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MULTIPURPOSE AGRICULTURAL ROBOT WITH PLOUGHING, SEEDING & SPRAYING MECHANISM

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Abstract- The paper presents about a project about the multiple agricultural tasks done by a single robot, i.e. – Ploughing, Seeding & Spraying. To develop the efficiency of the agricultural tasks we have to find the new ways. This project deals with a novel approach for cultivating lands in very efficient way. The distinctiveness of this agriculture robot system is, it's multitasking abilities which can be used for ploughing the field, seeding and pumping water & fertilizers, to work in both agriculture, afforestation and gardening platform. The project aim is to design, develop and the fabricate such a robot which can perform such tasks, in order to increase the overall efficiency in the agricultural model. This whole system of robot works with the help of a 12V battery and Motor connections. This model is just a prototype, which can be further improved both in design as well as operating capacity to make it more practical and suitable for actual-fields. More than 40% of the population in the world chooses agriculture as the primary occupation, in recent years the development of the autonomous vehicles in the agriculture has experienced increased interest.

Keywords – Robotics, Agricultural Robot, Climate Smart agriculture, Agricultural Automation, Mechanical Design, Computer-Aided Design

1. INTRODUCTION

The agriculture sector plays a vital role in enriching India's economy. Agriculture accounted for almost 17.8% of India's Gross Value Added (GVA) in 2019–20. According to the World Bank's collection of development indicators, employment rate in the Indian agriculture sector stood at 41.5% in 2020. From a socio-economic standpoint, agriculture is a vital sector which requires focus and awareness at all levels. In the recent years, the agriculture sector has been facing various challenges such as yield plateaus, soil degradation, water stress, high imports on oilseeds, nutrition deficiency, volatile prices, inadequate infrastructure linkages, post-harvest loss, and information asymmetry. However, adverse climate changes remain one of the most significant issues faced by this sector. According to a report, India lost approximately 5.04 million hectares of crop area due to cyclones, floods, cloudbursts, and landslides until November 25, 2021. Such calamities have had a severe impact on farmers, especially small farmers who constitute close to 85% of the total farmers in India. Thus, there is a dire need for smart agriculture in India. The Indian government has taken several measures for developing the sector, considering its importance. Notably, the government is exploring ways to enhance agricultural efficiency and profitability of farmers, and to help farmers double their incomes by 2022 compared to the base year 2015–16.

2. LITERATURE REVIEW

Introduction to Robotics – Robotics is the branch of technology that deals with the design, construction, operation, structural depositions, manufacture and application of robots. Robotics brings together several very different engineering areas and skills. Robotics is related to the science of electronics, Engineering, mechanics, mechatronics, and software. There is metalworking for the body and we have mechanics for mounting the wheels on the axles, connecting them to the motors and keeping the body in balance. You need electronics to power the motors and connect the sensors to the controllers. At last you need the software to understand the sensors and drive the robot around. Today Robotics is the rapidly growing field and it is continue in research, design, and build new robots that serve various practical purposes. As it has taken drive in various fields is there any possibility that robot can be introduced in the farming.[5].

Robotics in Agriculture & Farming Sector – The field and applications are too large to limit it to just one sector. But the scope of this paper, deals only with the Agricultural implications and applications of Robotics. It can be used in a variety of ways, such • **Robot drone tractors:** A new generation of robot drones is revolutionizing the way we farm, with manufacturing of different robots, i.e announcing the first ever robot drone tractor becomes part of the agricultural mainstream. Robot will decide where to plant, when to harvest and how to choose the best route for crisscrossing the farmland. These are used in America now. "We can design Robots to reduce the usage of pesticides, herbicides, fertilizers and water" a robotic scientist says.

• **Flying Robots to Spread Fertilizer:** A flying robot monitors the growing condition of the crops over farmlands in Ili, a Kazak autonomous prefecture in Northwest China's Xinjiang Uygur autonomous region, July 25, 2011. With camera equipment and an automatic fertilizing system in the front, the robot can fly autonomously and apply fertilizer independently. It is made by the national key laboratory of robotics of Shenyang Institute of Automation of Chinese Academy of Sciences.

• **Fruit Picking Robots:** The research is still in full progress, especially as the robots need to be carefully designed so that they do not bruise the fruit while picking. One solution is the use of suction grippers, used on automated fruit picking machines manufactured, for example, by ACRO. Citrus fruit robot pickers have thus far been the focus of research and development, but cherry pickers are also being researched. Vision Robotics, in particular, has made several robots that are already capable of taking over the work.

