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Wireless Communication Based Multipurpose Agriculture Robot

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Abstract:
Agricultural Robots are agricultural machines of a considerable power and great soil clearing capacity. This multipurpose agriculture robot gives an advance method to sow, plough, and water and cut the crops with minimum man power and labor, making it an efficient vehicle. This vehicle will cultivate the farm by considering particular rows and specific column at fixed distance depending on crop. Moreover, the vehicle can be controlled through Bluetooth medium using an Android smart phone. The whole process of calculating, processing, monitoring is designed with motors & sensor interfaced with microcontroller.

Keywords: Agricultural Robots, soil clearing capacity, Bluetooth medium, AT89S52, L293D, HC05 module, Android smartphone.

I. INTRODUCTION

From the beginning, agriculture is a crucial part of human society due to the reality that man and agriculture are directly related to each other. This fact leads towards the advancement and enhancement of the typical, inappropriate and time-consuming methodologies, used for agriculture.

Smart Agriculture is one of the good examples of use of technology in agriculture to get numerous benefits of highly efficient, cost effective, sustainable, fast and brilliant results. Robot is a mechanical, artificial agent and an electromechanical system. Software programming is used to make complicated tasks easy to perform. Agricultural robotics is use of automation in bio systems such as agriculture.

Numerous benefits of this technology are high efficiency, cost effective, sustainable, fast and brilliant results. Agriculture Robots are one of the many different technological implementations in agriculture. The robot here performs elementary operations in farming i.e. plowing of field, sowing of seeds and covering of seeds with soil etc which are controlled wirelessly via a Bluetooth Android application.

II. LITERATURE SURVEY

Amidst the various industries, the one sector it is quickly catching up with is the agriculture. With the concept of smart farming and digitization, it is gaining popularity like never before and is coming with the potential to offer high precision crop control, data collection and automated farming techniques.

Among most of the techniques one technique which is effective is multipurpose agriculture robot here; the system is focused on the design, development and the fabrication of the multipurpose agricultural robot with irrigation system in addition to plowing and seeding.

The multipurpose agricultural robot is used to control the functions like digging the soil, seed sowing, level the ground to close the mud and water spraying with least changes in accessories through Bluetooth without affecting cost. AT89S52 microcontroller is used to control various operations of the system. AT89S52 microcontroller is used to control plowing, seeding, leveling and water spraying through motor drivers of robot. Plowing motors are connected to output pins; leveling motors are connected to output pins of motor driver L293D. L293D is the motor driver for controlling DC motor operations for plowing and leveling.

DC Motor used for wheels which is connected to another L293D driver for proper movement of wheels. Similarly for seeding and water spraying functions, other L293D motor drivers are used. Bluetooth module is used to operate through Bluetooth app.

The Bluetooth module can be enabled through scan button. First make the module is paired to smart phone. Once the connection is established then the application will show connected status.

The nine commands are stored using set keys option for as F (forward), B (backward), L (leveling), P (plowing), S(Seeding), W(watering), 1(to stop Plowing and Seeding), 2(to stop Leveling and Watering) and 3(to stop all the functions of the robot). These commands shown in the Bluetooth app and programming in microcontroller is used for the operations performed in the system.

III. PROPOSED SYSTEM

The proposed system is focused on the design, development and the fabrication of the multipurpose agricultural robot with irrigation system in addition to plowing and seeding. Multipurpose robotic system is an advance method to sow, plow, water and cut the crops with minimum man power and labor making.

The machine will cultivate the farm by considering particular rows and specific column at fixed distance depending on crop. Also there is an additional function to check the soil moisture so that water pumping could be done whenever necessary. The block diagram of the proposed model is shown in Figure 1.

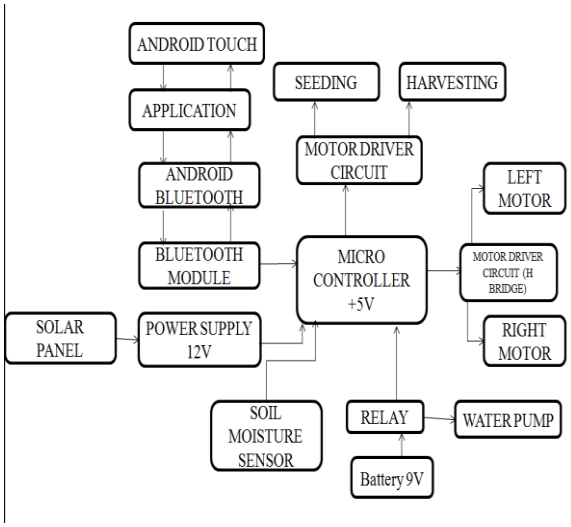

Figure.1. Block diagram of Multipurpose Agricultural robot

A. Hardware Model

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

- An android smart phone having Bluetooth facility that acts as a controller of the Agriculture robot.

