iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** VIII **Month of publication:** August 2021

DOI: https://doi.org/10.22214/ijraset.2021.37248

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VIII Aug 2021- Available at www.ijraset.com

RA02 Based Multi-Purpose Agricultural Robot

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Abstract: ***Agriculture seems to be one of the main industries which contributes to the development of a nation. Agriculture is the backbone of a nation. 70% of the income in India is based on agriculture. In this era of modern technology there have been technological advancements in almost every industry. Generally in the farms a lot of time is consumed for activities such as seed sowing, grass cutting and so on. Agriculture nowadays is facing various issues such as lack of labor, expensive machinery and much more. This proposed system aims to bring down the work for the farmers and hence make it easier for them to handle the current crisis and problems in a better and more efficient manner. The robotic vehicle can be controlled remotely with the help of a remote and all this can be done with the help of a LoRa module in order to control the movements of the robotic vehicle.***
Keywords: Agriculture, LoRa, RA02 LoRa, Arduino Microcontroller, Gear Motors

I. INTRODUCTION

Agriculture being one of the main occupations in India serves as the backbone of India and its economy and for sustainable growth of India, developments in the field of agriculture plays a very crucial role. India has a very huge population and the population seems to be growing day by day and thus the demand for production of food is also increasing day by day and hence it is required to find efficient means to attain this goal. This system in India as well as in other countries can be advanced to increase the production in farming and in also reduce the efforts of the farmers. Agriculture involves the activities such as growing of crops, animal breeding and growing plants for medicinal use and other products used to enhance the quality of human life. The history of agriculture goes back to thousands of years, and its development can be defined greatly by the different climates, technologies and many more such factors. If in a field where there has to be constant manual labour involved there are some good industrial improvements implemented the it would largely benefit not only the farmers but also help in boosting the production of food and also help in boosting the economy of a nation which is helpful for the nation as well as the individual[1]. The main agenda behind developing this robot was to create a prototype that can incorporate the latest technological improvements to enhance the agricultural yield for the farmers which would in turn help in boosting the economy of the farmers and also reduce the amount of manual labour that has to be done by the farmers to a great extent. This paper therefore aims to propose a system that would be helpful to the farmer to help them with processes such as seed-sowing, irrigation and grass-cutting.

Also another important idea behind this paper is to implement the above mentioned activities with the help of a LoRa module which enables long range communication at a better bandwidth and also at low power. The robot is operated using a remote that has been custom made for making the robot easy to handle. The remote would have switches to control the movements in four directions that is forward, backward, left and right. It would also have a stop switch and a switch for enabling seed-sowing, irrigation and grass-cutting mechanisms.

II. LITERATURE SURVEY

Over the past few years, there have been many people who have shown keen interest in designing and developing smart agriculture systems. The use of smart farming techniques can enhance the crop yield, at the same time reducing the efforts of the farmers and in turn reducing the dependency on manual labour to a great extent. In the olden days technological developments were quite less and hence the farmers had to work more to yield better results. In the field of agriculture the farmers face many issues. Nowadays the process of seed sowing is done either manually or by using tractors. Manual methods of seed sowing involves broadcasting the seeds by hand or digging holes in the ground and sowing the seeds [3]. Industrial agriculture which is based on large-scale monoculture farming has become the most dominant agricultural method of agriculture. The machine can be advanced for sowing the seeds in the farm along with grass-cutting and irrigation mechanisms. It can help in automatically sowing the seeds in land, cutting the grass in the fields and watering the crops in the fields. The machines are mainly applicable for small scale farming and are simple in design, and they can further be improvised in order to use the machine for large fields or farms and hence can be made more easily available to all farmers. The robot can be operated either using a custom made remote. [4] [5] The main aim is to develop a prototype that can help bridge the gap between agriculture and technology in an innovative and more efficient way which is less expensive.

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Volume 9 Issue VIII Aug 2021- Available at www.ijraset.com

III. METHODOLOGY

The most important part of the project or in other words the heart of the project is an Atmega 328P microcontroller. This would act as media for us to integrate the various components and make them all accessible to the user to operate it from anywhere within a particular radius.

The transmitter section acts as the remote which is used by the user to control the various movements and functionalities of the agriculture robot. Since we would be using our own customised remote to control the whole project we would be making the use of some control switches to control the movement or working of the various different components associated with the robot. The remote would be able to communicate with the robot with the help of a LoRa transmitter which sends its signals to a LoRa receiver which is attached to the agriculture robot itself. The module adopts LoRa which uses the spread spectrum technology.



Fig. 1 Transmitter section block diagram

Each module can connect with another module in different addresses and channels to achieve applications like networking. The receiver section proves to be the most challenging and most important part of the whole project. This section too uses the Atmega 328P module in order to control the various components such as the drivers, ploughing tools, seed sowing tools and many more connected to it.

