Bluetooth Controlled Farm Robot

Ajesh A[1], Anandhu K S[2], Jelvin Raju[3], Jerin Saji[4]

[1]B.Tech student, Dept. of Mechanical Engineering, Vijnan Institute of Science and Technology, Kerala, India
[2]B.Tech student, Dept. of Mechanical Engineering, Vijnan Institute of Science and Technology, Kerala, India
[3]B.Tech student, Dept. of Mechanical Engineering, Vijnan Institute of Science and Technology, Kerala, India
[4]B.Tech student, Dept. of Mechanical Engineering, Vijnan Institute of Science and Technology, Kerala, India

---***---

Abstract - *Robotics is a fascinating field of engineering that provides many opportunities for research. In addition, the evolution of technology in recent years has led to intelligent mobile robots. They can be sent in hard places instead of humans either because they are dangerous, either because they are difficult to access. The control of these robots, however, is a difficult task that involves knowledge in different areas such as robotics, automation, programming, electronics, etc. This project strives to develop a robot capable of performing operations like automatic ploughing, seed dispensing, fruit picking and pesticide spraying. For manual control the robot uses the Bluetooth pairing app as control device and helps in the navigation of the robot outside the field. Farmers today spend a lot of money on machines that help them decrease labor and increase yield of crops but the profit and efficiency are very less. Hence automation is the ideal solution to overcome all the shortcomings by creating machines that perform one operations and automating it to increase yield on a large scale. 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.*

***Key Words*: Robotics, Farming, Bluetooth, Arduino, DC motor, Servomotor**

1. INTRODUCTION

Robotics is playing a significant role in agricultural production and management. There is a need for autonomous and time saving technology in agriculture to have efficient farm management. The researchers are now focusing towards different farming operational parameters to design autonomous agricultural vehicles as the conventional farm machineries are crop and topological dependent. Till date the agricultural robots have been researched and developed principally for harvesting, chemical spraying, picking fruits and monitoring of crops. Robots like these are perfect substitute for manpower to a great extent as they deploy unmanned sensing and machinery systems. The prime benefits of development of autonomous and intelligent agricultural robots are to improve repeatable precision, efficacy, reliability and minimization of soil compaction and drudgery. The robots have potential for multitasking, sensory acuity, operational consistency as well as suitability to odd operating conditions. The study on agricultural robotic system had been done using model structure design mingled with different precision farming machineries.

The rapid growth of agricultural crop robotics in the last decade results from, (a) the convergence of maturing mechatronics technology, making such automation technically feasible and, (b) the demand for alternatives to human labor in crop production. Worldwide, agricultural workers are difficult to hire and retain. Increasing environmental and food safety concerns push agriculture to manage and apply inputs more precisely (Finger et al. 2019). The engineering side of agricultural robotics has advanced rapidly (Duckett et al. 2018; Shamshiri et al. 2018), but understanding of the economic implications has lagged. The objective of this study is to review the publicly available research on the economics of crop robotics and identify research needs and gaps. The results of this study will be of interest to agricultural researchers, agribusinesses, farmers and agricultural policy makers.

The characteristics of agricultural robots have been described by several authors (e.g. Duckett et al. 2018; Blackmore 2007), but there is no widely agreed definition. Because the focus of this study is on the economics of robotics for crop production in open fields, the working definition of a “field crop robot” for this study was: a mobile, autonomous, decision making, mechatronic device that accomplishes crop production tasks (e.g. soil preparation, seeding, transplanting, weeding, pest control and harvesting) under human supervision, but without direct human labor. Mobility is an essential part of the definition because field crops are typically geographically dispersed in the landscape. Autonomy is also essential because the field environment is not entirely controllable. Among the decisions that a field crop robot might make are distinguishing a crop plant from a weed, identifying an insect to choose the appropriate pesticide for micro dosing, choosing ripe fruits or vegetables, and stopping when it encounters an unknown obstacle.

The general objective of this project is to provide a synthesis of the results of research on the economics of field crop robotics. The specific objectives were to: a) list and summarize the publicly available research on the economics of field crop robotics, b) identify research gaps and needs related to crop robotics and c) propose research topics that need urgent attention. This review contributes to science by summarizing the knowledge that has been accumulated about the economics of crop robots, suggesting mechanisms for how those facts fit together, and identifying gaps in the science. The primary focus of this study is on farm level profitability because without profitability crop robots will not be widely used and the expected environmental, social and food safety benefits will not be achieved. Environmental, social and food safety benefits of the potentially profitable autonomous crop technologies were noted when identified. The overall hypothesis is that most studies of the economics of field crop robotics use partial budgeting to focus on changes in variable cost and consequently there is an urgent need for a more systematic study of the potential impact of automation and robotics.

