AOI: 10.11234.2024.00020
ACT2024: Special Proceedings of Applied Computer Technology

Application of Robotics in Agricultural System

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ABSTRACT

India is an agriculture-based country. Agriculture, with its allied sectors, is undoubted, the largest livelihood provider of this country, more so in the vast rural areas. Farmers work day and night without getting concerned about their health. So, we have come up with an idea of reducing their workload considerably by a robot that can plough the soil, spray water and pesticides, sow the seed and give fertilizer not only to agricultural fields but also to any kind of farming. According to us, this will be an efficient robot, both in terms of the production cost and health perspectives, and will be of immense help to a farmer, thus, will help in the development of the agricultural system of India.

I. INTRODUCTION

The development of agriculture was a watershed moment in humanity. Humans' ability to engineer the environment to generate enough food to sustain massive population growth was the first profound change in the relationship between fully-modern humans and the environment. Agriculture has moved us forward so far in 12000 years, but we are now at a turning point. Agriculture is not only necessary for food production but also plays a significant role in the economic sector as well. Automation in agriculture is the main concern and an emerging subject across the world. The population is increasing tremendously and with this increase, the demand for food and employment is also increasing. The traditional methods which were used by the farmers were not sufficient to fulfill these requirements. Thus, new automated methods were introduced. Here, in this paper, we have dealt with not only why and how to implement Robotics based Automated Farming but also have developed a robot that can sow seeds in the agricultural field, give water and pesticides to the crop, as well as can measure the soil moisture and give fertilizer in the agricultural field.

II. FUNCTIONAL FEATURES OF THE ROBOT

The key features implemented in the model are as follows:

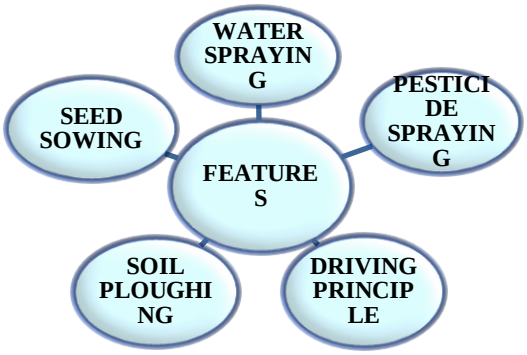


Fig. 1. Features implied in the model

III. HARDWARE MODEL OVERVIEW

Fig. 2a. Top View of Model

Fig. 2b. Side View of Model

IV. CIRCUIT DIAGRAM

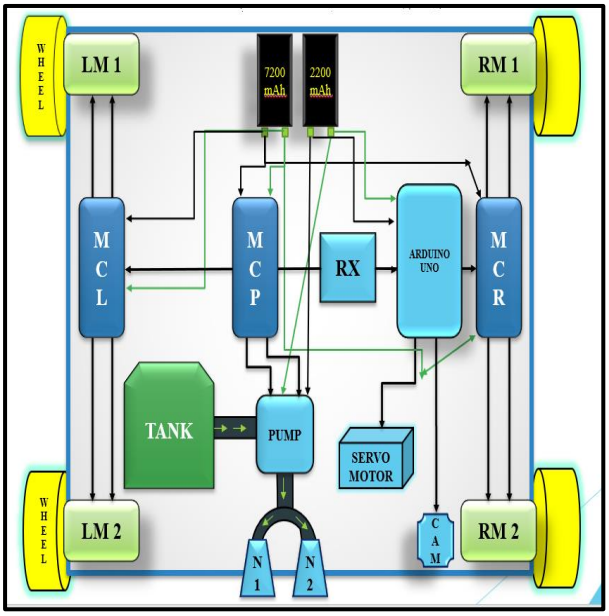


Fig. 3. Circuit diagram of the model

V. COMPONENTS WITH SPECIFICATIONS

The components which have a significant role in the construction of the project are listed below:

1. *Brushed DC Motors*:

Brushed DC Motors are one of the simplest types of DC motors. It uses brushes to deliver current to the motor windings through mechanical commutation. Here we have used a total of 4 brushed dc motors each of 12 Volt specifications. As they have high efficiency, high starting torque, and speed thus for these features brushed dc motors have been used in this project.

2. *LiPo Battery*:

We have used two different Ratings LiPo or Lithium Polymer batteries, one is of 5200 mAh 80C 22.2 V and another one is of 2200 mAh 11.1 V, which works on the Lithium-ion Technology instead of normal use liquid electrolyte. The kind of battery is rechargeable thereby providing users with huge savings in terms of cost. Generally, in LiPo batteries, the positive electrode is typically made of a chemical compound called Lithium-cobalt oxide **(LiCoO2)** or Lithium iron phosphate **(LiFePO4)**. The negative electrode is generally made of carbon (graphite). They have a high capacity, low internal resistance, and good coulombic efficiency; that's why has been used in this project.