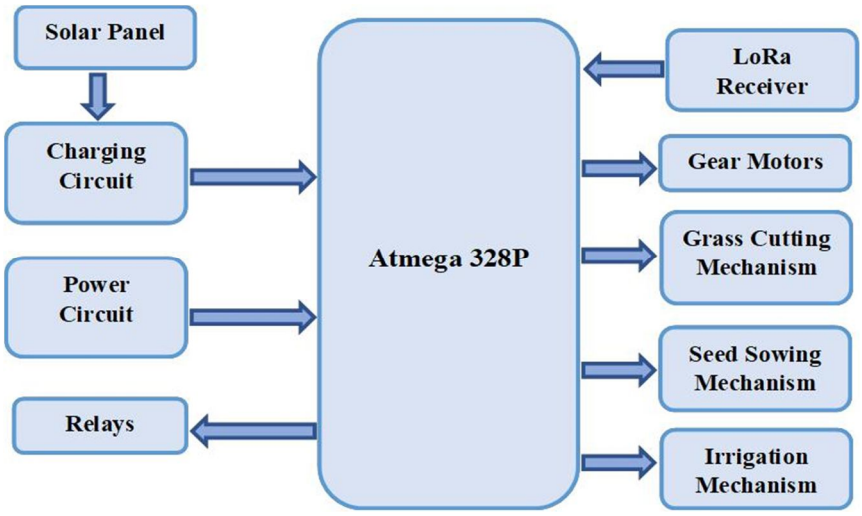


Fig.2 Receiver Section Block Diagram

The Motor Drivers basically perform the work of monitoring and controlling the movement of the robotic vehicle with the help of DC motors. The receiver section also comes up with a solar panel associated to it as in the rural areas it is most commonly seen that there are a lot of power cuts and in such situations, the farmers cannot rely only on the power source provided which needs to be charged.

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So, in order to overcome these circumstances we use a solar panel which would convert this energy of the sun and store it in a charging circuit which can be used as an alternative energy form in order to make the usage of things easier.
Relays are generally used to control the flow of smaller currents in a circuit and do not usually control power consuming devices except for devices such as small motors and a few more.
The machine can automatically sow seeds in the land. The robot cannot read computerized input that is given, hence L298 motor driver is used to convert this computerised information to mechanical information which can help in the movement. Relays are appended to robot machine that is controlled by driver circuit. These relays help in switching of states for the seeding mechanism in the robot. Similarly, the relays control the switching states for grass cutting and irrigation mechanisms.

IV. WORKING

The developed robotic vehicle can be moved in various directions like forward, backward, right and left. These directions are given by the user by pressing the respective control switches which have been incorporated in the remote that would be manually designed. Then, the LoRa transmitter fitted on the remote would send the commands in the form of signals to the receiver module.
The receiver module fitted on the robot on receives the command and sends it to the Arduino module which will send it to the microcontroller. The microcontroller then drives the motor driver circuit to help the robot move. In addition to these movements, several functions like seed sowing, grass cutting and irrigation are performed. [6]
All the below functionalities are achieved with the help of a LoRa transceiver module that would be used to control the functioning of the whole mechanisms and the robot. LoRa uses a license-free sub-gigahertz radio frequency bands like 433 MHz, 868 MHz in Europe, 915 MHz in Australia and 923 MHz in Asia. LoRa allows data to be transmitted over long distances with a low power consumption.
The main agenda behind using this Lora module is to reduce the amount of power consumed and also to reduce the dependency on the network and range. The main target is to achieve a range of approximately 1 to 1.5km operating range by using the most effective cost efficient methods.

A. Seed Sowing

The seeds are stored in a small funnel and it is attached to a pipe whose ending is attached to a small sliding flip structure. The movement of the flip is controlled with the help of a dc motor. The dc motor along with a gear is attached to the flip and the flip moves back and forth which controls the falling of the seeds.

B. Irrigation

Based on the farmer's requirement the farmer can water the field. This can be done using a relay and a dc motor. The relay controls the functioning of the motor and in turn the motor helps in pumping the water out. When the particular control switch is pressed it controls the working of the relays and the motor in turn.

C. Grass Cutting Mechanism

There are multiple ways in which this mechanism can be implemented. One of the methods that we as such are using is the method to chop off the weeds or any other grass or grass like plants growing in the field and not the crop harvesting mechanism.

V. BENEFITS



Fig. 3 Designed transmitter section

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Fig. 4 Designed receiver section (top view)

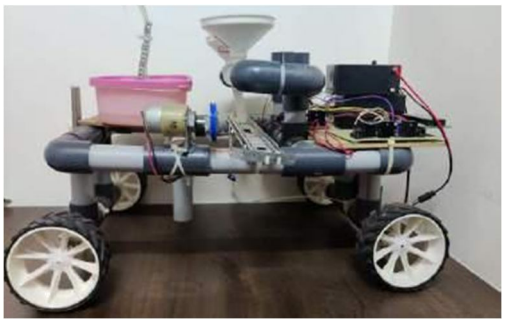


Fig. 5 Designed receiver section (side view)

D. Reduction in Wastage of Water

The spraying of water is controlled with the help of a motor which reduces the wastage of water to a great extent by spraying the water through the nozzle.

