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Original Article

IoT and Mechatronics Based Agrobot

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Abstract: *Agrobots are autonomous robots that carry out agricultural techniques and assist farmers in their fields. This robot is controlled by an Raspberry Pi Pico to perform agricultural processes such as dropping seeds and grass cutting. It could replace the conventional farming mechanism in the third world century. As we know, conventional agriculture still uses livestock in rural areas and they suffer greatly. They useold equipment and use organic fertilizers by hand Increase. The yield is not large. An increase in population has reduced agricultural resources, resulting in fewer people working in agriculture and more people in urban areas. Therefore, we need to find new ways to improve the efficiency of agriculture around the world. This has led to increased interest and spending in the field of agricultural robotics. This new farming method that uses robot to overcome all the problems that faces in traditional farming. This includes machines and new instruments that produce high productions. The agrobot is also designed to perform all agricultural processes on its own, consuming very little manpower and increasing productivity. The main advantage of using this autonomous farming robot is to check environmental conditions such as soil humidity and moisture as well as increase productivity. This approach to developing robots (machinesthat are smarter) will change the old ways of farming and bring a new world to this field of agriculture.*

Keywords: *IoT, Robotics, Automatic, Agricultural Operations.*

I. INTRODUCTION

As we know, Food and water is the most basic need of a Human Being. Humans has been the most important and necessary part in food production from ages, and thus humans have become the limiting factor; because all the agricultural activities are carried out manually by famers, and humans have limitations to performed any activities in terms of quality as well as quantity. Historically, Farmers has not been able to produce more quantity and good quality of food for ever increasing population in the world, thus the use of Machines or Technology is indeed a necessity in today's technology driven world. The objective to use technology is to boost the productivity and to insure the Ease and safety of a human operator during performing activities.

Automatic technology has been applied or used in every aspect of the manufacturing, designing, construction, production, etc. and has given relatively good output. In farming activities most of the energy and time consuming work operations are carried out by the farmers and labours. For example, in the field, the farmers had to lift the heavy bags of vegetables, fruits, seed, etc. for collecting and ploughing process, also during harvesting and fertilizing they have to carry the containers of fertilizers on their back. These operations are hard, repetitive, time and energy consuming operations for farmers. After the manual operation performed by labours or farmer, then comes the machine-based operations such as tractor for plowing, this tractor based activity needs fuel and operator, also produces high noise and vibrations, and thus cannot be considered automatic and user and environment-friendly. And, thus it is high time that we implement engineering and science of automation in the field of agriculture.

The Study and Development of Agricultural Robots was started from a decade and these robots are termed as Agrobot, which are mainly used for seeding, spraying and plowing and cutting processes. The Agrobot is designed and built by using a microcontroller, motor drivers, various sensors, wireless communication modules, etc. Varieties of the robots, machines and technologies are in the stage of Study, research and development. A robot is considered efficient if it performs activities independently (Automatic) and is economically considerable by an ordinary farmer. Over a decade, agriculture has been progressing towards becoming a technical operation oriented field from a manual based operation domain, using a wide range of equipment, tools and machines, also, the new age of researchers are studying for advanced application of robotics in use of agricultural activities.

II. BACKGROUND

An early stage of development, automatic vehicle design had been studied for years, with many theories being studied from late 90s. Totally the concept of automatic farm technology is not entirely new. Examples of using the guide-wire routing method on early for unmanned tractor prototypes date back to the decade. In the late 90s, the ability to integrate a computer with image sensor contributed to the potential for vision oriented automatic systems. In the mid of 90s, experimenters studied machine vision. Also, during this decade, orange harvesting programs by using robots were successfully implemented at the University of Florida. India experience dramatic productivity growth during the 1970s and 1980s. This is due to a series of steps leading to accessibility to agricultural technology, often referred to as the Agriculture based revolution called Green Revolution. The main causes of agricultural expansion during this period were the spread of varieties of crop that can be used in coming modernized society, the advantage of it was an investment that led to the strengthening of irrigation and the expansion of irrigated areas. Growth has slowed in regions where the technology of the Green Revolution has had a major impact. New methods are now essential to pushing yield limits, using inputs more productively, and moving to low-maintenance, high-quality growing patterns.