3. *Digital Motor Controllers*:

We have used three DMC of 60c, two for controlling the 4 brushed dc motors and one for operating the pump. The DMC 60c can control the voltage supplied to each motor from 0 to 12V thus allowing us a smooth control of the robot. Also, it can brake the robot instantly if we so desire to stop the robot at any given point in time.

4. *Arduino UNO*:

It is a low-cost, flexible, and easy-to-use programmable open-source microcontroller board that can be integrated into a variety of electronic projects. Here Arduino UNO is getting an input voltage of 12 V from the lower rating battery and sending 5 V to the receiver circuit, as operating the operation of the camera and the servo motor.

5. *Pump Drive*:

We have used a Pressure Pump (12V/4A/5LPM/100 PSI) for the water and pesticide spraying mechanism of the robot. Pressure pumps are typically centrifugal pumps with impellers that pull water in and push the water out at increased pressure.

6. *Transmitter & Receiver*:

The transmitter is the controller in the hands of the operator. It is a FLYSKY FSi6 transmitter with 6 channels. We are using channels 1, 2, and 3. The receiver is the FS iA6B which takes the input from the transmitter and controls the drivers. The transmitter can **operate up to 1500 meters**. The range of it depends on magnetic interference. Whereas the receiver has 2 antennas and 6 channels.

7. *MG995 Servo Motor*:

MG995 is a Servo Motor that is popular for its performance and low price. Here it is used for the seed dispensing mechanism. The Red wire of the motor is connected to V_{cc} of 5 V through a buck converter that steps the own voltage of 12 V to 5 V, the Brown wire is connected to the ground in Arduino Uno and the Orange wire gets PWM input from the Arduino Uno.

8. *LM2596 Buck Converter*:

LM2596 DC-DC Buck Converter is a step-down module that has been used in this particular project to provide 5 V input power to the Servo Motor from the 12 V supply of the battery. Buck Converter is a type of chopper circuit that is designed to perform step-down conversion of the applied dc input signal.

9. *ESP32 Camera*:

ESP32-CAM can be widely used in various IoT applications. ESP32-CAM is a WIFI+ Bluetooth dual-

mode development board that uses PCB onboard antennas and cores based on ESP32 chips. It can work independently as a minimum system.

10. Liquid Tank:

It is a basic structure that has been used as a container for water or pesticide and it is connected to the pressure pump through a tube.

11. Chassis:

The chassis has been made with strong and durable material. It is used for giving the robot mechanical support and holding circuit materials.

12. Sprayer Nozzle:

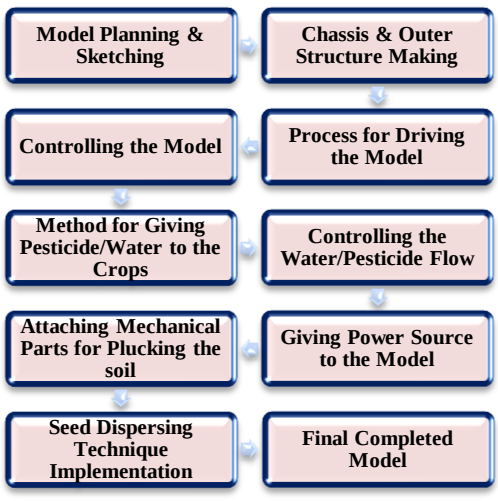
Here we have a two-terminal sprayer nozzle, that helps in better spraying of the liquids. And due to their control through the pump they create smoke-like formation during spraying.

13. Wheels:

Here 4 high gripping wheels have been used which are connected to 4 brushed dc motors on each side. They give better stability during driving operations

VI. MAKING PROCEDURE

Some of the major pre-requisites before starting the construction of the project will be Power Electronics, Electric circuits, Electrical Machines, Electrical and Electronic equipment, and of course Robotics. One should have a clear knowledge of the following subjects to implement the project model. Here, in this section, we will try to demonstrate the simplest and most efficient way of building the hardware construction. So that anyone intending to develop this model or want to give up-gradation to this model; would be beneficial for him.



VII. PRECAUTIONARY MEASURES

1. All connections in the given model should be neat and tight and well working to get the exact outcome.
2. Architectural design of the model should be good and of proper measurement for getting better stability during operation.
3. Gapping between components should be good so that model can get better air circulation and cooling.
4. Wheels should be mounted tightly to the DC Motors so that any kind of accident does not happen during the driving condition of the model.
5. One should purchase the necessary components from genuine manufacturers so that any kind of unwanted failure does not occur in the operating state because of a fake or duplicate product.
6. Do not touch the mouth while working with pesticides, it is always recommended to wear gloves during this type of operation.
7. Try to clean up (pesticide or water) Tank regularly so that any impurities do not go into the pump drive and as well as the pipe remains clean.
8. Condition of every piece of equipment should be examined regularly to get maximum efficiency from this model.
9. Though every element of the model is unbreakable and waterproof, and the overall model is very rugged in construction, still it is recommended to take care during operating this model.
10. At extreme and unavoidable critical atmospheric conditions, it is recommended not to use this model for any operation.