E. Reduced Wastage of Seed

The dropping of the seeds is controlled with the help of a small gear motor which makes sure that the seeds do not spill out unnecessarily resulting in the reduction of the number of seeds wasted.

F. Lower Operating Power

Since the LoRa module operates at a lower power compared to the other modules such as Bluetooth and Zigbee it is more efficient to operate at a lower power.

VI. HARDWARE REQUIREMENTS

A. Arduino Microcontroller (ATMEGA 328)

The Arduino Nano is a small and user friendly and it usually works on the basis of the principles used by the ATmega328P microcontroller. It has a functionality similar to that of the Arduino UNO, but it quite small and has a quite different package. The major difference is that it does not come with a DC power jack. It can be programmed easily using an open source software such as the Arduino IDE.



Fig. 6 Arduino Nano

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B. RA02 LoRa module:

LoRa /Long Range is a module which uses the LoRa modulation techniques. LoRa is a low power WAN modulation technique which uses the spread spectrum modulation techniques which are based on the chirp spread spectrum technology (CSS). The RA02 LoRa module provides a LoRa technology that can be easily used with Arduino, Raspberry PI, ARM and many such microcontrollers. It works at a frequency of approximately 433MHz [2].



Fig. 7 RA02 LoRa Module

C. Gear Motors

A gear motor is basically a DC motor which comes with a gearbox. The use of the gear head along with the motor reduces the speed with which the motor operates which also increases the torque output. The most important values related to the gear motors are speed, efficiency as well as torque. We can select the gear motor that is most suitable for our application by first computing the load, then the speed and then the torque requirements.



Fig. 8 Gear Motor

$P=F*V$
$=200*radius*\omega$
$=200*0.25*2\pi*11/60$
$=57.59watt$

Number of teeth on gear$=zg/cos\theta g = 20/cos(45)$
$=28.28 \sim 29$

$Torque(T)=P/\omega$
$=57.59*2*\pi*11/60$
$=66.34$ N-m

D. L298N Motor Driver

The L298N Motor Driver is a high power motor driver module used for driving different motors such as DC, gear and stepper motors. The module consists of a L298 motor driver circuit and a 5V regulator (78M05). The module can control a maximum of 4 DC motors at a time.



Fig. 9 L298N Motor Driver

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ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VIII Aug 2021- Available at www.ijraset.com

VII. SOFTWARE REQUIREMENTS

A. Arduino IDE

The Arduino Integrated Development Environment or popularly known as the Arduino IDE is basically an open source coding environment which consists of a text editor for writing the code, a toolbar that helps manage the various libraries and other important functions of a board and a number of different menus. It is used to connect to the Arduino boards of all types and in turn provide a platform to upload the code to the board.

It mostly uses the principles of Embedded C programming to develop the programs and even comes with a set of pre fed libraries and examples. The code is usually divided into two main parts the first being the set up code which mainly deals with all the initialisation works and the second one is the loop which mainly deals with the functionalities which have to be run on the board continuously.

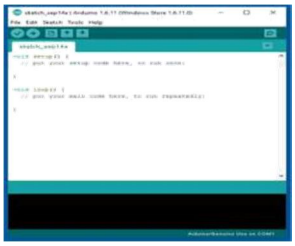


Fig. 10 Arduino IDE

VIII. RESULT

Using the above mentioned hardware and software components we have designed a solar powered robot that can perform the simultaneous operations such as irrigation, grass cutting and seed sowing. The transmitter section has been successfully implemented using the Arduino Nano, RA02 lora module and has been verified that the transmitter section is successful in transmitting the data and this has been verified with the serial monitor.

The receiver section has been successfully implemented and the mechanisms such as seed sowing, irrigation and grass cutting have been implemented successfully by transmitting the commands using the transmitter module.

The seed sowing mechanism that has been implemented in the project can help in sowing various seeds of different varieties with different diameters. Some of the seeds along that we have tested with our machine for the process of sowing were horse gram of 3mm, methi of 2.41mm, coriander seeds of 3mm, mustard seeds of 1.5mm and sesame seeds of 3mm.

Based on the observations made after the project has been implemented is that there is approximately a delay of 1 to 1.5 seconds between the data that has been transmitted at the transmitter and the data that has been received at the receiver end.

Due to its simplicity and portability it can be easily bought and used by the farmers. So we feel that this project would help us in contributing a lot to this outside world and hence we would like to present it.

