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Agricolae Amicus Bot: A True Farmer's Friend

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Abstract: Agriculture is the linchpin of any sort of financial system and it is the only area where engineering has not penetrated into greater depth. The field of agriculture is responsible for the existence of towns, cities, nations, stock market and economy. Agriculture or farming is the base of a civilization or a nation and any stable economy. The discovery of agriculture and the art of cultivating the field was the first step of mankind towards stabilized life. Farming is not a business; it's a means of life. Any culture can exist without other professions, merely to live without agriculture is impossible. Automation of agricultural sector is the need of the hour and this paper describes the use of Agricolae Amicus Bot which performs the farming activity of ploughing with command received from the remote. Agricultural activities like ploughing, seed dispersal, fertilizer / pesticide / herbicide spraying, weed removal, harvesting etc. can be easily implemented with the help of a robotic vehicle which is controlled with the help of a remote. This paper describes the functioning of this bot and the future aspects of development of this bot**.**

Keywords: AA Bot, Infrared, GPS, UAV, Data Acquisition, RF, BLE, IoT

I. INTRODUCTION

India is an agriculture based economy. The major work force in our nation consists of farmers; however the contribution of agriculture to GDP is hardly 17.5%. Agriculture in India in the late 1950s and 1960s was carried out without the utilization of technology. The farm size was too small and the farmers were also unaware about the variations which can be introduced in farming to increase the output per hectare. Green Revolution was a key initiative, which aimed at modernizing the Indian agriculture system. Green revolution was the first major step where the farmers were introduced to the high yielding varieties and novel types of chemical fertilizers. Green Revolution proved that even the agricultural system cannot survive without technology and to cater the present needs agriculture has to work in sync with technology. Green revolution transformed India from the insufficiency of crops to a state of self-sufficiency.

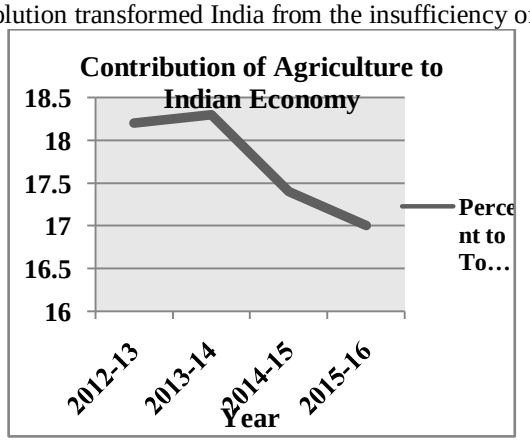

Fig. 1: Graph of Contribution of Agriculture to Indian Economy

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The production rate in India is somewhat sound and likewise it is among the top producing states in the globe. Over the past few years the manufacturing and the service sector's contribution to GDP has increased, but there is a perpetual decline in the contribution of the agrarian sector; as it has fallen from 50% in 1950s to just 15.4% in 2015-2016. The contribution of agriculture to the Gross value Added of India as released by the Central Statistics Office, Ministry of Statistics & Program Implementation, signify that there is continuing decline in the contribution of the farming sector to Indian economy. The contribution of agriculture to the Indian economy is evidenced in the accompanying graph:
[1]. The major cause for the decay of the contribution of the agricultural sector to the Indian economy is due to the fast growing and structurally changing economy of the state. Nearly 54.6% of the population of our nation is involved in farming and its contribution remains only 17% to Gross Value Added of our country [2, 3]. The major event related to the farming practices in India is the low production per hectare. As compared to other major producing countries like Brazil, China; India has low production per hectare of the crops grown. The problems that the hinder the agricultural efficiency of India include the reduction in the size of farming land, depreciation in the fertility of soil, inadequate access to irrigation facilities and uneven access to the role of advanced engineering. The role of automation in agricultural is must to achieve efficiency in agricultural practices and to increase the output per hectare. The ever rising population of the Earth has put an extreme emphasis on the farmers to increase their yield and to feed the entire population so that the problem of food deficit is eliminated. The Indian agricultural system has advanced a lot, but a lot more is remaining to be implemented. The time has come when our agricultural systems shifts from simple systems to the Precision Agriculture system. The size of land available for farming is getting decreased over the years and so it is the need of the hour that the output obtained from the given piece of land should be maximum and at the same time it is also required to make the agriculture free from labour intensive system and make agriculture a technology intensive system. The consolidation of several technologies like GPS technology, robotics technology, etc. with agriculture is the need of the hour to enhance the output per hectare. Recently there are many research institutions which have already assembled robotic tractors or robotic vehicles for agricultural practices [4]. Farming robots specific for a particular task like automatic rice transplanter [5], or a robot for orchard application [6] are also developed for a particular objective. Agricolae Amicus Bot [AA Bot] is one such prototype which can be implemented for performing the farm activities like ploughing, seed dispersal [16], fertilizer/herbicide/pesticide spraying, weed removal and harvesting. The AA Bot at present can only plough the field effectively and also disperse the seed which are placed in its container. The bot is at present in the second stage development and more improvements are yet to be implemented to make it a perfect next gen machine which is compatible for all farm activities. Currently the bot is controlled with the aid of remote but with improvements it is possible to control it with the help of smart phones or any other wireless controllers like RF, BLE [Bluetooth Low Energy].