• **Robot Cattle Grazing and Automatic Milking:** Is the milking of dairy animals, especially of dairy cattle, without human labour. Automatic milking systems (AMS), also called voluntary milking systems (VMS), were developed in the late 20th century. They are commercially available since the early 1990s. The core of such systems, that allows complete automation of the milking process, is a type of agricultural robot. Automated milking is also called robotic milking therefore. Common systems rely on the use of computers and special herd management software. Producing fresh food for us to eat every day.
[1]

Impact of Budget 2022 – It focusses on smart and modern agricultural practices. Budget 2022 focuses on smart and modern agricultural practices. According to the Prime Minister of India, agricultural loans have surged 2.5 times over the past seven years. These loans will help modernise agriculture significantly and enhance natural farming, with a prime focus on Agri-waste management. Furthermore, under the PM Kisan Samman Nidhi scheme, US$ 26.4 billion (Rs. 2,00,000 crore) has been disbursed to 11 crore farmers. Also, the government's efforts towards promoting the use of organic products have driven expansion in the organic products market to US$ 1.5 billion (Rs. 11,000 crore). The government is also providing financial support to Agri-tech start-ups and promoting the adoption of AI to revolutionise agricultural and farming trends.[2]

3. DESIGN OF THE AGRICULTURAL ROBOT

3.1 Objectives of Design

The vehicle has been designed taking into account the following:

• It must move in a soft soil as well as in an environment with many obstacles and tight spaces.

• It must have enough capacity for optimal work performance.

• It must perform different tasks i.e. – Ploughing, seeding & water spraying, simultaneously.

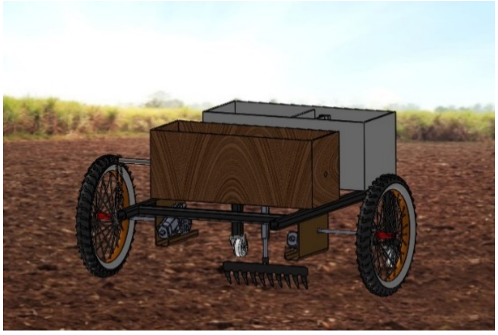
The CAD-CAE technology has been used in the mechanical design of the vehicle. This technology provides a virtual prototyping to validate the design before its manufacture. This is done by creating geometric models of the components of the vehicle which are assembled virtually and tested with different mechanical motions. This software also helps optimize the arrangement of the components, the weight, and the aesthetic appearance of the vehicle. Once the virtual prototype was defined and analysed, a physical prototype would be built and tested.

3.2 Design Components

The main components of the robot are –

- Base frame: (27*18)"
- Rear Wheels: 7"
- Front castor wheels: 2"
- Ductile Iron Square Pipe: (1*1)" 3Kg
- Plougher – 12 Teeth (12*3)"
- 12V Battery
- Wiper Motors (12V, 45 RPM): 2
- Front Housing Box: (18*7.5*7)"

- Water Tank: (7.5*6.5*3)", 2.39L
- Seed Dispenser: (18*6*7)"
- Actuator: 12V BLDC Motor (200 RPM) with a 4" lead screw



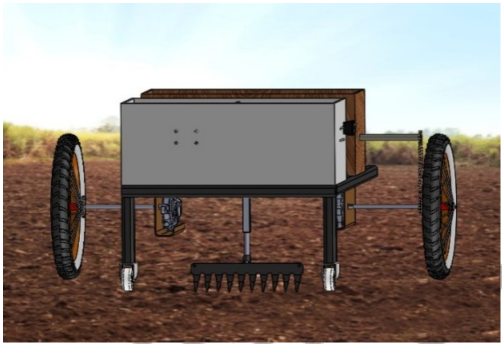


Fig. 3.1: Graphical Representation of Model

3.3 Operations

Our robot can perform various operations like –

1. Steering Operation –
   a) Robot is powered by two wiper motors, which are also responsible for turning.
   b) The motors are powered by a 12V battery
   c) The power for motor is regulated by Relay switch.
   d) The direction of motor rotation can be controlled by remote controller for steering the vehicle to either left or right side direction.

2. Ploughing Operation –
   a) Actuator is designed using a 12V BLDC (200 RPM) motor attached with a 4" lead screw, for the ploughing operation.
   b) The screw is further connected to a plougher (rake), which has 12 teeth (12" * 3").
   c) The actuator is powered by the same 12V battery, and is controlled by a 6-pin DPDT switch.
   d) The actuator can be adjusted according to the desired depth at which the ploughing is needed.

