Robo Farming - A Platform for Unmanned Agriculture

M. Mathankumar, P. Thirumoorthi

Abstract: ***Modernization in the field of agriculture augments day by day. The robotic control systems play imperative role in modernization of diverse fields. For farm preparation in agriculture field a system based on robots is developed, which reduces the human power. The proposed architecture has two main sections such as monitoring section and control (robotic) section. The communication between them is done through wireless technologies. The control section is constructed by using temperature sensor, humidity sensor, seed dispenser, seed storage, sprayer construction, robotic system with motors, wireless camera network, microcontroller, Zigbee transceiver and power supply. The entire system is controlled by microcontroller, which dictates the operating sequence to all networks. Here sensor outputs are processed by their corresponding embedded programs, robot driven by their internal motors in desired directions. Based on the wireless camera footages monitoring section transmits the commands for ploughing, seed sowing and spraying using LABVIEW software through Zigbee.***

Keywords: Farming, Sensors, Robots, LABVIEW, PIC microcontroller, Zigbee, Agriculture.

I. INTRODUCTION

In the recent years automation in agriculture is done through the use of robots. The robots resolve the major drawbacks in conventional farming. It provides effective solutions such as less fuel consumption, more precision, optimized utilization of pesticides and fertilizers. By deploying robots, each crop or plant can be taken care individually by ensuring their essential requirements such as nutrients, water. Hence the overall yield and quality of the crop can be increased [1] [2]. The proposed robotic system replaces the heavier agricultural machinery which is not suitable to work in wet and mud spattered conditions. The conventional machines get stuck in the field when it is too wet and their operation is tedious in rainy seasons. It also offers the possibility of replacing labors and provides effectual solutions with return on investment. This is taken into account especially when it is harmful for health of the workers. This self-governing robot performs agricultural procedures such as ploughing, seed sowing, and fertilizer spraying. Monitoring the farms across 24x7 is tiresome for farmers. Usage of wireless technologies to monitor and control the field reduces the environmental impact, supervise individual plants and increase efficiency [3] [4] [5].

II. BACKGROUND WORKS

Mr.Sagar R. Chavan et al [6] enhanced the agricultural robotic control system by developing a smart machine which has autonomous functions. It cultivates the seed in defined rows and columns at fixed distance depend on seed types. The system is built with microcontroller, positioning sensors and encoder. K Durga Sowjanya et al [7] developed the autonomous vehicle controlled by Android APP and Bluetooth technology. In that they discussed the parameters of vehicle during drip irrigation.

Shriyash Thawali et al [8] constructed a model which suits selected type of crops, vegetables and fruits. It automates the irrigation and harvesting process of agriculture. Here lower end microcontroller is used, which leads to processing difficulties and memory limitation. T. Hemalatha et al [9] designed a system based on sensors which gives input to the controller. Based on the location acquired by the system it operates and the navigation is controlled wirelessly.

Charansingh A. Patil et al [10] surveyed the different technologies involved in the improvement and modernization of agriculture. They discussed the pros and cons of precision farming, autonomous irrigation and selective harvesting.

III. ROBO FARMING

A. Proposed System

To prevail over the discussed problems in the previous sections a multifunctional agri-robot is developed with more precision and flexibility. The robot will be utilized for cultivation process which includes ploughing, seed dispensing and fertilizer spraying. The control section is constructed by using sensors, processing units, robotic system with motors, wireless camera network, microcontroller and Zigbee transceiver. The entire system is controlled by microcontroller, which dictates the operating sequence to all networks. Here sensor outputs are processed by their corresponding embedded programs, robot driven by their internal motors in desired directions. Based on the wireless camera footages monitoring section transmits the commands for ploughing, seed sowing and spraying using LABVIEW software through Zigbee.

Hence this agricultural robot is used for multiple functions in agricultural land to trim down the human power.

Here the robot works with rechargeable battery and appropriate driver circuits are used. Fig.1 and 2 shows the control and monitoring sections of the proposed system respectively.

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B. System Overview

A base frame chassis is made over the wheels of robot which is driven by DC gear motor. At one end of the frame plougher is fitted with level actuator to dig the soil. On the top a funnel is used to store the seed and for seed dispensing as programmed. It is made up of metal sheets and controlled by DC gear motor. According to the crop type the seeds are sowed in a particular pattern through the drilled hole in the funnel. In the other end of the frame fertilizer spraying unit is fitted which is also driven by DC gear motor. Adding up to this the temperature and humidity sensors is incorporated with this system to monitor the field.

The wireless video camera mounted on the top of the robot transmits the picture from the agricultural field location to monitoring station. By designing the LABVIEW front end window we can manually control the robot using Zigbee wireless mesh protocol.

