Advanced Agricultural Robot Operated by Smart Phone

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Abstract— Agricultural Robot or agribot may be a robot deployed for agricultural purposes. Fruit picking robots, driverless tractor / sprayer, and sheep shearing robots are designed to exchange human labour. In most cases, tons of things need to be considered (e.g., the dimensions and colour of the fruit to be picked) before the commencement of a task. Robots are often used for other horticultural tasks like pruning, weeding, spraying and monitoring. Robots also can be utilized in livestock applications (livestock robotics) like automatic milking, washing and castrating. Robots like these have many benefits for the agricultural industry, including a better quality of fresh produce, lower production costs, and a smaller need for manual labor. Our robotic vehicle is an agricultural machine of a substantial power and great soil clearing capacity. This multipurpose system gives a complicated method to seed sowing, ploughing, watering the crops and harvesting with minimum man power and labour making it an efficient vehicle. The machine will cultivate the farm by considering particular rows and specific columns at fixed distance counting on crop. Moreover the vehicle are often controlled through Bluetooth medium using an Android smart phone. The whole process calculation, processing, monitoring are designed with motors and interfaced with Microcontroller.

Keywords: Microcontroller and ultra-sonic sensor, EPROM, Stepper motor, D.C Motor

I. Introduction

"The discovery of agriculture was the first big step toward a civilized life. "Is a famous quote by Arthur Keith. This emphasizes that the agriculture plays a vital role in the economy of every nation. Since the dawn of history agriculture has been one among the many earnings of manufacturing food for human utilization. Today more and more lands are being developed for the assembly of an outsized sort of crops. The field of agriculture involves various operations that require handling of heavy materials. For example, in manual ploughing, farmers make use of heavy ploughing machines. Additionally, while watering the crops farmers still follow the traditional approach of carrying heavy water pipes. These operations are dull, repetitive, or require strength and skill for the workers. In the 1980's many agricultural robots were started for research and development. Kawamura and co-workers developed the fruit harvesting robot. Grand and co-workers developed the apple harvesting robot. They have been followed by many other works. Over history, agriculture has evolved from a manual occupation to a highly industrialized business, utilizing a wide variety of tools and machines. Researchers are now looking towards the belief of autonomous agricultural vehicles. The first stage of development, automatic vehicle guidance, has been studied for many years, with a number of innovations explored as early as the 1920s. The concept of fully autonomous agricultural vehicles is way from new; samples of early driverless tractor prototypes using leader cable guidance systems go back to the 1950s and 1960s. The potential benefits of automated agricultural vehicles include increased productivity, increased application accuracy, and enhanced operational safety. Additionally, the rapid advancements in electronics, computers, and computing technologies have inspired renewed interest within the development of auto guidance systems. Various guidance technologies, including mechanical guidance, optical guidance, radio navigation, and ultrasonic guidance, have been investigated. A robot may be a machine which will be programmed and reprogrammed to try to certain tasks and typically consists of a manipulator like a claw, hand, or tool attached to a mobile body or a stationary platform.

A. *The Current State of Agricultural Robotics:*

Today agricultural robots can be classified into several groups: harvesting or picking, planting, weeding, pest control, or maintenance. Scientists have the goal of creating robot farms. Where all of the work will be done by machines. The main obstacle to this kind of robot farm is that farms are a part of nature and nature is not uniform. It is not like the robots that work in factories building cars. Factories are built around the job at hand, whereas, farms are not. Robots on farms have to operate in harmony with nature. Robots in factories don't have to deal with uneven terrain or changing conditions. Scientists are working on overcoming these problems.

B. *Robots Used for Agriculture:*

The number of agricultural robots, agrobots, is increasing each year. The jobs they can do are also increasing with new technology in hardware and software. Robots are milking cows, shearing sheep, picking fruit, weeding, spraying, and cultivating, they use GPS and sensors for navigation. The new robots are getting smaller and smarter.

C. *Fungicides:*

Robots can be used to combat plant diseases that cause a lot of damage to crops. Fungi are the most common causes of crop loss in the entire world. To kill a fungal disease you need a fungicide, a kind of pesticide. Fungal diseases interfere with the growth and development of a crop. They attack the leaves which are needed for photosynthesis and decrease the productivity of the crop and cause blemishes on the crops which make them worth less on the market. After the crops are harvested fungi can grow and spoil the fruits, vegetables, or seeds. Robots can treat plants that have been infected or destroy them if necessary. They could treat just the plants that need it, instead of covering the entire crop with fungicide.