3. Seed Sowing Operation –
   a) A wooden box (18*6.5*7) inch is used for seed storage as well as dispensing mechanism.
   b) Three holes of 1" diameter each are used which are further connected to valves for controlling the appropriate quantity of seeds dropping.
   c) A rotating shaft is passed through the box, which is powered by the rear wheels through a chain-sprocket mechanism.
   d) As the motor is switched on, the wheels tend to rotate and rotation of shaft makes the seeds fall on the cultivated filed. There is time gap where seeds is alternately fed to the ploughed field

4. Water Spraying Operation –
a) The front box houses the water tank as well as the battery components.
b) A water pump is used for pumping water, which passes through a tube. The tube is attached in front of the box.
c) The power for pump is regulated by a toggle switch.

4. RESULTS

Multipurpose agricultural robot is definitely useful to all the farming community across globe as it would not only reduce the manpower needed to complete the tasks but also increases the efficiency of farmers.
While there are many agricultural implants that are manufactured and utilize Robotics and AI, our robot is innovative and unique in the following ways:

• Its design is such that the entire operation can be carried by single individual and requires less human intervention. All three functionalities mentioned such as digging, sowing, and sprinkling of water & fertilizer are done simultaneously.

• Unhindered operation of this machine in semi-arid and arid regions is easier as the movement is not interrupted by wet and muddy soil.

To improve the efficiency in the agricultural sector there is a need of the mechanical control system. This can be achieved by the robots which can work faster with more productivity. This maneuverability and multi-tasking is the main advantage of our agricultural robot as it performs tilling, laying seeds, spraying fertilizers, sprinkling water all simultaneously that too utilizing solar energy. It can also help in removing weeds and do additional tasks, how we program with different tools.

Multipurpose_Agricultural_Robot_with_Ploughing_Seeding_Spraying_Mechanism

Table 4.1: Comparison of usage efficiencies across Factors

Factors	Labor	Tractor	Robot
Man Power	High	Moderate	Less
Time Required	High	Moderate	Less
Ploughing	Manual	Manual	Automatic
Seeding	Manual	Manual	Automatic
Watering/Fertilizer	Manual	Manual	Automatic
Required Energy	Very High	High	Less
Wastage	High	Moderate	Less

5. CONCLUSION

This work does not provide any quantitative result on the evaluation of the effect of robotics introduction in agriculture on human workers replacement. It rather outlines the conditions, constraints, and inherent relationships between labor input and technology input in the production, in order to evaluate the effect of aadoption automation and robotics in agriculture.

There is a discussion on the potential for implementation of robotics in agricultural production in developing countries. The basic argument behind this discussion is that it is not necessary to go through a primary mechanisation phase before entering an advanced technologies phase e as for example though in developing countries people never experienced the use of land-line phones they are able to use mobile phones efficiently. However, the implementation paradigm must be completely different of the one in developed countries. In the latter case, robotics improves or replace a conventional component of a well-structured production system. In the former case, it would be needed to introduce a whole system and not just scattered components of a system tested elsewhere. Sub-Saharan areas have experienced attempts to expand the cultivated area and to modernise agriculture by just bringing tractors into production. Such attempts have consistently failed because a tractor by itself is not an effective tool for inducing the process of agricultural intensification.[5]
The system engineering approach is an imperative requirement for the analysis at hand. Beyond the economic approach, the system engineering approach is needed for the analysis and reconfiguration of the complex mix of human labour and robotic machines in a production system. Output rate improvements (directly through increased productivity and indirectly from increased reliability) in one set of tasks necessarily generate the requirement for increased output rates in the remaining tasks in order to secure the increased value of the whole system. In general, all scientific work on the effect of automation and robotics in labour market are elaborated from a macroeconomics perspective, e.g. implementing instances of the Cobbe Douglas or constant elasticity of substitution (CES) production functions, based on aggregate data on labour force, occupation,

productivity and so on. However, in the case of agricultural production, such data, although available, do not depict the full picture on labour force, especially in the level of low-skilled labour (which low-skill labour in a lot of country economies is the majority of the workers related to agriculture). This is due to the fact that in agriculture there are a lot of seasonable and unregistered workers. To this end, we believe that the right approach for evaluating and predicting the effect of automation and agri-robotics in agricultural labour, is a bottom-up approach where the analysis should start from the farm level. This means that agricultural operations should be expressed in terms of actual required workforce (for example in workhours per harvested unit of product) for a given level of implemented technology.

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