Agriculture robot (Agribot) for harvesting underground plants (rhizomes)

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Abstract: Agriculture plays a vital role in socio-economic development of India. Agriculture is the cultivation of animals, plants, fungi, and other life forms for food, fiber, biofuel, medicinal and other products used to sustain and enhance human life. Agriculture is the most essential and foremost economic activity of all times. Until the Industrial Revolution, the vast majority of the human population laboured in agriculture. Pre-industrial agriculture was typically subsistence agriculture/self-sufficiency in which farmers raised most of their crops for their own consumption instead of cash crops for trade. But now, agriculture is undergoing a structural change leading to a crisis situation. The growth rate of agricultural output is gradually declining in the recent years due to labour scarcity and more expensive. Seed and chemical prices are rising too, creating the need for their efficient use. The recent survey shows that the world should double their agriculture productivity to feed the entire booming population by 2050. At that time with efficient management of natural resources will meet increasing demand by adopting modern technology in farming to improve agricultural productivity. Hence, as the farmers are struggle with higher seed and chemical prices, the prospect of labour shortages and growing world demand for food will drive to think an innovative and more efficient farming method. These problems in agriculture led us to propose an automated design "Agribot" which can perform most of the farming activities.

Keywords: automation, harvesting, income, pesticide, side shaft, transmitter, India

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1 Introduction

Agriculture is a source of livelihood and food security for Indians. In recent times, there is a shortage of labour in the agriculture fields and this led us to do some innovation (Agribot) to reduce this problem (Southall et al. 2002) (McIntosh.2015). It can utilize the energy resources efficiently. And it monitors the entire farming field round the clock. It can also remove the pests using pesticides. A dedicated mechanical arm is fitted with the robot to harvest the rhizomes (Dorhout, 2011). The entire design is automated with the help of GSM. Growth of agriculture is decreasing rapidly day by day mainly due to the shortage of labour. Even though the shortage of rainfall, monsoon failure, extended summer seasons and greenhouse effect have its part in destroying the growth of agriculture, shortage of man labour is the main reason for reduction in the growth of agriculture. This shortage of man power is mainly due to the following reasons:

- Industries in urban areas:
- Development of IT and Core companies will attract the young minds:
- Maintenance of agricultural lands is difficult. The farmers have to spend a lot of money and time to maintain their agricultural lands:
- Reduction in agricultural income.

2 Materials and methods

In recent years, electronic equipments plays a major role in implementing new agricultural tasks related to the Precision Agriculture such as remote sensing and spatial variability mapping. The authors Godoy et al. (2009) described the design and implementation of agricultural

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robot suitable for remote sensing applications. They discussed about the developed electronic hardware, the operation of wireless tele communication system and the distributed control based on CAN protocol and ISO11783 for the mobile agricultural robot. The performance parameters obtained with the robot operation are analysed to benchmark the developed system. They proved that their systems meet the robot movement design requirements and give an acceptable response time for control commands and supervision (Godoy et al., 2009).

Chouhan and Singh (2014) proposed about Mechanization Index (MI) based on the share of cost of use of mechanical power operated farm equipment over total cost of use of animate and mechanical power operated farm equipment. The analysis revealed a large diversity in MI for different crops at state and National levels. According to their statistics wheat crop recorded highest MI index of 40.77% at the national level and a highest of 56.17% in Punjab. In Punjab Paddy crop recorded 35.58% MI, but it was only 17.40% at the national level. The MI of other crops varied mustard (32.52%), gram (31.91%) and sugarcanes (9.09%). From the analysis they inferred that states having higher MI or tractor intensity recorded better crop yield. In order to observe the growth and yield of the plants, the authors Thenmozhi et al. (2014) proposed a microcontroller based design to sense temperature, humidity, and sunlight by using corresponding sensor module.

To solve optimization issue of productive project of large-scale farms, to fulfill scientific and automation of crop productive project, to improve the optimization efficiency, and then to enhance the economic and social benefits of large-scale farms, the authors Yu and Shen (2010) proposed an improved genetic algorithm. They adopted J2EE to develop and optimize web-based agricultural productive project (Yu and Shen, 2010). Tamaki et al. (2009) developed an autonomous agricultural system for the operation in paddy fields. They designed a rice transplanting robot guided by a real time kinematic global positioning system (RTKGPS) and an inertia measurement unit (IMU) using the controller area network (CAN).