In this the robots are developed to concentrate in an efficient manner and also it is expected to perform the operations autonomously. The proposed idea implements the robot to perform the functions such as planting, irrigation, fertilization, monitoring a crop. These functions can be integrated into a single robot and then performed. The robot is expected to perform the functions such as planting, irrigation, fertilization, monitoring, autonomously in the field.

1.1 Literature Review

The paper number [4] presents a streamlined approach to future Precision Autonomous Farming (PAF). It focuses on the preferred specification of the farming systems including the farming system layout, sensing systems and actuation units such as tractor-implement combinations. The authors propose the development of the Precision Farming Data Set (PFDS) which is formed off-line before the commencement of the crop cultivation and discusses its use in accomplishing reliable, cost effective and efficient farming systems. The work currently is in progress towards the development of autonomous farming vehicles and the results obtained through detailed mathematical analysis of example actuation units.

The reference paper [5] addresses the advanced weed control system which improves agriculture processes like weed control, based on robotic platform. They have developed a robotic vehicle having four wheels and steered by dc motor. The machine controls the weed in the firm by considering particular rows per column at fixed distance depending on crop. The obstacle detection problem has also been considered, sensed by sensors .the whole algorithm, calculation, processing, monitoring was designed with motors &sensors.

The reference paper [6] addresses the current scenario of the world, as most of the countries do not have sufficient skilled manpower specifically in agricultural sector it affects the growth of developing countries. So they have made an effort to automate the agricultural sector to overcome this problem. An innovative idea of their project was to automate the process of sowing crops such as sunflower, baby corn, groundnut and vegetables like beans, lady's finger, pumpkin and pulses like black gram, green gram etc. to reduce the human effort and increase the yield. The plantations of seeds are automatically done by using DC motor. The distance between the two seeds are controlled and varied by using Microcontroller. It is also possible to cultivate different kinds of seeds with different distance. When the Robot reaches the end of the field the direction can be changed with the help of remote switches. The whole process is controlled by Microcontroller.

The reference paper [7] addresses the advanced system which improves agriculture processes like cultivation on ploughed land, based on robotic platform. They developed a robotic vehicle having four wheels and steered by DC motor. The advanced autonomous system architecture gives the opportunity to develop a complete new range of agricultural equipment based on small smart machines. The machine will cultivate the farm by considering particular rows and specific column at fixed distance depending on crop. The obstacle detection problem will also be considered, sensed by infrared sensor. The whole algorithm, calculation, processing, monitoring are designed with motors & sensor interfaced with microcontroller. The result obtained through example activation unit is also presented.

2. HARDWARE REQUIREMENTS

2.1 Arduino Uno

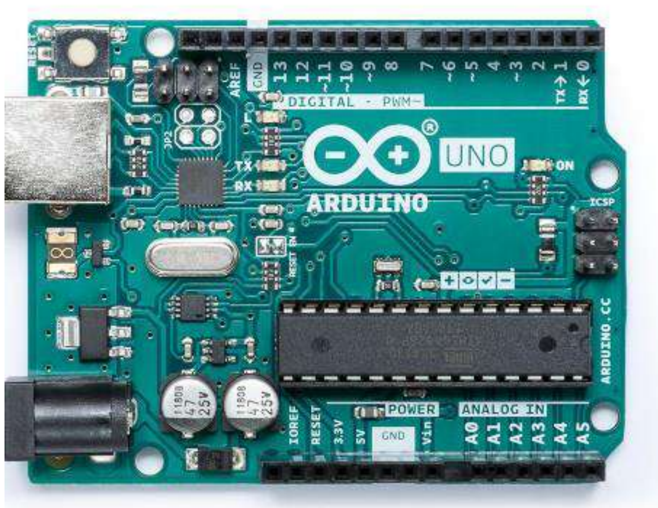

Fig-1: Arduino Uno

Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button.