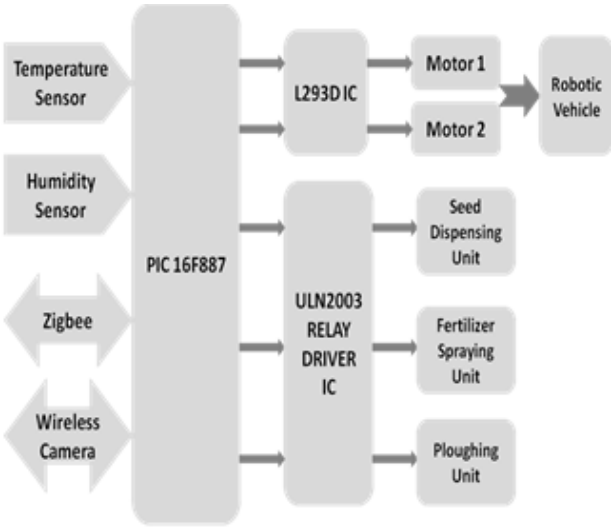

Fig. 1 Functional Block Diagram – Control Section

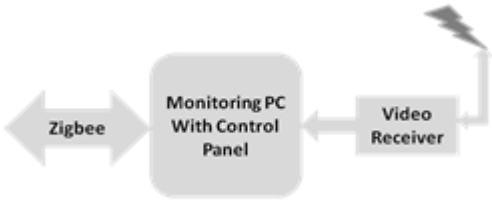

Fig 2 Monitoring Section

IV. IMPLEMENATION OF RESULTS

A. Simulation Results

Fig. 3 shows that robot moves in forward direction, ploughing, fertilizers spraying and seed dispensing modules are in ON condition. Fig. 4 shows that robot moves in reverse direction, ploughing and seed dispensing units are turned ON and fertilizer spraying unit is turned OFF. Fig. 5 gives the process flow diagram of the system.

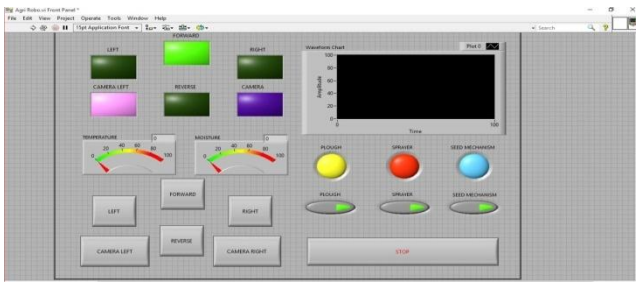

Fig. 3 Simulation result 1

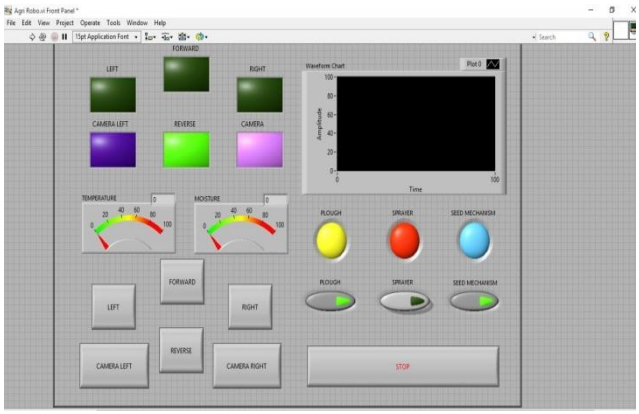

Fig. 4 Simulation result 2

B. Hardware Results

In Fig. 6 the RS 232 is enabled and the robot moves in forward direction, ploughing, seed dispensing and fertilizer spraying units are running. The sensors are turned ON and camera shoots in right direction. In Fig. 7 the modules are turned OFF.

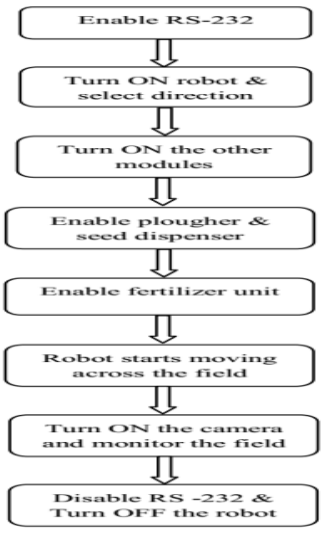

Fig. 5 Process flow diagram

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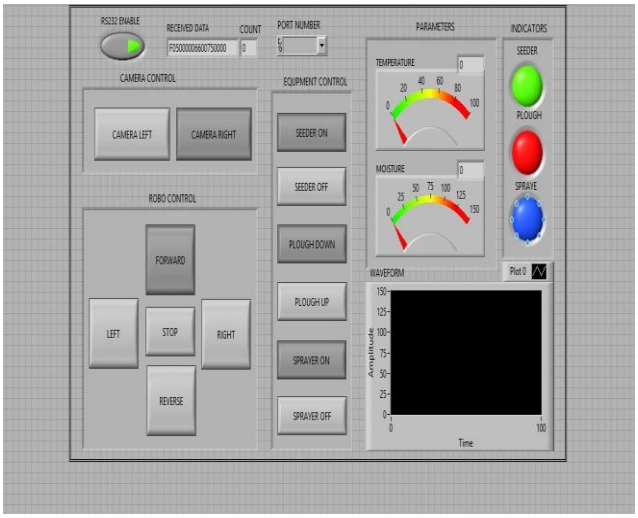