Ge et al. (2010) described a web-based Project Management System (PMS) for data sharing and cooperative research and speeding up the progress of the projects. Vijayakumar and Rosario (2011) provided a technical support to increase the rice production by developing rice crop monitoring system using WSN. Thus automated control of water sprinkling and ultimate supply of information to farmers can be done. Kumar et al. (2014) designed two recharge filters with modified flow pattern of recharging water from vertical to horizontal. According to the performance analysis, horizontal arrangement of filter materials followed by a sand layer to inflow water at the end will enhance the performance (Kumar et al., 2014). However, to obtain desired filtration rate, larger surface area will be required in horizontal filters as compared to vertical filters.

2.1 Methods

To cultivate the rhizome plants in big agricultural fields tractors are suitable. But in small and very small agricultural fields, the tractors cannot be used to harvest the rhizome plants. A poor farmer cannot buy and use the tractor in his agricultural land for harvesting rhizomes, since the cost of the tractor is very high. In such a situation, our Agribot plays a vital role to help the farmer in harvesting the rhizomes

We can construct this project in two different ways

1) Fully automated- Microcontroller (Muhammad et al., 2008; Ge et al., 2010) is programmed to move the Agribot for approximately 15 meters. With the help of batteries and rack, portion of Agribot goes up and pluck the plants which grow beneath the soil.

2) By using transmitter and receiver-Here the Agribot can be controlled with the help of transmission and receiving systems (Katsuhiko and Yoshisada, 2009). This provides communication for 80 meters. But it must be operated with the help of push buttons.

3) In order to observe the initial condition and output of our project, it is simulated using PROTEUS software. The conceptual diagram obtained by simulation is shown in Figure 1.

We have made our first initialization on the software named KEIL and PROTEUS. This work was on two modes, one is fully automated and the other is by using transmitter and receiver. This initialization model is only for the transmitter and receiver system. One microcontroller is used for transmitting system and other microcontroller for receiving system. When the relays from the transmitting sides are on, the signals from the transmitting system reaches the receiver and the motor starts operating. In order to monitor the output, motors are replaced by LED's. The mechanical system consists of rack, pinion, robotic arm and wheels. The electrical system consists of the circuit connection as shown in Figure 2b.