2.1.1 Specifications

- Microcontroller: ATmega328P
- Operating Voltage: 5V
- Input Voltage (recommended): 7-12V
- Input Voltage (limit): 6-20V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- PWM Digital I/O Pins: 6
- Analog Input Pins: 6
- DC Current per I/O Pin: 20mA
- DC Current for 3.3V Pin: 50mA
- Flash Memory: 32 KB (ATmega328P) of which 0.5 KB used by boot loader
- SRAM: 2 KB (ATmega328P)
- EEPROM: 1 KB (ATmega328P)
- Clock Speed: 16 MHz
- LED_BUILTIN: 13
- Length: 68.6 mm
- Width: 53.4 mm
- Weight: 25 g

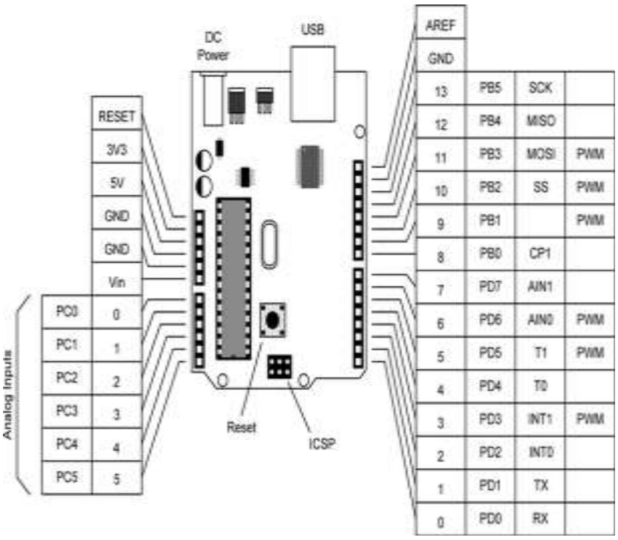

Fig-2: Arduino Uno Pin Configuration

2.2 Bluetooth Module HC-05

The Bluetooth Transceiver HC-05 TTL Module (With EN Pin)) Breakout is the latest Bluetooth wireless serial cable. This version of the popular Bluetooth uses the HC-05/HC-06 module. These modems work as a serial (RX/TX) pipe. HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. This serial port Bluetooth module is fully qualified Bluetooth V2. 0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband.

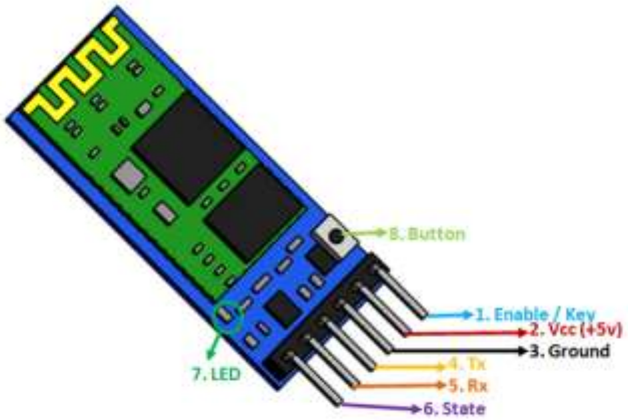

Fig-3: Pin Configuration of HC-05

2.2.1 Specifications

- Serial Bluetooth module for Arduino and other microcontrollers
- Operating Voltage: 4V to 6V (Typically +5V)
- Operating Current: 30mA
- Range: <100m
- Works with Serial communication (USART) and TTL compatible
- Follows IEEE 802.15.1 standardized protocol
- Uses Frequency-Hopping Spread spectrum (FHSS)
- Can operate in Master, Slave or Master/Slave mode
- Can be easily interfaced with Laptop or Mobile phones with Bluetooth
- Supported baud rate: 9600,19200,38400,57600,115200,230400,460800.

2.3 Motor Driver (L298N)

The L298N Motor Driver Module is a high voltage Dual H-Bridge manufactured by ST Company. It is designed to accept standard TTL voltage levels. H-bridge drivers are used to drive inductive loads that requires forward and reverse function with speed control such as DC Motors, and Stepper Motors. It uses the popular L298 motor driver IC and has an on-board 5V regulator which it can supply to an external circuit. It can control up to 4 DC motors, or 2 DC motors with directional and speed control. Motor drivers acts as an interface between the motors and the control circuits. Motor require high amount of current whereas the controller circuit works on low current signals. So the function of motor drivers is to take a low-current control signal and then turn it into a higher-current signal that can drive a motor.