By 1996-97, automation in agriculture was becoming a major topic of debate with the counter view of precision and reliability in agriculture. Many Indian manufacturers and researchers have also started developing and designing various types of Agrobots. Some of the papers regarding the same are listed below. These papers discussed the effect of seeding depth, seed spacing, seeding error rate, and power seed sowing equipment on seed germination and yield efficiency. Also, the paper was concentrating on using various technologies that can be used in co-ordination with robotics.

III. LITERATURESURVEY

"Smart Agriculture Using Agri-Bot" (K.Gowthami, K. Greeshma, N.Supraja, IJAER, 2019) This paper provides a system to perform seeding process on farm. The main concept behind this paper is to design and implement a prototype that is effective and of low-cost. A Robot that can performs agricultural tasks without human interventions. This project is based on the wireless communication system (Bluetooth) using microcontrollers (Arduino).

"Automatic Weed Detection in Corn Fields and Intelligent Herbicide Spraying Robots" (G.Sowmya, J.Srikanth, IJSETR, 2017) Image processing. The advantage of this project is that beetroot is detected with the help of a camera and herbicide is sprayed on the infected crops, thus saving time.

"Autonomous Soil Design: Monitoring Robot" (Patrick M. Piper and Jacob Vogel, IEEE, 2015) this work designs and develops a robot for soil monitoring. This robot is configured with a Stevens Hydra Probe II that allows him to measure soil humidity and temperature on his and his GPS for navigation.

"IoT-Based Smart Agriculture - Making the Fields Talk" (Muhammad Ayaz Mohammad Ammad-uddin, Zubair Sharif, Ali Mansour, and el Hadi M. Aggoune, IEEE, 2019) The idea of this paper is to utilize WSN, and technologies like unmanned aerial vehicles, cloud computing and wireless communication technology to enable farmers to produce high quality crops and fulfill the growing demands of a growing population. . This paper proposes a system that implements the technology-based farming concepts from beginning to end of harvesting period, requiring negligible human intervention.

"Agricultural Automation System by Field Support Robot AgroBot" (C Jeeva, SaherMairaj, ArchitKeshavGangal and Farheen, IJPAM, 2018) The system consists of an Arduino UNO that serves as the heart of the system. This system consists of cameras that detect obstacles in the way and help you carry out the required actions, providing three main functions: sowing and harvesting. The main idea behind it is to design a multitasking robot. This saves working time, reduces labor costs and aids in correct seeding method.

"Vision-Based Intelligent Robotic System Supporting Agricultural Crops" (Nikhil Paliwal, PankuriVanjani, Jing- Wei Liu, SandeepSaini, and Abhishek Sharma, IJSHC, 2019) Decide on a prototype model. His IoT robot at the base to help identify leaf infections. This consists of disease detection, soil data connectivity and the use of UGVs and UAVs to help with field classification to provide a solution for mixed crops. The main idea of the paper is to provide farmers a method to detect diseases early.

"Design and implementation of his Agrobot with automaticsuntracking" (v. Radhika,B.Sharmila,R.Ramya, M. Gopisri, IJEAT, 2019). This proposed Agribot consists of Arduino, solar panel, GSM module and sensors. Solar panels are used to charge the robot. The ultrasonic sensor detects hurdles and also helps dig holes for seeding at a predefined distance. A pH sensor helps calculate the moisture level of the soil. Electrochemical sensors help the determine soil fertility, and optical sensors help move the robot. The main purpose behind this system is to reduce the burden on the farmers and get better yields.

"AGROBOT: Seeding and Irrigated Agriculture Machine" (Shubham Khandelwal, Neha Kaushik, Sagar Sharma, IJAR, 2017) This structure has a vehicle-powered ATMEGA328 microcontroller that acts as the master operator. He performs four functions such as plowing, sowing, harvesting crops, and irrigation. A solar panel is used to charge the battery. Given the length and width of the field, the robot will automatically move her. The aim of the system is to help farmers achieve good yields and to minimize the use of non-renewable resources.

"AGROBOT: Seeding and Irrigated Agriculture Machine" (PonnuPriyaSaju, AnilaP.V, IJREAM, 2019).This system proposed is based upon an LPC1769 microcontroller based upon ARM cortex M3. For soil mositure level measurement FC-28 hygrometer is used. The agrobot controls seed planting and irrigation operations. For running the watering process a relay is used, when the moisture in soil is low, the relay gets on; the microcontroller sends a high signal. This prototype was constructed from aluminum and foam panels to make it light and reduce weight. The main objective behind the system proposed is to promote the precision farming techniques.

