown with only their roots exposed to the mineral solution. Aeroponics is the technique of growing plants by suspending their roots in the air and spraying them with nutrient solutions.

1.3 Real Time Monitoring system

The farming environment is constantly monitored by various environment parameter sensors interfaced with the Arduino board. The User is notified on his Cell phone through SMS sent by the GSM module interfaced with Arduino board. The user is typically alerted about the physical parameters like pH, humidity and the temperature. Also the same can be viewed on a 16x2 LCD display.

2. System Architecture

The simplicity of the robot can be judged by the following block diagram.

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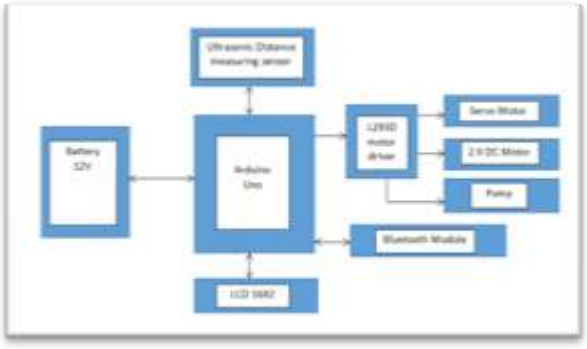

Figure 2 Robot Block Diagram

The necessary real time environmental sensors are interfaced with the Arduino Mega.

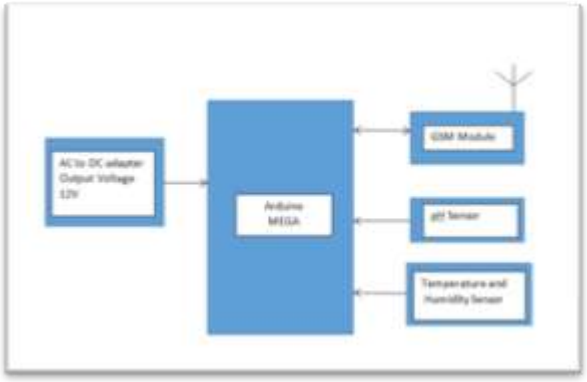

Figure 3 Real Time monitoring system at the farm

2.1Arduino Uno

Arduino Uno Rev3 is a microcontroller board based on the ATmega328P, an 8-bit microcontroller with 32KB of Flash memory and 2KB of RAM. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, and a reset button.

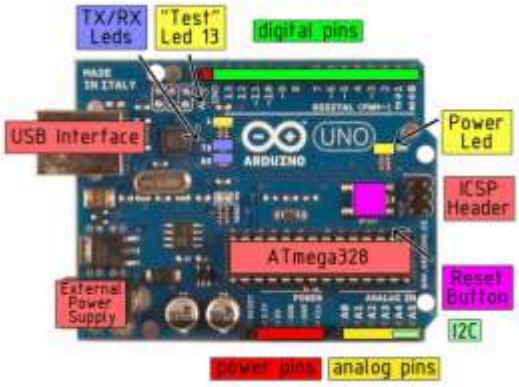

Figure 4 Arduino Uno

2.2 L293D Motor driver shield for Arduino

The shield contains two L293D motor drivers and one 74HC595 shift register. The shift register expands 3 pins of the Arduino to 8 pins to control the direction for the motor drivers. The output enable of the L293D is directly connected to PWM outputs of the Arduino. Up to 4 bi-directional DC motors with individual 8-bit speed selection can pe interfaced. Terminal blocks are provided to easy hook up of wires.

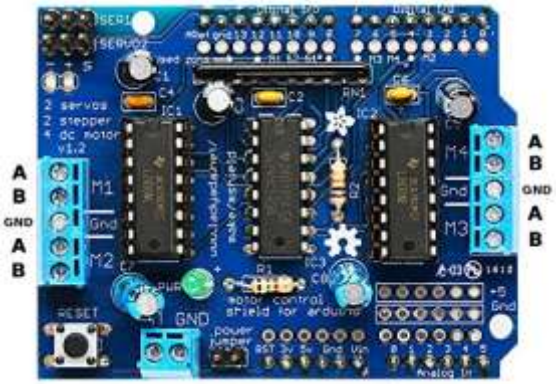

Figure 5 L293D Motor driver shield

2.3 Ultrasonic Sensor HC-SR04

The HR-SR04 ultrasonic sensor uses sonar emission technique to determine distance. A model of the HC-SR04 Ultrasonic Module is given in the figure 6. It offers range detection without contact but with high accuracy of stable readings to use the package in an easy manner. But acoustically soft materials like cloth can be difficult to detect. It comes with a complete ultrasonic transmitter and receiver module.