IX. CONCLUSION

Innovative inventions can have a remarkable influence in the field of agriculture. By using this innovative mechanism of seed sowing, irrigation and grass cutting we can save time required to do the basic activities such as seed sowing, grass cutting and it also reduces the labour cost and dependency to a great extent. It can serve as a great help for the small scale farmers and can further be developed for the usage by the large scale farmers. After building the machine and considering its various drawbacks, it can be concluded that this solar powered robotic vehicle can perform various operations simultaneously and hence saves lots of energy and other resources.

After considering different advantages and disadvantages of the existing machine, it is concluded that the automated robotic vehicle for farmers can be improvised to:

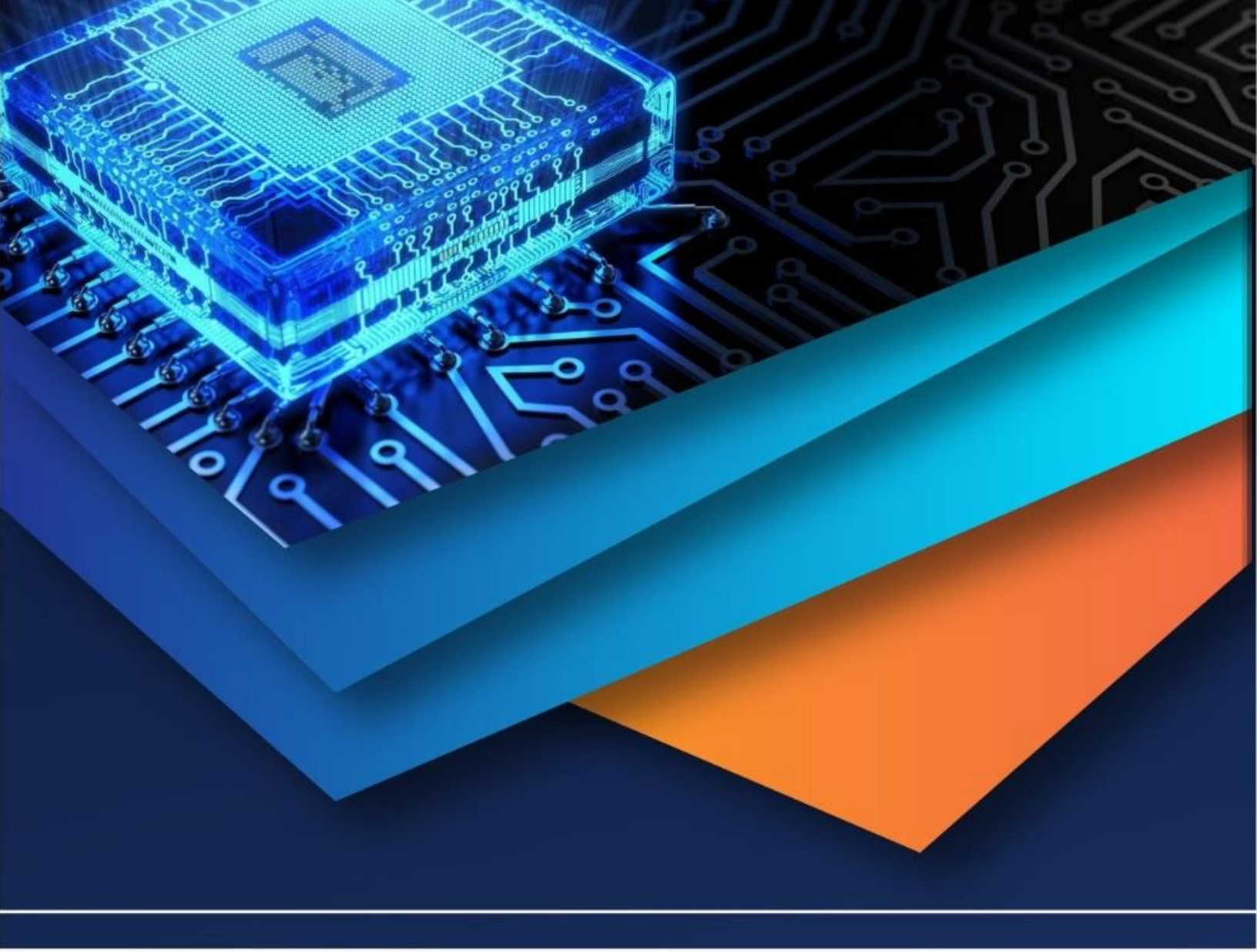
A. Maintain row spacing between the seeds
B. Make proper utilization of the seeds with lesser loss.
C. Achieve better automation in the field of agriculture.
D. A cutter can be used as a grass cutting machine instead of using a DC motor with blades attached to it.
E. Using a ploughing tool along with a motor to automate the ploughing process.

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