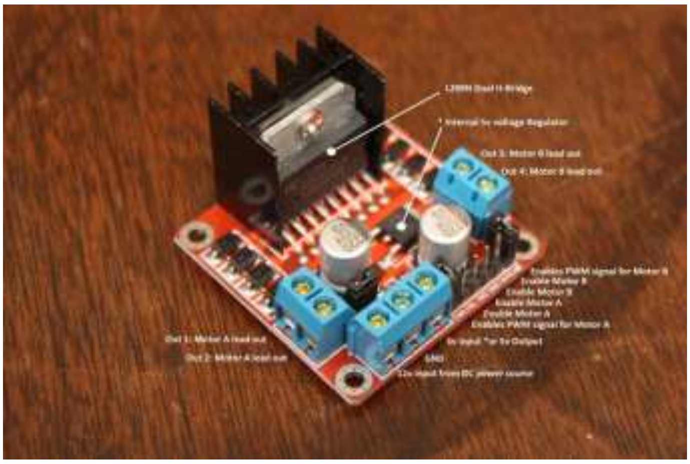

Fig-4: Pin Configuration of L298N Motor Driver Module

2.3.1 Specifications

- Motor driver: L298N
- Motor channels: 2
- Maximum operating voltage: 46V
- Peak output current per channel: 2A
- Minimum logic voltage: 4.5V
- Maximum logic voltage: 7V

2.4 DC Gear Motor

Fig-5: 12V DC Gear Motor

This is 12V DC motor which has a gearbox of 45mm diameter. The planetary type gearbox of this motor has a metal gears and a centre shaft. The Shaft of the motor is loaded with bearing for wear resistance and smooth operation. 300RPM 12V Johnson, high torque DC geared motors is used for robotics applications. It gives a massive torque of 9Kgcm. The motor comes with metal gearbox and off-centered shaft.

2.4.1 Specifications

- 300RPM 12V DC motors with Metal Gearbox and Metal Gears.
- 6mm diameter shaft with M3 thread hole.
- Gearbox diameter 40 mm.
- Motor Diameter 28.5 mm.
- Length 63 mm without shaft.
- Shaft length 30mm.
- 180gm weight.
- 9.06kgcm Holding Torque.
- No-load current = 800 mA, Load current = up to 7.5 A (Max).
- Recommended to be used with DC Motor Driver 20A or Dual DC Motor Driver 20A.

2.5 Servo Motor SG90

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing.

SG90 1.2kgCm 180 Degree Rotation Servo Motor rotates 90° in each direction making it 180° servo motor. It is a Digital Servo Motor which receives and processes PWM signal faster and better. The TowerPro SG90 9g Mini Servo is 180° rotation servo. It is a Digital Servo Motor which receives and processes PWM signal faster and better. It equips sophisticated internal circuitry that provides good torque, holding power, and faster updates in response to external forces.

A servomotor is a closed-loop servomechanism that uses position feedback to control its motion and final position. The input to its control is a signal (either analogue or digital) representing the position commanded for the output shaft. The motor is paired with some type of position encoder to provide position and speed feedback. In the simplest case, only the position is measured. The measured position of the output is compared to the command position, the external input to the controller. If the output position differs from that required, an error signal is generated which then causes the motor to rotate in either direction, as needed to bring the output shaft to the appropriate position. As the positions approach, the error signal reduces to zero and the motor stops.

The very simplest servomotors use position-only sensing via a potentiometer and bang-bang control of their motor; the motor always rotates at full speed (or is stopped). This type of servomotor is not widely used in industrial motion control, but it forms the basis of the simple and cheap servos used for radio-controlled models.

More sophisticated servomotors use optical rotary encoders to measure the speed of the output shaft[2] and a variable-speed drive to control the motor speed.[3] Both of these enhancements, usually in combination with a PID control algorithm, allow the servomotor to be brought to its commanded position more quickly and more precisely, with less overshooting.