II. SYSTEM OVERVIEW

The project consists of multi-controller configuration as we used two microcontrollers which include Arduino Uno and Arduino Mega 2560 for carrying out the farm activities. The basic task carried out by Arduino Uno is motion of the robot with the help of remote and controlled seed dispersal with the help of servo motor attached to the seed container and the motor is controlled with the help of remote again. Arduino Mega 2560 is used for lifting the plough up when not in use and brings the plough down when required for ploughing. Arduino Mega is also responsible for sending the moisture content data to ThingSpeak cloud which helps in real time analysis of the moisture content of the soil.

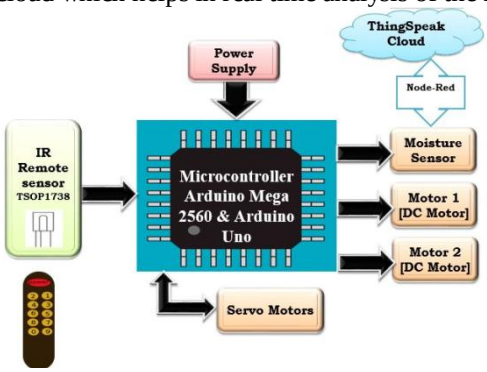

Fig. 2: Block diagram of Project

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To send the data to ThingSpeak cloud the software application used is Node-Red. The brain or rather the command center of the AA Bot is the Arduino Uno and Arduino Mega 2560 Microcontroller which controls the entire function of the circuit and the IR Remote sensor is used to sense the signals sent from the remote. Since this the phase II of the project, the components required in the project are limited and with advancement in the later stages of the project, the components required for the project also increases. The basic block diagram of the system is as follows:

A. Arduino Microcontroller:

Arduino is an open source embedded electronics platform which assists to construct many projects. It is one of the most inexpensive options available for designing the embedded system applications and building of many user application projects and prototypes. The programming of the chip on the board can be easily done using Arduino Integrated Environment [IDE] which helps to program the chip easily using the various available libraries and APIs of the Arduino IDE. Even if do not assemble the hardware for the project, we have the facility of simulating the Arduino based circuits using the various simulation softwares like Proteus [15], Arduino UNO Simulator etc. In this case the microcontroller is programmed such that whenever it picks up any signal from the remote, it pushes the desired motor and making the robot move in that particular way.

The Arduino Uno microcontroller contains the Atmega328 IC which is the true microcontroller chip and the brain of the board. The Arduino UNO board has a total of 14 input/output pins out of which six are analog pins and six pins can be used for PWM purpose. For expansion of the board size and for more number of input/output pins one can take a higher version of Arduino Uno that is an Arduino Mega. To develop an IoT based project and to have control over the sensors on a larger scale there are options to use Raspberry Pi like processors to have an effective control over the entire functioning of the robot. Raspberry Pi opens the door for scaling up of this project from prototype to the product level one.

B. IR Remote Sensor:

This is the IR remote sensor which senses the signals broadcast by the remote and decode it to give hex code which is utilized by the microcontroller to process the information and check the rotary motion of the motor to move the automaton in the wanted way. The IR remote sensing element used in the robot is manufactured by Vishay Semiconductors and is named TSOP1738. The first four initial signify the packaging trend of the sensor and the final two digits signify the range of frequency supported by the sensor. This sensor consumes less power and has good shielding against electric disturbances. The sensor requires an input voltage in the range of 3.3 to 5V [11].

C. Motor Driver:

The voltage and the current requirements of the motors are very high as compared to the supplying capacity of the Arduino Uno microcontroller. Even the back emf which is generated by the motors has the capability to damage the microcontroller. So to connect a motor to the microcontroller we require a driver IC which could provide the required current and voltages to the motor and at the same time it will protect microcontroller from the back emf of the motor. The most commonly used driver IC is IC L293D.The motor driver IC is available in the form of shields which can be directly connected to the Arduino Uno board. The Adafruit motor driver shield is utilized to connect four DC motors, up to two stepper motors and two servo motors. Motor driver shields provide a very cheap alternative for the connection of motors to the microcontroller and do not make the circuit connections clumsy.