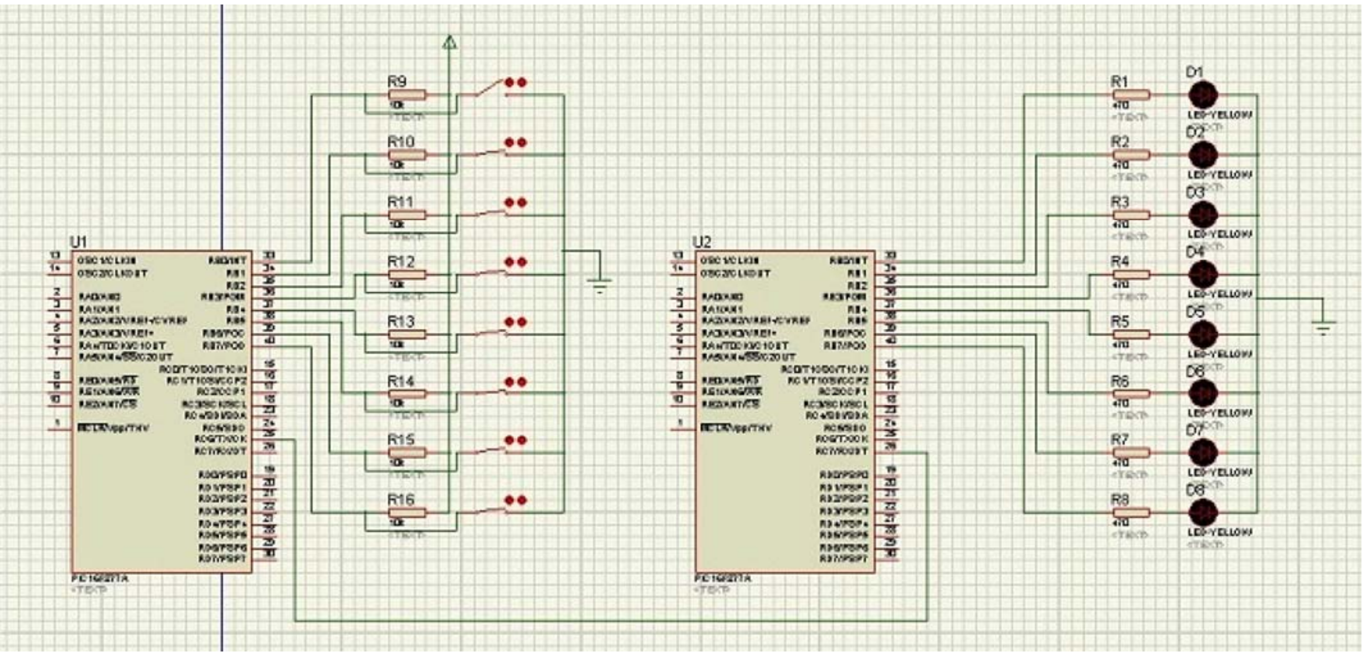
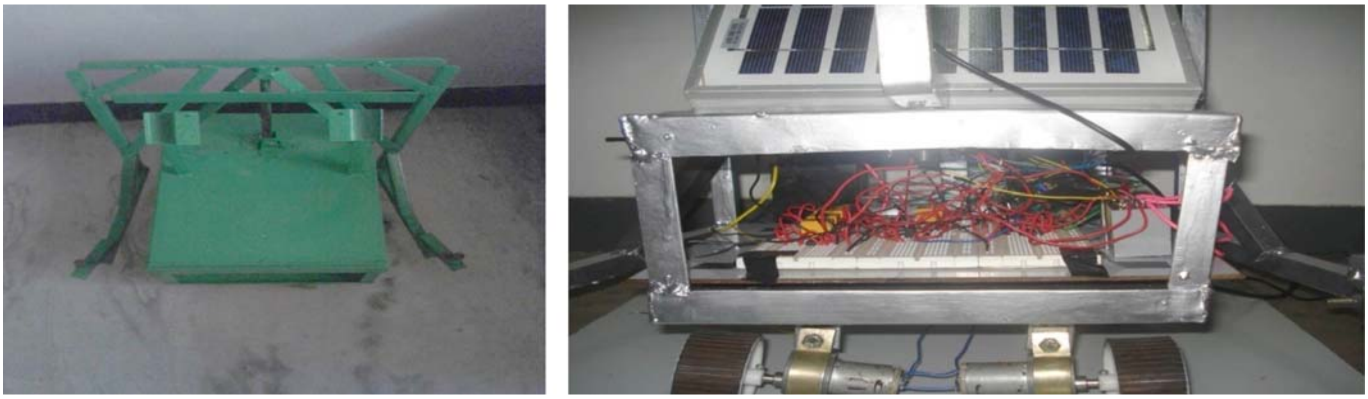


Figure 1 Simulation result



a. First Stage of our project

b. First Stage of Agribot.

Figure 2 The initial models of our project

2.2 Detailed description of some of the components used

2.2.1 Side shaft DC motors

Four side shaft motors (60 rpm) are used for driving four wheels in order to move the Agribot in different directions. The shaft motors with four wheels which is used in Agribot is shown in Figure 3.

2.2.2 Geared motors

Two gear motors (60 rpm) as shown in Figure 4 are used for plucking the rhizome plants. Rhizome plants are the plants which grow beneath the soil. Gear motor is an assembly composed of an electric motor and a reduction gear in a single unit. The most common types have planetary, planetary-lantern and wave transmissions. For greater compactness, the driving gear of the reduction gear is mounted directly on the motor shaft. Gear motors are used in universal drives for general use; they are manufactured serially by specialized enterprises. They can operate in a horizontal, vertical, or tilted position.

2.2.3 Wiper motor

Mostly, the wiper motors are used in vehicles for operating the wipers. In order to pluck the rhizome, a small wiper motor is fitted as shown in Figure 5. The project is designed in such a way that the plants have been plucked from the soil, one by one with the help of wiper motors. The up and down operation of wiper motor is carried with the help of rack. Figure 6 shows the structure of the rack used in this work.