"IoT-Based Precision Agriculture with AgroBot" (Mr. V. Gowrishankar, Dr. K. Venkatachalam, GRDJE, 2018) This Paper Provides information on demonstration and operation of Agribot controlled by IoT. This robot performs a variety of his functions such as plowing, seeding, and spraying pesticides. Servomotors and solenoid valves are implemented to implement the seeding and insecticide spraying mechanisms. The goal of his project was to help farmers get better yields and avoid direct contact with the chemical pesticide.

"IOT-Ready Pesticide Sprayer with Solar Powered Security System" (Amaresh. A. M. Anagha G Rao, FennazAfreen, Moditha. N, IJERT, 2020). This robot is used to spray pesticides on his using a solar powered his pump system. Movement of the robot between crops is monitored by the farmer using an android application. If there is an intruder in the field at, the robot captures an image of the intruder and sends it at to the farmer. This robot can be used to spray disinfectant during COVID disinfection. The primary objective of this project is to build a nominal installation that will enable farmers to increase crop yields and reduce exposure to chemical pesticides.

"Solar Power Agrobot for Farm Monitoring Using Internet of Things (IOT)" (SivaprasadAthikkal, AmbarishPradhan, AbhilashGade, A.Mahidhar Reddy, IJEET, 2020)This proposed Agribot is Consists of IR, humidity and temperature sensors.solar panels were used to harness the naturally available sunlight. The sensor checks the temperature of the soil, irrigates the land according to the temperature and sends the data to his cloud. This robot changes course when it encounters obstacles. The main intention behind this project is to help farmers and build economical robots that utilize available natural resources.

IV. MOTIVATION

Building a Machine or a technology, which is efficient more than human and budget friendly as well, will automatically create interest in society or in a operations oriented domain. Agriculture is a domain that has been dominated by manual human operation and there goes a lot of money as expenses for material, power (energy), labour, etc. Therefore, as we say the necessity is the mother of innovation. Necessity and Operation optimization can be seen as the motivation for developinga technology or a machine that can de-burden the loads of farmer sand revolution is the agriculture domain.

V. IDEA CONCEPTUALIZATION

After brainstorming on various fields, a idea arose to do something in the field of agriculture and for the problems faced by the farmers during Performing agricultural activities. Also, performing agriculture activities manually could be hectic, time and energy consuming, and can affect production in terms of quantity as well as quality. Also, need for labour and labour wages are weakness of agronomics. In achieving Solution for this we went through a literature survey and took help from various research papers. We came to conclusion to design, develop and implement the agriculture robot also called Agrobot. Agrobot is a robot considered for agricultural purposes. This Bot performs basic elementary operations like Ploughing, Cutting and Seeding to minimize the Manual work of farmers and additionally increasing speed and accuracy.

VI. OBJECTIVES

The objective of this paper is to design, develop and implement the hardware model of agrobot that perform basic operations like Seed dropping, crop cutting, and can turn automatically without human interventions.

VII. SYSTEM ARCHITECTURE

There are a number of microcontrollers present in the mar- ket. In this paper we have chosed Raspberry Pi Pico replacing

it with Arduino UNO. The reason we chose Raspberry was because of the technical specifications, working principle, operating system, data processing unit, clock speed, power management, uses and finally cost. Taking in mind these all features we decided to choose Raspberry Pi Pico. The proposed robot is executed to help farmers in their on-fields operations. The controlling Component of the whole Structure is Raspberry pi pico, facilitate Lower power consumption and various power-saving modes, thus concluding that it can run on battery power.A 360 degree rotary is introduced in the hardware of the robot which will give a reasonable perspective of the way ahead and will likewise help the agrobot to avoid any obstruction on the off chance that the robot experiences in its way with the goal that any legitimate activity could be taken. The proposed framework has main functions: Seed dropping and Crop cutting. On a circuit board Raspberry pi pico, 3 L2983 Motor Driver IC, Four 60 rpm Dc Motor for wheels and one 100 rpm Dc Motor for Seeding and Crop Cutting Mechanism, 9 lithium ion Cells and 3 switches are used to design this two functions; as shown in fig. 1. Motor driver divides and circulates sufficient amount of current and voltage to the motor to perform their operation smoothly. Mo- tor drivers are interfaced with Microcontroller, and controller sends the command to the motor driver for operating the dc motor responsible for seeding and crop cutting mechanism. The 360 degree rotary is used, so that the agrobot turns itself at appropriate specified distances.