- **An agricultural robot having the following components:**

a) A microcontroller 8051 development board which acts as the heart of the robot and controls the entire device.

b) The IC used is 89S52.

c) Motor driver circuit L293D to increase the current rating.

d) Bluetooth HC05 module to establish connection with the Smartphone and receive commands.

e) 4 DC motors for performing the activities.

The whole system of the robot works with the battery. The robot requires 12V battery to operate the system. The base frame consists of 4 wheels connected on four sides as arms and the rear wheel is driven by dc motor. One end of the frame, cultivator is made to dig the soil. The seeds are sowed through drilled hole on the shaft. Leveler is made to close the seeds and water pump sprayer is used for spraying the water. Bluetooth technology through smart phone is used to control the entire operation of robot for plowing, seeding and irrigation systems.

The Heart of the proposed system is Microcontroller. Bluetooth module, DC motors, relays are interfaced to the Microcontroller to provide various operations like Plowing, seeding, leveling and water spraying. The entire mechanism of the system is controlled by Bluetooth module from Android smart phone. The wireless communication of Bluetooth technology enables the robot to move in four directions as front, back, right and left. The microcontroller in the proposed model enables various functions in the field according to the commands received from smart phone. Also there is the presence of soil moisture sensor which senses the moisture of the soil and this is indicated by a LED. The top view of prototype model is shown in figure 2.

Figure.2. Top view of Prototype models for plowing, leveling, seeding and water spraying operations

The various operations of the prototype model is demonstrated below.

• Plowing function

The primary purpose of plowing is to turn over the upper layer of the soil, bringing fresh nutrients to the surface, while burying weeds and the remains of previous crops and allowing them to break down. In the prototype model shown above, a cultivator with spikes is used for plowing the farm. The cultivator is lowered down according to requirement to dig the soil.

• Seed sowing function

Seeding is planting seeds in a place or on an object. In the prototype model shown above, a box is used for Seed storage and the seed sowing takes place when wheels are rotated. This process is controlled by the Bluetooth app in the smart phone.

• Mud closing and leveling function

Leveling means give a flat and even surface to the field. In the prototype model shown above, a roller is used to perform leveling and mud closing functions. The mud is closed in the sowed soil and the rolling mechanism is used for leveling.

• Irrigation function

Irrigation is the method in which a controlled amount of water is supplied to plants at regular intervals for agriculture. In the prototype model shown above, relays are used to control the water pump to spray the water in the field.

• Harvesting function

Basically harvesting means cutting of the crops when they are ready. It is the final stage of farming. In the prototype model, a

cutting blade is being used for the crop cutting. Its height can be adjusted according to the height of crop being agriculture. Again the function is controlled by Bluetooth application.

B. Software Model

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 Robot 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.

Code Snippets for motor driver circuits interfaced to microcontroller:

```
sbit IN1P=P1^0;          /*
sbit IN1N=P1^1;
sbit IN2P=P1^2;
sbit IN2N=P1^3;          initialising the pins
sbit IN3=P1^4;
sbit IN4=P1^5;
sbit IN5=P0^0;           */
```

The above code is used to initialize the microcontroller pins with the motor driver circuit's output. In Embedded C, it is required to initialize the bits using "sbit" that stands for single bit. The motor driver used is L293D, which works on the principle of H-bridge. It allows the DC motor to drive on any direction. Below is the IC for L293D.