D. *Herbicide:*

Another use for robots is in weeding. Robots can pull weeds from around the plants or just cut the tops off. All of the material can be collected by a robot and brought to a composting site limiting the need for herbicides, chemicalsthat destroy or inhibit the growth of plants. Herbicides are intended to kill weeds but many times also damage the crops.

E. Pesticide:

Pesticides are used to control insects that can be harmful to crops. They are effective but have many side effects for the environment. Insects also adapt to the toxin in a pesticide and the survivors breed and pass the resistant trait on to the next generation making stronger insects that are harder to kill. Robots could solve this by removing pests from the crops without using chemicals. They might suck them up with a vacuum. A bellow base air system makes a vacuum that doesn't require the large amount of power of regular vacuum systems. There are ways to kill the insects without chemicals. Microbial fuel cells could be used to reduce the insects to electrical power with bacteria. Pesticides kill everything. Robots could be programmed to rid particular pests and not harm anything else.

F. Mushroom Picking Robot:

Mushrooms are a very difficult crop to grow. There is a lot of labour involved. Many mushroom farms are becoming extremely high tech. They use computerized systems and monitor all production phases. The robot mushroom picker is an ongoing research project at the University of Warwick in the UK. Their goal is to develop farm machinery that can reduce the labour costs of producing farm crops, in this case, mushrooms. The robot picks the mushrooms using a small suction cap on the end of its robotic arm. The robot has a charged coupled camera on board to tell which mushrooms to pick in a tray or bed, since mushrooms mature at different times during a six to ten week period. It uses the camera to tell the exact size of the mushroom and only pick the correct ones. Mushrooms grow in dark, damp places that are often inhospitable to humans. This makes the robot a perfect choice to work on a mushroom farm. The robots can only work half as fast as a human, but it doesn't mind working in the dark, or for 24 hours a day.

II. LITERATURE SURVEY

The paper number [1] presents a streamlined approach to future Precision Autonomous Farming (PAF). It focuses on the preferred specification of the farming systems including the farming system layout, sensing systems and actuation units such as tractor-implement combinations. The authors propose the development of the Precision Farming Data Set (PFDS) which is formed off-line before the commencement of the crop cultivation and discusses its use in accomplishing reliable, cost effective and efficient farming systems. The work currently is in progress towards the development of autonomous farming vehicles and the results obtained through detailed mathematical analysis of example actuation units. The reference paper number [2] addresses the advanced weed control system which improves agriculture processes like weed control, based on robotic platform. They have developed a robotic vehicle having four wheels and steered by dc motor. The machine controls the weed in the firm by considering particular rows per column at fixed distance depending on crop. The obstacle detection problem has also been considered, sensed by sensors .the whole algorithm, calculation, processing, monitoring was designed with motors &sensors interfaced with microcontroller.

III. METHODOLOGY

In this project we will be designing a multipurpose vehicle that will be able to plough the land, sow the seeds, water the crops, level the land and carry out harvesting. We will be using an android smart phone application to control the vehicle to respond to the control signal. This type of vehicle should be useful for the farmers as a low investment option, also for the ease of use and friendly user interface it provides. Instead of buying 2 or more machines to carry out the various functionalities, the farmer can get his work done by using our single efficient multipurpose agribot. Agribot is deployed on a metal sheet developed with inbuilt roller and cultivator. The front end of the metal sheet is given the harvesting feature, while both Water pump used to water the crops and seed sowing will be added at the cultivator end. We use two motors to control the forward, backward, left and right movement. One motor each is used to control harvesting, seed sowing and watering the crops. The working begins when the Farmer opens the application and can press the options provided on the display screen. This android application is developed using Java. The Bluetooth on the android phone will send the RF signals serially, on the other hand the Bluetooth present in the robot will take actions according to the instructions given by the Farmer. We use Embedded C and Keil Vision compiler. The Interfacing is done using Microcontroller 8051. The heart of our robot is Intel's most powerful family of microcontroller 8051,we are using AT89C2051 Two microcontrollers IC2 is first microcontroller which acts as master controller decodes all the commands received from the transmitter and is responsible for executing all the commands received from the remote and also generating pwm pulses for the speed control .LD293 motor driver IC which drives two motors these two motors are vehicle driver motors and it also runs the motors for all other attachments of agriculture in the vehicle.