VIII. RESULT

A. Stage 1:

In this stage, we have designed a basic simulation circuit which includes various components. This Stage basically made us understand how to connect motors drivers, motors, and sensors to microcontroller and with each other Figure 2.

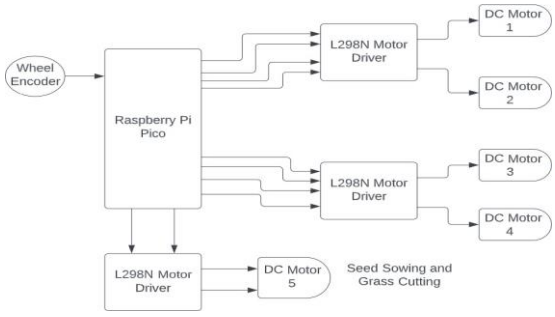

Figure 1: System Architecture

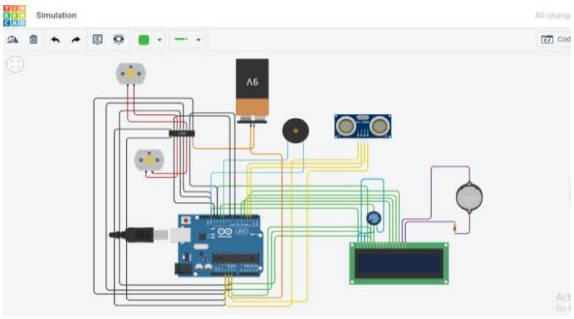

Figure 2: Stage 1-Simulation

B. Stage 2

During this stage, by referring to the simulation circuit we designed in the first stage, we were able to implement a basic hardware circuit as shown in Fig 3. and Fig 4. The goal in this Stage was to create a small vehicle type structure which can turn automatically itself when a object is detected by ultrasonic sensor; and when a object is detected buzzer rings. This basic model was built using Arduino uno and L2938 motor driver

C. Stage 3

During this stage of Project development, we were more focused to implement a seed dropping mechanism and make a prototype of robot that can be controlled remotely using android. Servo motor was used to implement a basic seeding mechanism co-ordinated with Arduino nano. Bluetooth mod- ule HC-05 was used for communication between a project and Android. Refer to Figure 5 and Figure 6.

D. Stage 4

The other goal during this stage was to implement a crop cutting mechanism and design an automatic driving system. For automatic driving system, we have used a 360 degree rotary. Seeding mechanism is implemented in such a way that, it uses the same motor used for seeding mechanism, just by changing the disc.

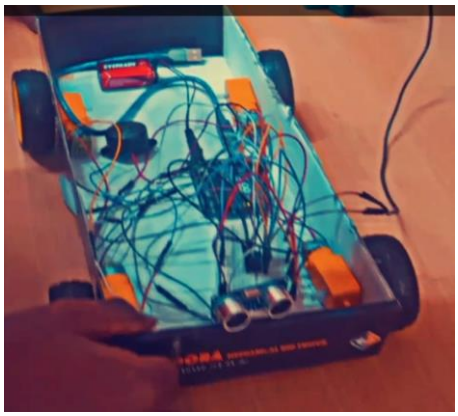

Figure 3: Stage 2-Basic Implementation

In this paper a robot termed as 'Agrobot' has been designed, implemented and demonstrated to perform operations like seeding and crop cutting on an agriculture field. Robot will reduce the efforts of the farmers and will improve quality of production and the efficiency of production. The robot performs the tasks automatically and turns at specified distances in a sequence without human intervention. We had an objective to make the agrobot as suitable as possible for the farmers. Below is the list of outcome achieved:

- A Basic Structure of Agrobot is successfully implemented
- Raspberry pi pico as a microcontroller is successfully interface with all other components to obtained a proper co-ordinated function of agrobot
- The agrobot is designed and developed to perform operations like Dropping Seeds and Grass Cutting
- Not prone to hazardous chemicals like pesticide
- Runs on Battery so no harm done to farmland due to oil spill

The model developed is a basic representation of agrobot, as shown in Figure 7 and Figure 8 This model further can be upgraded to perform operation like digging land and seeding a seed, fertilizer spraying, plants health monitoring, ploughing, automatic water spraying, etc. Agrobot has a huge scope in the agricultural domain. Technologies like robotics, IoT, AI, mechatronics, WSN, Cloud Computing can together create wonders in field of agriculture. These technologies are further explained.