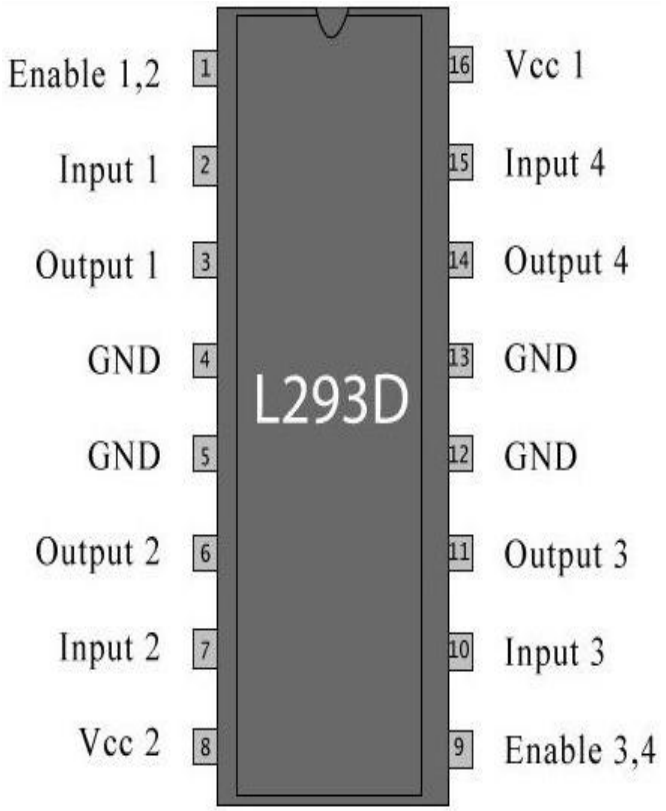

Figure.3. Pin Diagram of L293D Motor Driver IC controller

When a motor is connected to the o/p pins 3 and 6 on the left side of the IC, following is a truth table for the functioning of the motor:

I/P 1	I/P 2	Direction
1	0	Clockwise
0	1	Anticlockwise
1	1	No movement
0	0	No movement

Below is the snippet of the code used for both the motor movement:

```
IN1P=1;          /*
IN1N=0;                  forward
IN2P=1;
IN2N=0;                  */

IN1P=0;          /*
IN1N=1;
IN2P=0;          Backward
IN2N=1;                  */

IN1P=1;          /*
IN1N=0;                  Right
IN2P=0;
IN2N=0;                  */

IN1P=0;          /*
IN1N=0;                  Left
IN2P=1;
IN2N=0;                  */
```

The above codes are compiled in Keil Micro Vision Platform which is an integrated development environment to compile codes like Embedded C. Below is the screen view of the software.

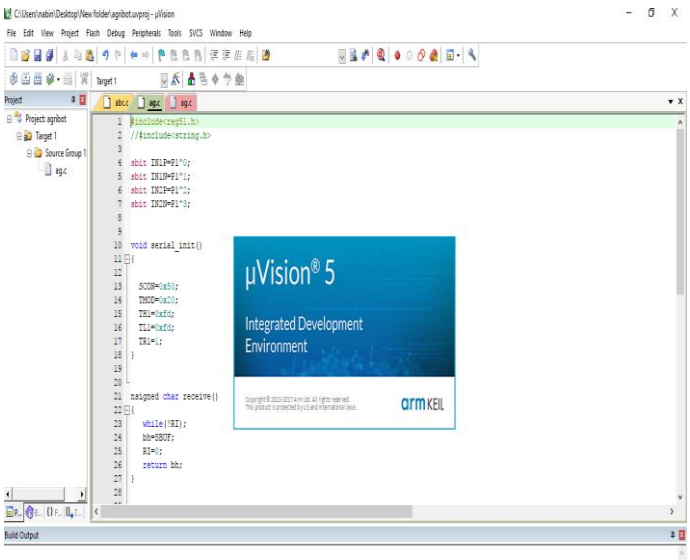

Figure. 4. Keil Micro Vision Platform

Bluetooth module is operated through Bluetooth app. The Bluetooth module can be enabled through scan button. First make sure that the module is paired to smart phone. Once the connection is established then the application will show connected status in place of not connected as shown in figure 5 below. The eight commands are stored using set keys option for as Forward, Backward, Leveling, Left, Right, Harvesting, Seeding, and Water Pump (watering). According to the

applied commands and program loaded to microcontroller the robot will move and performs above functions.