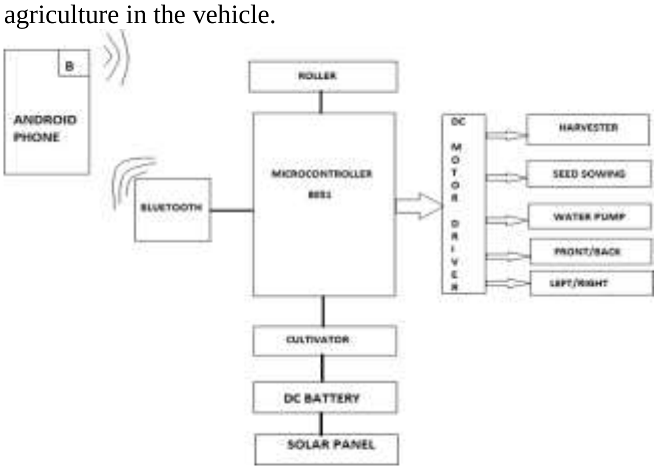

Fig. 1: Block Diagram of Agribot

IV. SYSTEM REQUIREMENTS SPECIFICATIONS

System requirements specification (SRS) is a text written to specify in detail the system components, both hardware and software, which are needed for the system implementation, along with functional and non-functional and operational requirements, as anticipated from the system.

A. Hardware Specification

This section gives details of the hardware components required for the system implementation and deployment. Agricultural Robot requires the following hardware components:

1) An android smart phone having Bluetooth facility that acts as a controller of the Agribot.
2) A microcontroller 8051 development board which acts as the heart of the robot and controls the entire device.
3) The IC used is 89S52.
4) Motor driver circuit L293 to increase the current rating.
5) Bluetooth HC05 module to establish connection with the smartphone and receive commands.
6) DC motors for performing the activities.

B. The Software Specification

This section gives details of the software components required by the intended system under development. Agricultural Robot requires the following software components.

1) Operating System: This application works well with android 4.0 and all versions above this.
2) Backend: Java will be used for developing backend of the Agribot application. Embedded C is used to program the agricultural robot.
3) Front End: It is developed using ADT Bundle toolkit and the language used is XML.
4) The cross compiler used is Keil Micro Vision 3.
5) Flash Magic software is used for dumping code into microcontroller.

V. FLOWCHART

Fig. 2: Flowchart Of overall System

Figure 2 shows the flow of events in overall system. The user activates Bluetooth Once connection is established he selects an activity from the list and the selected activity is performed until the stop signal is received.

VI. SYSTEM IMPLEMENTATION

This chapter explains at length how WSN BASED ADVANCED AGRICULTURAL VEHICLE OPERATED USING SMART PHONE - AGRIBOT can be implemented as a real time working system, rather than just being a creation in pen and paper. This chapter begins with the description of the various development platforms, utility software and other concepts used in the project and later moves on to show the important code snippets from the plethora of codes which have been used for the implementation.

A. Module 1: Sender Side - Android phone along with its user

Step 1: Initialize the intent request codes.
private static final int REQUEST_CONNECT_DEVICE = 1;
private static final int REQUEST_ENABLE_BT = 2;
Step 2: Note the message types sent from the Bluetooth ReadService Handler. public static final int MESSAGE_STATE_CHANGE = 1; public static final int MESSAGE_READ = 2;
public static final int MESSAGE_WRITE = 3;
public static final int MESSAGE_DEVICE_NAME = 4;
public static final int MESSAGE_TOAST = 5;
Step 3: Call an instance when the activity is first created. super.onCreate(savedInstanceState);
Step 4: Set up custom title and select the LED device using its ID. cmdBtn = (Button) findViewById(R.id.Load1ON); cmdBtn.setOnClickListener(this);
cmdBtn = (Button) findViewById(R.id.Load1OFF); cmdBtn.setOnClickListener(this);
Step 5: Save the connected device's name.
mConnectedDeviceName = msg.getData().getString(DEVICE_NAME);
Step 6 :Create a dialog box to indicate successful or unsuccessful message. AlertDialog.Builder builder = new AlertDialog.Builder(this);
Step 7: Prevent the phone from sleeping.

B. Module 2: Bluetooth- Connect the Agribot and the android phone

Step 1: Connect to Bluetooth module.
Step 2: Detect the list of devices.
Step 3: Check if visible devices are greater than zero.
Step 4: Check if the Bluetooth adopter is equal to NULL. Terminate the activity if it is equal to NULL.
if (mBluetoothAdapter == null)
{
finishDialogNoBluetooth(); return;
}
Step 5: Continue the process if the Bluetooth adopter is not equal to NULL. mConnectThread = new ConnectThread(device); mConnectThread.start(); setState(STATE_CONNECTING);
Step 6: Start pairing of devices.

C. Module 3: Agribot- Establish connection and perform activity

Step 1: Check whether DeviceListActivity returns with a device to connect.
Step 2: Get the device MAC address. String address = data.getExtras() .getString(DeviceListActivity.EXTRA_DEVICE_ADDRESS);
Step 3: Get the BLuetoothDevice object. BluetoothDevice device = mBluetoothAdapter.getRemoteDevice(address);
Step 4: Attempt to connect to the device if the request has been received. mSerialService.connect(device);
Step 5: Once device connected perform the activity based on the id received.