D. Remote:

Remote is the major controlling part of the robot which controls the motion of the robot. The remote is basically used to control the robot wirelessly and the signal sent by the remote lie in the infrared range with a frequency of around 38 kHz. The remote that is used in the project is just for the purpose of controlling the actions of the AA Bot. Instead of this remote other controlling technologies like BLE; RF etc can also be used for having the access to the robot over long distances.

E. Node-Red:

It is an application software developed by IBM which used for designing of the IoT based applications and projects. This software transforms the host PC or laptop into a server because of which it can communicate with other cloud based servers and send data to that server. This software acts like a software connecting the host server to the cloud server for data exchange in an easier manner.

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F. Servo Motor:

Servo Motor is widely used motor in the robotics application as it allows for the precise control over the motor's motion. The servo motor is used in this project for the controlled dispersal of the seeds. As the mixer rotates the cement, in the same manner the servo motor is used to rotate the seed container in the desire manner and as the container rotates, the seeds inside the container are pushed out through a small outlet in the container.

III. WORKING

The working or rather functioning of any embedded system is dependent on the microcontroller. The microcontroller acts as the brain of the systems giving the appropriate directions to various parts of the system to carry out the specified task in a particular order and give the desired output. In the case of Agricolae Amicus Bot the microcontroller that is the Arduino Uno gives directions to the motors of the robot to move the bot in the specified directions on receiving the signal form the remote. The overall functioning of the robot on receiving the signals from the remote can be correctly represented by the flowchart given in the figure 4 & 5. As the robot moves in the desired direction, the plough attached to robot ploughs the field and seeds present in the container get dispersed after the field is ploughed. Since the robot is just the stage II model, the tasks carried out by the bot is complex and also dynamic in nature in the sense the user does have the control over the plough or the mechanism of seed dispersal. There are two flowcharts which depicts the task carried by Arduino Uno and by Arduino Mega separately.

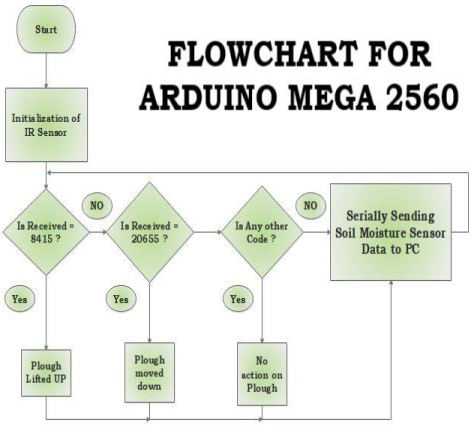

Fig. 4: Flowchart showcasing Arduino Mega's Workflow

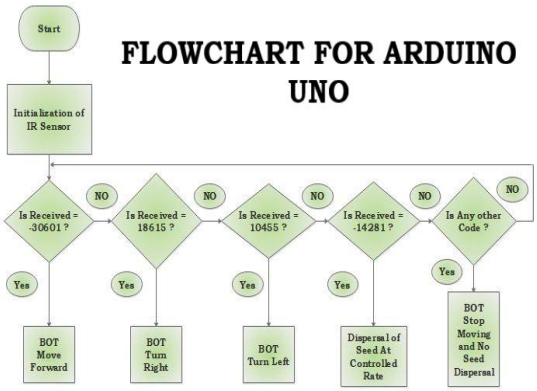

Fig. 5: Flowchart showcasing Arduino Mega's Workflow

Agricolae Amicus Bot can be utilized or rather employed for various farming activities. It is possible to perform all the farm activities just by the click of a button. The farm activities which can be performed using AA Bot are briefly depicted in the following diagram:

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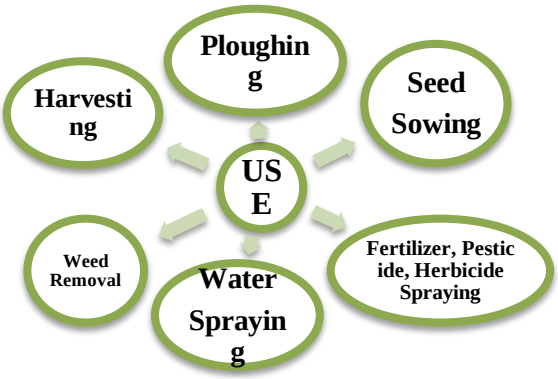

Fig. 6 Uses of AA Bot

IV. FUTUROSCOPE:

The field of agriculture is such that there is advancement going on but there is yet more remaining until the agriculture field reaches the zenith of development. Advancements in the field of agriculture require the mixing of electronics field with computer science and information technology to give meaningful results. The field of computer science and information technology is required to for utilizing of the available information and to use that information to give meaningful data which can be used for further processing. The field of electronics is required to make the hardware systems which can extract the information from the agricultural field and then carry out the specific tasks [7]. GPS technology takes on a significant part in robotics field which serves to create the movement of the robot fully automatic by guiding the robot's path through GPS [8-9].GPS [8-9].