VIII. APPLICATIONS

Agriculture is the largest manufacturing sector across the globe that is in immense need of technology. It is also the backbone of the Indian economy. Now that robots are taking over a larger part of our daily lives, it is time that we explore this possibility in the field of agriculture. Although the green revolution has made us self-sufficient with our food grains for years to come, we are living in a time of global food chain crisis. There is population growth coupled with resource crunch, climate change, and migration from rural to urban regions. To combat these trying times, robotics and autonomous systems should be explored in agriculture. Some applications explored within the scope of this project:

1. Pesticide and water spraying
2. Soil ploughing
3. Seed dispensing

IX. LIMITATIONS OF THIS MODEL

There are varieties of features present in this model that will be very useful in the Indian agricultural system for not only harvesting crops but for many other purposes

also. But like every coin has its opposite side this model also has some limitations.

1. This model can only be operated through the ground but not through air, like drones. For that reason, sometimes when agricultural fields are waterlogged under extreme weather conditions scenarios it will be difficult to operate this model through the ground.
2. Though the model is made up of high-quality materials; still in extremely hot weather, there is a chance of overheating the model which can lead to damage of components. For that reason, we have analyzed a solution to this issue that is discussed in the next section in "Future Scope".
3. The Lipo batteries are chargeable and of higher ratings. But maybe there is a chance of battery draining at high temperatures. And it could arise in the middle of the operation. For those worst-case scenarios, we need to be prepared, and we can implement some kind of continuous power source in this model, just like solar cells.
4. There is no moisture sensing device included in this model that might create confusion among users in terms of how much water or pesticide needs to be sprayed in the soil. This limitation also comes with some ideas to overcome this issue. We have discussed that part in the next module.
5. It is extremely costly to build robots and keep them running.
6. Farmers may lose their jobs and for a country like India where a lot of people are employed in agriculture, it would lead to unemployment.

The above points are those limitations that have been found in the process of constructing this model. But finding limitations of any scientific model is a continuous process and is based on several trial-and-error methods. That's why it always should be kept in mind that there can be certain limitations that may arise in the long-term use of this model, which have not been noticed so far. If we get to know any sort of further information regarding the limitations of this robot, we will work on resolving those issues.

X. FUTURE SCOPE OF THE MODEL

The robot as developed by us is currently capable of performing some of the most essential steps in the process of agriculture, which are ploughing, sowing seeds, and spraying water and pesticides. However, this agricultural robot has a lot of possibilities that can be implemented in the future.

1. In the future, it is possible to make certain modifications to the tank such that the bot can spray both the stuff together, with less human interference, that is, a compartmentalized tank with two spraying nozzles fitted to it may be used, so that repeated refilling of water or pesticide is not needed.
2. Another significant addition can be a soil moisture sensing mechanism probe. Soil moisture sensors are used to measure the volumetric moisture content or in simple words, the water content of the soil, according to the environmental conditions of that particular area.
3. As the Lipo batteries are rechargeable, hence we can use solar cells to charge the batteries with renewable energy sources which will also reduce the cost of maintenance for this robot.
4. In critical atmospheric conditions, if we can operate the model through the air just like a drone, that might be a possible solution. For that, we can calibrate a Drone Structure in this model; considering the factors like weight, dimensions, and power supply.
5. Extreme weather conditions may arise many times in a year during crop cultivation, sometimes it is observed that the weather is very hot and humid for consecutive days in those situations this model could get overheated, and maybe extreme conditions can lead to permanent damage. For that reason, we could introduce an RTD (Resistance Temperature Detector) or some temperature sensing devices that can alert the user about the over-heating of the model.
6. we can cover the model with a heat-insulating and waterproofing material as an additional safety measure.

XI. CONCLUSION

Our project "APPLICATION OF ROBOTICS IN AGRICULTURAL SYSTEM" is currently in the intermediate stages, focusing on spraying water and fertilizers and the dispersal of seeds, along with ploughing the field. However, this robot can be improvised further to implement more technical aspects that can help farmers in future, as discussed in the previous section of Future Prospects of the Project. Here though we need to ensure the audience that through this paper there is no intention of promoting the use of pesticides in the agricultural field. There are several risk factors related to the use of pesticides, and that's why we have tried to minimize the risk factors associated with agricultural farming through this project. We always recommend you to practice Organic Farming if you have the scope of doing that. We believe, in the beginning, stages of the project itself, it can help reduce the workload of farmers, if produced on large scale, and on further development with advanced technologies, in future, this robot will clearly change the face of the Agriculture sector and industry. This robot aims to reduce manual workload to a huge extent, without compromising on the quality of work. Hence, not only will affect the employment sector. However, methods can be achieved to train people to work on these advanced technologies. This will make sure that the employment sector doesn't get affected. To end, we hope that our

Project robot has the capability to transform the current Agricultural sector's scenario if utilized and developed further, in the future.

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