Fig-6: Servomotor SG90

Table -1: Description about Wires of Servomotor SG90

Wire Number	Wire Color	Description
1	Brown	Ground wire connected to the ground of system
2	Red	Powers the motor typically +5V is used
3	Orange	PWM signal is given in through this wire to drive the motor

2.5.1 Specifications

- Operating Voltage is +5V typically
- Torque: 2.5kg/cm
- Operating speed is 0.1s/60°
- Rotation: 0°-180°
- Weight of motor: 9gm

3. SOFTWARE REQUIREMENTS

3.1 Bluetooth Electronics

Control your electronic project with an Android device. This app communicates using Bluetooth to an HC-06 or HC-05 Bluetooth module in your project. Since version 1.2 of the app, it will now also communicate to Bluetooth low energy modules such as the HC-08 and via USB-serial connection.

This app comes with a library containing 11 Bluetooth examples for Arduino. See the electronics page for examples. It can also be used with Raspberry Pi or any other rapid prototyping system in which you have included a suitable Bluetooth module to your project.

• Ideal for learning electronics in a fun way.
• Ideal for rapid prototyping a new idea.
• Ideal for exhibiting your project.

Some electronics skills required. Requires an Android device with Bluetooth capability enabled. Large selection of controls available including buttons, switches, sliders, pads, lights, gauges, terminals, accelerometers and graphs, Drag and drop them onto the panel grid. Then edit their properties. 20 customizable panels available. Import/Export panels to share them. Discover, Pair and connect to Bluetooth devices. Then click Run to use the panel.

Fig-7: Developed App Page

3.2 Arduino Uno IDE

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, mac OS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards.

The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU tool chain, also included with the IDE distribution. The Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

In October 2019 the Arduino organization began providing early access to a new Arduino Pro IDE with debugging and other advanced features.

3.2.1 Developed Program

```
#include<Servo.h>
#include<SoftwareSerial.h>
SoftwareSerial Nerial(11,12);
{
int servoPin = 10;
int IN1 = 2;
int IN2 = 3;
int IN3 = 4;
int IN4 = 5;
int IN5 = 6;
int IN6 = 7;
char Incoming_value = 0;
Servo Servo1;
boolean seed = false;
boolean direct = true;
void setup() {
Serial.begin(9600);
Nerial.begin(9600);
pinMode(IN1, OUTPUT);
pinMode(IN2, OUTPUT);
pinMode(IN3, OUTPUT);
pinMode(IN4, OUTPUT);
pinMode(IN5, OUTPUT);
pinMode(IN6, OUTPUT);
Servo1.attach(servoPin);
Servo1.write(180);
}
void loop() {
if(Nerial.available() > 0) {
Incoming_value = Nerial.read();
// Code for Direction control of RC
if(direct) {
if(Incoming_value == 'F') {
digitalWrite(IN1, HIGH);
digitalWrite(IN4, HIGH);
}
else if(Incoming_value == 'B') {
digitalWrite(IN2, HIGH);
digitalWrite(IN3, HIGH);
}
else if(Incoming_value == 'K') {
digitalWrite(IN1, HIGH);
}
else if(Incoming_value == 'J') {
digitalWrite(IN4, HIGH);
}
else if(Incoming_value == 'R') {
digitalWrite(IN1, HIGH);
digitalWrite(IN3, HIGH);
}
else if(Incoming_value == 'L') {
digitalWrite(IN2, HIGH);
digitalWrite(IN4, HIGH);
}
else if(Incoming_value == 'M') {
digitalWrite(IN3, HIGH);
}
else if(Incoming_value == 'N') {
digitalWrite(IN2, HIGH);
}
else
digitalWrite(IN1, LOW);
digitalWrite(IN2, LOW);
digitalWrite(IN3, LOW);
digitalWrite(IN4, LOW);
}
}
else {
if(Incoming_value == 'F') {
digitalWrite(IN2, HIGH);
digitalWrite(IN3, HIGH);
}
else if(Incoming_value == 'B') {
digitalWrite(IN1, HIGH);
digitalWrite(IN4, HIGH);
}
else if(Incoming_value == 'K') {
digitalWrite(IN3, HIGH);
}
else if(Incoming_value == 'J') {
digitalWrite(IN2, HIGH);
}
else if(Incoming_value == 'R') {
digitalWrite(IN1, HIGH);
digitalWrite(IN3, HIGH);
}
else if(Incoming_value == 'L') {
digitalWrite(IN2, HIGH);
digitalWrite(IN4, HIGH);
}
else if(Incoming_value == 'M')
digitalWrite(IN1, HIGH);
}
else if(Incoming_value == 'N') {
digitalWrite(IN4, HIGH);
}
else {
digitalWrite(IN1, LOW);
digitalWrite(IN2, LOW);
digitalWrite(IN3, LOW);
digitalWrite(IN4, LOW);
}
}
// Code for Pump
if(Incoming_value == 'C') {
digitalWrite(IN6, HIGH);
}
else if(Incoming_value == 'c') {
digitalWrite(IN6, LOW);
}
```

```
// Code for Pump
if(Incoming_value == 'D') {
digitalWrite(IN5, HIGH);
}
else if(Incoming_value == 'd') {
digitalWrite(IN5, LOW);
}
// Code for Grass Cutter Module
if(Incoming_value == 'A') {
digitalWrite(IN6, HIGH);
}
else if(Incoming_value == 'a') {
digitalWrite(IN6, LOW);
}
// Code for Seeding Module
if(Incoming_value == 'E') {
Servo1.write(90);
delay(1000);
Servo1.write(180);
delay(1000);
}
// Code for Setting Direction of RC
if(Incoming_value == 'W') {
direct = false;
}
else if(Incoming_value == 'w') {
direct = true;
}
}
Incoming_value = 0;
}
```