Fig. 6 Hardware result 1

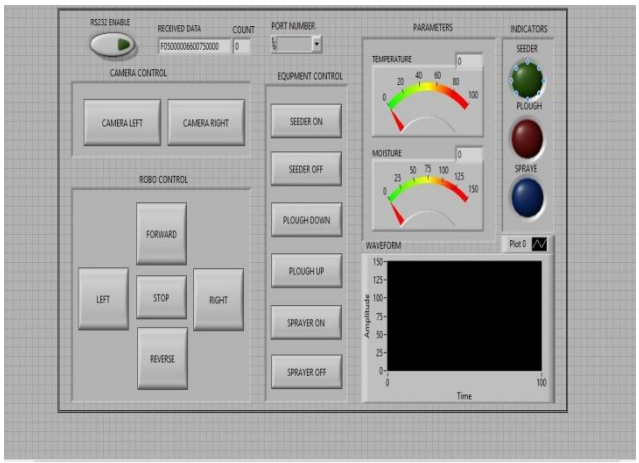

Fig. 7 Hardware result 2

The robotic vehicle is controlled by PIC16F887 microcontroller, the L293D IC drives the wheels of robot through motor 1 & 2 in either forward or reverse direction. The IC is connected to 18, 23 and 24 pin of microcontroller. Then relay driver ULN2003 IC is used for driving a wide range of loads. This driver IC is connected to the 15, 16 and 17 pin of microcontroller. In this system ULN2003 drives loads such as plougher, seed dispenser, sprayer controller unit and wireless camera.

Plougher is interfaced in 33 and 34 pin through the level actuator. The level actuator aids the plougher to move up and down. Seed dispenser is interfaced in 27 and 28 pin through the geared motor for stepping action. Fertilizer sprayer is interfaced in 27 and 28 pin. The speed can be varied using gear mechanism with delay function. Using the program in microcontroller the operation is chosen accordingly as shown in the simulation result. Temperature sensor LM35 and humidity sensor is interfaced in the ADC pins 2 and 3 of microcontroller respectively. Zigbee transceiver is interfaced in Tx and Rx pins of PIC. The monitoring section of the system has personal computer to control the robot using LABVIEW software and video receiver to receive picture message from control section. [11]

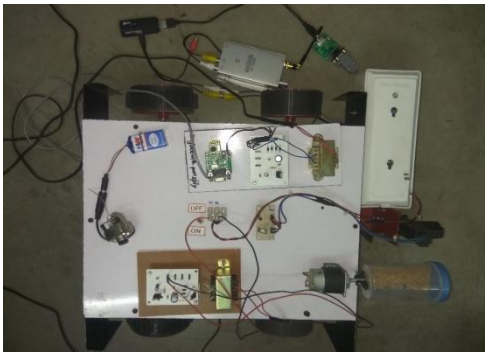

Fig. 8 Hardware Prototype– Top view

Fig. 9 Hardware Prototype – Front view

In Fig. 8 and 9 the top and front view of the developed hardware is displayed.

C. Comparison of parameters for different cultivation process

S.No	Motor characteristics	Obtained values
1	DC supply	3 – 12V
2	No load current	45mA
3	Load current	0.5A
4	Speed	10 RPM
5	Torque	10.5 kg-cm
6	Distance covered per min	10m

Table I. Ploughing Function

S.No	Motor characteristics	Obtained values
1	DC supply	4 – 12V
2	Load current	1.3 A
3	Speed	30 RPM
4	Torque	28 kg-cm
5	Area covered per min	7.5mx7.5m

Table II. Seed Dispensing Function

S.No	Motor characteristics	Obtained values
1	DC supply	4 – 12V
2	Load current	1.3 A
3	Speed	30 RPM
4	Torque	28 kg-cm

Table III. Fertilizer Spraying Function

V. CONCLUSION

Still many people in India strive hard to sustain with agriculture as their occupation. This sort of innovation is needed for the farmers to develop the agricultural fields. It makes them to get better yields, increase quality, and conserve time. Here the robot developed is working on rechargeable batteries for prototyping. This can be developed to work on hydraulic power like tractors. It will increase the speed of operation and accuracy in seed sowing.

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