VII. SYSTEM TESTING

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a product. It provides a way to check the functionality of components, sub-assemblies, assemblies and/or a finished product. It is a process of exercising software with the intent of ensuring that the software system meets its requirements and user expectations and does not fail in an unacceptable manner.

The following are the design of the test cases that validate the functioning of the internal program logic and that the inputs produce valid outputs.

A. Unit Test Case: Activating Bluetooth

Test Case ID	Activate Bluetooth
Description	The application requires Bluetooth to be enabled for working.
Input	Pair the Bluetooth of the Smartphone with the Bluetooth of Agribot.
Expected output	Connection established. Devices paired
Actual Output	Connection established. Devices paired
Result	Success

Table 1(UT): Unit test case for Activating Bluetooth

B. Unit Test Case: Select an activity (basic operations)

Test Case ID	Select an activity(basic operation)
Description	To select an activity from a list of activities. The basic operations are forward, reverse, left, right, stop.
Input	Choosing of an activity.
Expected output	Movement of Agribot
Actual Output	Visible Movement of the Agribot based on activity selected.
Result	Success

Table 2 (UT): Unit test case for selecting a basic operation on the Smartphone

C. Unit Test Case: Select an activity

Test Case ID	Select an activity.
Description	To select an activity from a list of activities.
	The main operations are seeding, harvesting, water pumping.
Input	Choosing of an activity
Expected output	Movement of Agribot
Actual Output	Visible Movement of the Agribot based on activity selected.
Result	Operation performed successfully

Table 3(UT): Unit test case for selecting an activity from a list of activities.

VIII. HARDWARE IMPLIMENTATION

Fig. 3: Final Agribot with Solar panel

Figure 3 shows the final Agribot powered using a Solar panel to harness solar energy.

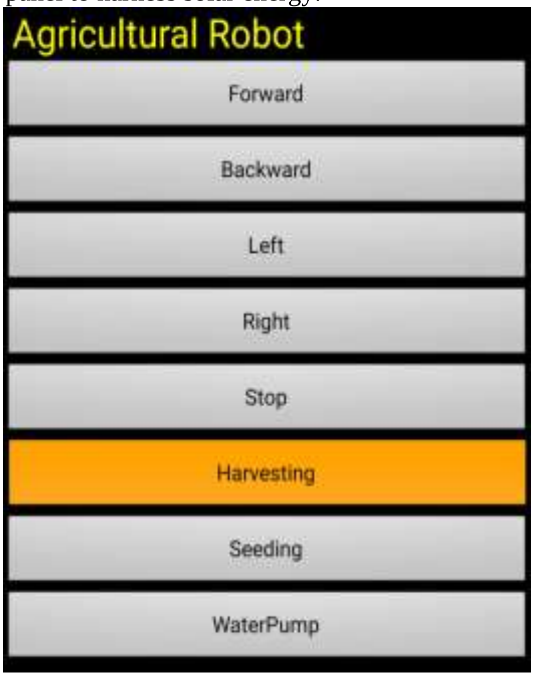

Fig. 4: Movements and operations selection

Figure 4 shows Movement and operation selection. The selected activity gets highlighted. In the above snapshot harvesting option is selected.

IX. FUTURE ENHANCEMENT

1) As far as future enhancements are concerned, this project has ample scope.
2) As an extension to this initial prototype many sensors can be added to detect obstacles and make the robot smarter.
3) Sensors to detect the depth of the land to appropriately sow seeds can be added.
4) A camera can be installed on the Agribot and the application can be modified in orderto display the field with a 360 degree view on the app as the robot moves.
5) New technologies like Zigbee, Wifi, IOT, WiSmart can be used to have a large connectivity range.
6) Sensors to detect temperature and moisture content and take actions of sprinkling water can be added.
7) A pesticide sprinkler can be added along with a sensor that detects the quantity of pesticide required.

X. CONCLUSION

1) This project introduces wireless technology in the field of agriculture.
2) Exploits features of Android platform to help Farmers Significantly.
3) Provides a flexible user interface to farmer to control the machine effectively.
4) It reduces manual labour requirement which is a boon to the farmers as finding labourers is a very difficult job today.
5) The Agribot can work in any sort of climatic condition as well as can work nonstop unlike humans.
6) The time required to carry out the five functionalities reduces considerably in comparison with carrying out the same activities manually.
7) It is a onetime investment which reduces the overall farming cost considerably.
8) This Agribot acts as a gateway to automated smart farming.

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