IX. FUTURE SCOPE

Our agricultural enterprises and researchers have developed much small and heavy agricultural equipment to meet the needs of traditional agriculture, but precision agriculture re- quires robots and pneumatic mechanisms. Now that robots have entered Every Production domain, is it important to consider why robots are not entering the agricultural sector? When robots are used to control weeds, they can help reduce herbicide use and the product will be an organic product. Just like robots can be used to transplant seedlings and avoidintensive labor. We had read in various papers about impressive innovations by various inventors. We believe that advanced intelligent agricultural machinery, sensors or readers, and wearable PDA are very useful for computation and agricultural accuracy. There are many hurdles in agriculture sector in all countries especially in India. The numbers of farmers per day is getting smaller, many have left the agricultural profession and it is no longer profitable, they don't want to lose, the risk is increasing day by day. Young farmers are more interested in investing in automation than older farmers. New technology should be introduced looking at the market situation and customer thinking process (generally taking the young generation of farmers into consideration). The agricultural sector is slowly moving towards precision agriculture, where farming is based on individual crops. Detect plant or flower type using AI and machine learning and other advanced methods. This helps farmers provide plants with a suitable environment for sustainable growth. Eventually, more customized fruit and botanical production will grow, leading to an increase in product types and production processes. Ar- tificial intelligence technology is advancing rapidly and can be used to detect crop and unwanted weed diseases in farms using CNN,

RNN or other computer networks. Greenhouse method of agriculture can provide a specific and relatable condition for plants, but this method requires manual labour work or human invention.

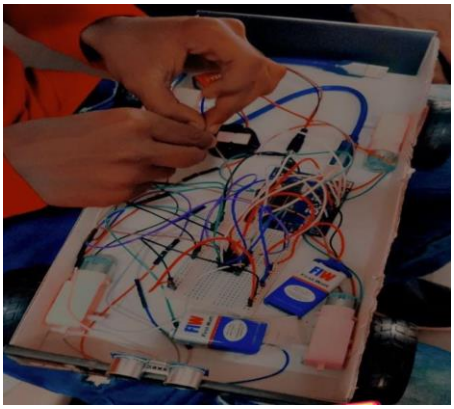

Figure 4: Stage 2-Basic Implementation

Figure 5: Stage 3-Initial Seeding Mechanism

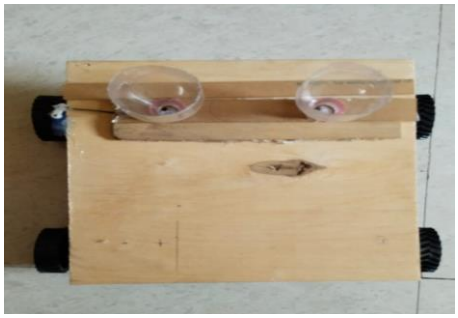

Figure 6: Stage 3-Initial Seeding Mechanism

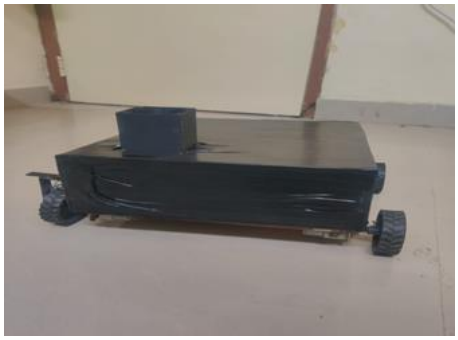

Figure 7: Front View of Agrobot

Figure 8: Side View of Agrobot

Thus, here we can consider and can implement technologies like WSN, wireless technology, mechantronics and IOT, image processing, communication protocols and various sensors. Operation like weather monitoring, harvesting crops and fruits (24/7 harvesting) can be performed by robot. Robotics applications are widespread in agriculture, as robots can be used for seeding, harvesting and planting, fertilizing, pesticide spraying and watering, weeding and spraying, etc. A farmers often needs about 25-30 workers to do the same work. Thermal image processing can also be developed using drones and thermal cameras. Drones monitor farms and continuously provide real-time field data, so farmers know which areas of their fields are low on water and can start watering only those specific areas. This prevents the field from flooding and water shortages, and plant always receives rainfall. Various different approaches can be used to provide a sustainable environment and technology for improved growth.

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