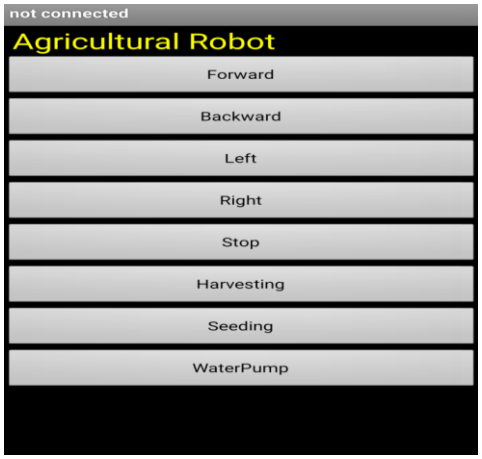

Figure.5. Application window for Bluetooth controlled robot

IV. METHODOLOGY

AT89S52 microcontroller is used to control various operations of proposed system. Port1 of AT89S52 microcontroller is used to control movement, seeding, leveling and water spraying through motor drivers of robot. Movement motors are connected to output pins (0, 1, 2 & 3) through motor driver L293D. L293 D is the motor driver for controlling DC motor operations for forward, backward, left and right movement. Similarly for seeding and harvesting functions, other L293D motor drivers are used. For water pumping, a relay is used. The flow chart for the proposed model is shown in figure 6. Developed in 2 phases, hardware and software. The hardware design resulted in interfacing Bluetooth module, DC motors, Plowing system, leveling system, irrigation system and seeding to microcontroller through motor drivers. And a soil moisture sensor to sense the moisture content in the soil and indicate it via a LED. The software part includes developing and testing with the support of Bluetooth APP for movement of wheels, seeding, water spraying and harvesting functions. The C program is developed for microcontroller to control the above operations.

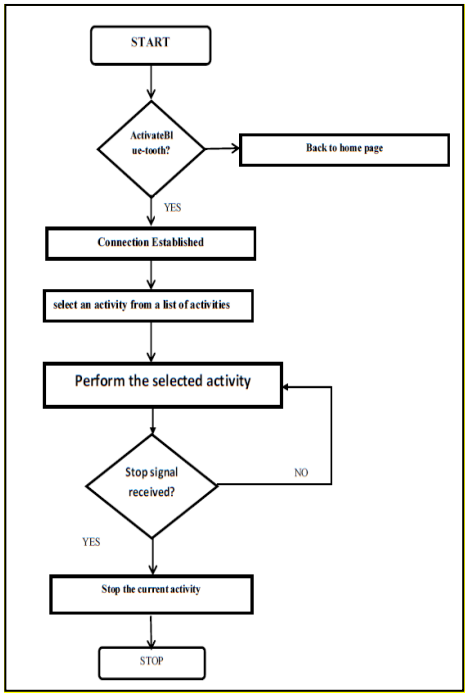

Figure.6. Flowchart for the proposed model

V. UNIT TEST CASES

Table .1. Unit test case for activating bluetooth

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

Table.2. Unit test case for selecting a basic operation on the Smartphone

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 agriculture robot
Actual Output	Visible Movement of the agriculture robot based on activity selected.
Result	Success

Table.3. Unit test case for selecting an activity from a list of activities.

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 agriculture robot
Actual Output	Visible Movement of the agriculture robot based on activity selected.
Result	Success

It is also analyzed that the prototype model of proposed system can be used to perform plowing, seeding, leveling,

water spraying and harvesting and it can lift a weight of 6kgm per 1 cm as the speed of the motor is 60 rpm. The real time working diagram is shown in figure 7.

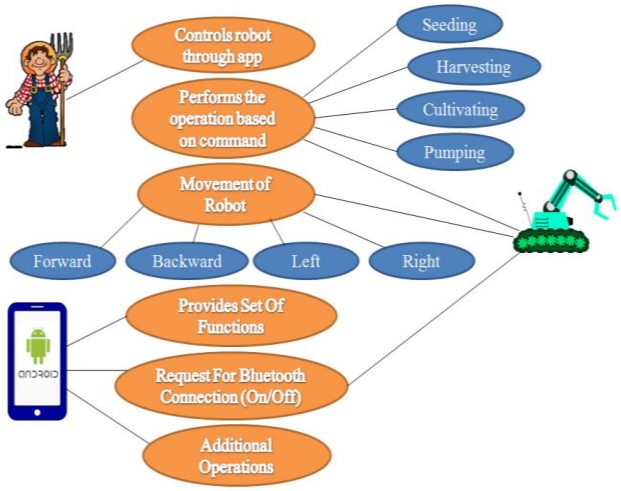

Figure.7. Real time working

VI.CONCLUSION

Wireless communication based multipurpose agricultural robot has successfully implemented and tested for various functions like plowing, seeding, leveling and water spraying. It was developed by integrating agricultural robot with embedded C programming. This project introduces wireless technology in the field of agriculture. Various parameters like soil condition, area covered by the robot and weight of the material for leveling are analyzed for different motors. It reduces manual labor requirement which is a boon to the farmers as finding laborers is a very difficult job today. The Agriculture robot can work in any sort of climatic condition as well as can work nonstop unlike humans. The time required to carry out the five functionalities reduces considerably in comparison with carrying out the same activities manually. It is a onetime investment which reduces the overall farming cost considerably. The proposed system is mainly used for crop establishment, plant care and selective harvesting. In future, it can be extended by using ultrasonic sensors and cameras for performing the same operations without human operator for measuring the various parameters like soil condition, area covered by the robot and weight of the material for leveling.

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