Figure 6 Ultrasonic Sensor HC-SR04

2.4 Bluetooth Module HC-05

HC-05 module is an easy to use Bluetooth) module, designed for wireless serial connection setup. The module operates in the 2.4 GHz ISM band. The transmitted power is ≤4dBm. The module functions on +3.3V DC and 50mA current consumption.

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Figure 7 Bluetooth Module HC-05

2.5 Temperature and Humidity Sensor

The DHT11 is a basic, low cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and gives out a digital signal on the data pin (no analog input pins needed). The sensor holds good for 20-80% humidity readings with 5% accuracy and 0-50°C temperature readings ±2°C accuracy.

Figure 8 DHT11 Temperature and humidity sensor

2.6 pH Meter

An acidic solution has far more positively charged hydrogen ions in it than an alkaline one, so it has greater potential to produce an electric current in a certain situation, it's a like a battery that can produce a greater voltage. A pH meter takes advantage of this and works like a voltmeter: it measures the voltage (electrical potential) produced by the solution whose acidity we're interested in, compares it with the voltage of a known solution, and uses the difference in voltage between them to deduce the difference in pH. The pH meter has two probes a silver and a bronze probe, between which the potential is measured.

Figure 9 pH Meter

2.7 GSM Module

A GSM Module is basically a GSM Modem (like SIM 900) connected to a PCB with different types of output taken from the board, like TTL output (for Arduino, 8051 and other microcontrollers) and RS232 Output to interface directly with a PC (personal computer). The board also has pins to attach mic and speaker, to take out +5V or other values of power and ground connections. The module is configured and controlled via its Tx and Rx pins using AT commands.

Figure 10 GSM Module SIM900

3. Process Description

The process description is broadly classified into robot section and farm section. The robot section comprises of components that take care of pest control and collision avoidance. While the farm section comprises of environmental parameter measurements, Aeroponics and plants.

3.1 Robot section

The user is required to switch on the robot from his mobile phone which is paired via Bluetooth to the Bluetooth module fixed on the robot. The Arduino processes the distance measurements from the ultrasonic sensor and decides to move forward or take a slight turn due to an object in near vicinity. Simultaneously, the pump is turned on which pumps the pesticide or any nutrient medium, the direction of the nozzle is swayed in a periodic motion by a servo motor.
Thus the entire farm is covered by the robot in due course of time. When the user prefers to switch off the robot, he gives the stop command from his paired mobile phone.

3.2 Farm Section

The vertical farm consists of stacks of plates arranged on top of one another on which the plants are allowed to grow. The plants are allowed to grow over a cloth which is stuck on each plate, through which the roots can penetrate while growing. The root is exposed to mist directly through pipes or simply by hanging the roots over a passage of mist. This mist primarily carries all the nutrients needed by the plant. Such technique is referred to as Aeroponics. Which is proven to be more water efficient and efficient in recycling water.
To increase efficiency of the growth of the plant we equip the farm with environment sensors. The sensors consist of the pH meter, temperature and humidity sensor (DHT 11). The values from these sensors are displayed on a LCD screen. Also to provide the user status of his/her farm while he/she is away, a GSM module is interfaced to the Arduino Mega. This module sends a SMS to the users phone number containing the readings from the sensors.

4. Conclusion

On comparing productivity of outcome from conventional farming techniques it's noticed that productivity goes twice as high.

Due to preference of Aeroponics over traditional irrigation methods, water is conserved by 90%. The unabsorbed water is recycled.
Also usage of fertilizers is reduced, as the crops are grown in indoor conditions and chances of pests and rodents is less.
The waste produced at the farm like stems, fibrous roots damaged fruits and vegetables are to be utilised for vermicomposting, biogas generation and fodder for cattle.

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