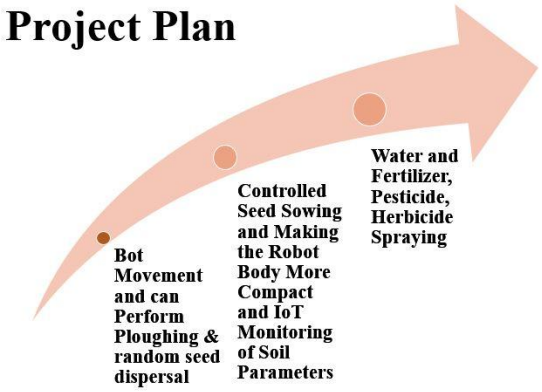

Fig. 7: Future Plan of Project

Having autonomous vehicles for farming activities is really due to the advancement in GPS technology and the development in data acquisition and processing systems [8]. Unmanned Aerial Vehicles also play a very important role in precision agriculture where UAVs can be employed to carry out the tasks like water spraying, etc. [10-13]. The basic parameters of soil like moisture content, pH of soil, etc can be monitored and even the framers can have the real time access to these parameters using the support of IoT. These parameters can be sensed using the various sensors and the data obtained from these sensors can be plotted real time using IoT based platforms like ThingSpeak, Bluemix by IBM, IoT Gecko etc [17-20]. The watering of the field or spraying of fertilizers can be done depending upon the data received from the sensors. For instance, if the soil is too moist, then the bot will not spray any water on the field. The tasks of weed removal can also automized using this same bot by further modifying its design. The specified goals for the Agricolae Amicus Bot is depicted in following timeline in figure 5.

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V. CONCLUSION

Automation of agriculture is the need of the hour to serve the ever growing population. There are many hindrances which affect the yield per hectare of Indian agricultural systems and India is an agro- based economy; to excel in this agro-based economy Indian farm should be equipped with modern tools and machinery. AA Bot is just a small initiative in the modernization of agricultural field and if the prototype gets transformed into a real life product then surely it is going to be a boon for the farmers of India. To reach the status of self sustainability in the sphere of farming, it is the need of the hour to transform such prototypes into real life directly applicable products. AA Bot is currently completed the second stage of development in terms of prototype, once all the three stage are completed, then only it is the right time to transform this prototype into product.

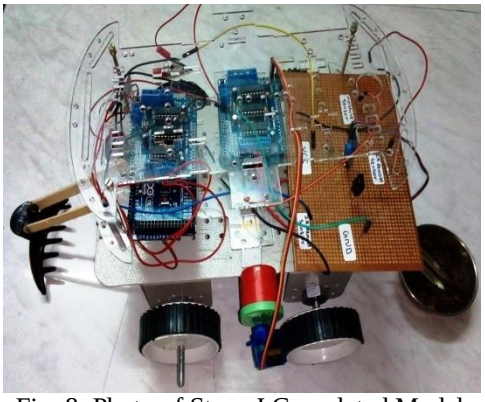

Fig. 8: Photo of Stage I Completed Model

Fig. 9: Node-Red Application for Moisture Sensing

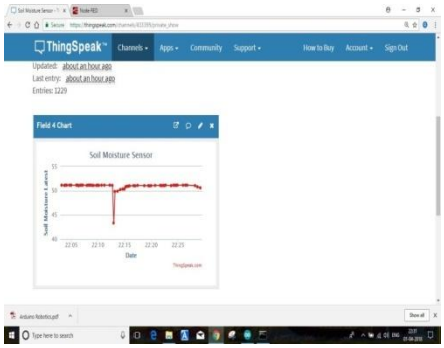

Fig. 10: Real Time Plotting of Soil Moisture on ThingSpeak

It is also possible to automate the agricultural bots with the help of AI and neural networks so that the decisions regarding the various farm activities will taken by the bot itself and thus the agriculture system shifts from labour centric nature to a robot centric nature. Implementation of AI in the agricultural systems of India is very far sighted dream and before the fulfillment of that dream, we have to make our agriculture system fully in synch with the latest

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available technology. Indian agriculture is facing a constant decline in its contribution to GDP and to revive the glory of Indian agriculture and increase its contribution to Indian GDP, it is the need of the hour to shift from just agriculture to smart and precision agriculture.

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