Figure 3 DC shaft motors with wheels

Figure 4 Geared motors

Figure 5 Wiper Motor

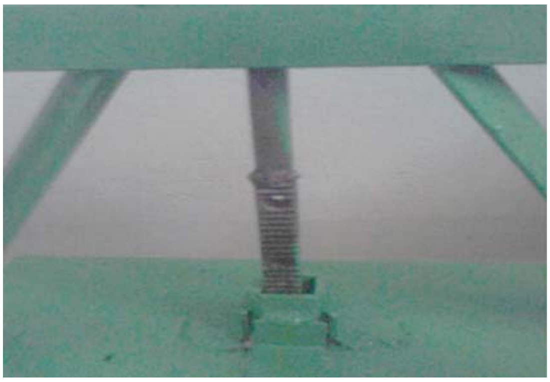


Figure 6 Rack

2.2.4 Soil Moisture Sensor

To measure the water content in soil, soil moisture sensors are needed. Since, the SMEC 300 soil moisture sensor gives better performance with low cost, it is used in this work.

2.2.5 Rotating Blade

Figure 7 shows how rotating blade is used for cutting the unwanted plants above the ground. This blade is operated by the power provided from 300 rpm motor.

Figure 7 Rotating blade

Table 1 describes the range and specification of hardware required to construct this model.

Table 1 Hardware description

Name	Range and Specification
Side Shaft Motors	60 rpm
Gear Motors	60 and 200 rpm
Wiper Motor	60 rpm
Batteries	12 and 24v
Relay	12 to 230v
Crystal Oscillator	20 MHZ
Water pumping Motor	Plastic and Small
Rack And Pinion	Small
R433A Transmitter and Receiver	RF Module- 80 Meters Communication
GSM	MODEM
Soil Moisture Sensor	SMEC 300
Light Emitting Diodes	Small
Push Buttons	Small
Wheels	Medium Size

2.2.6 Conceptual block diagram

The block diagram of Agribot is as shown in Figure 8. The name of the microcontroller used in this project is PIC16F877A. Soil moisture sensor SMEC300 is used to measure the moisture. A 12 V battery and a solar panel are used to operate the motors. Since the operating voltage of microcontroller varies between 4-6 V, 5 V battery is required for the operation of the Agribot. When the signal from the microcontroller reaches the relay, the relay gets on and the motor starts running. With the help of wiper motor and gear motor, the robotic arm starts operating and with the help of DC side shaft motor the wheels and the grass cutter starts working. This is the simple operation of our project.

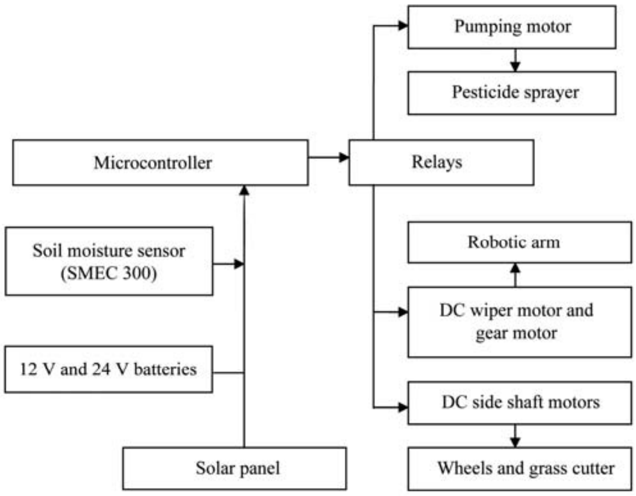


Figure 8 Agribot block diagram

3 Result and discussion

Figure 9 displays a completed model of our Agribot. The following modules are incorporated to complete the design

Figure 9 Completed model

- Sensor module
- Controller module
- Communication module
- Power Supply module
- Motor module

Agribot performs the following tasks

- Harvesting of rhizome plants:
- Pesticide spraying with the help of pumping motor:
- Sensing soil moisture condition with the help of SMEC300 sensor.

4 Conclusion

The main aim of this project is to reduce the labor cost and modernize the traditional agriculture with the help of available technology. It emphasizes the need for automating the farming practice amid the growing prevalence of hectic life style. Being compromised with soil sustainability, it can assure higher output and profitability.

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