3.3 Autodesk Fusion 360

Autodesk, Inc. is an American multinational software corporation that makes software services for the architecture, engineering, construction, manufacturing, media, education, and entertainment industries. Autodesk is headquartered in San Rafael, California, and features a gallery of its customers' work in its San Francisco building. The company has offices worldwide.

The company was founded in 1982 by John Walker, who was a co-author of the first versions of AutoCAD. AutoCAD, which is the company's flagship computer-aided design (CAD) software and Revit software are primarily used by architects, engineers, and structural designers to design, draft, and model buildings and other structures. Autodesk software has been used in many fields, and on projects from the One World Trade Centre to Tesla electric cars.

Autodesk became best known for AutoCAD, but now develops a broad range of software for design, engineering, and entertainment—and a line of software for consumers, including Sketchbook. The manufacturing industry uses Autodesk's digital prototyping software—including Autodesk Inventor, Fusion 360, and the Autodesk Product Design Suite—to visualize, simulate, and analyse real-world performance using a digital model in the design process.

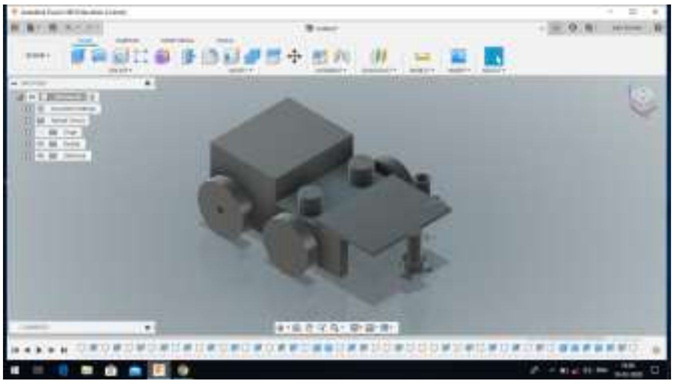

Fig-8: Developed Design

4. PROJECT IMPLEMENTATION

4.1 Working

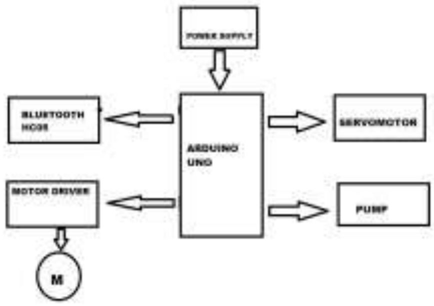

Fig-9: Interface Block Diagram

- Mainly works with the help of an Arduino platform and Bluetooth module.
- Consists of mobile application controls with Bluetooth interface.
- A motor is used to rotate a blade to cut the weeds.
- A coupled wheel is used so that it can travel easily
- A pesticide pump is placed on one side and water pump on other side.
- A servomotor is used to drop seeds.

This is an agricultural-based robot. In this robot, we are using the L293DN IC motor driver that operates the robot forward, backward, right side and left side. A motor is used rotate a blade to cut the weeds. It also consist of water pump for watering. A servomotor is used that helps to drop the seeds. All the instructions are given through Bluetooth controlled android application.

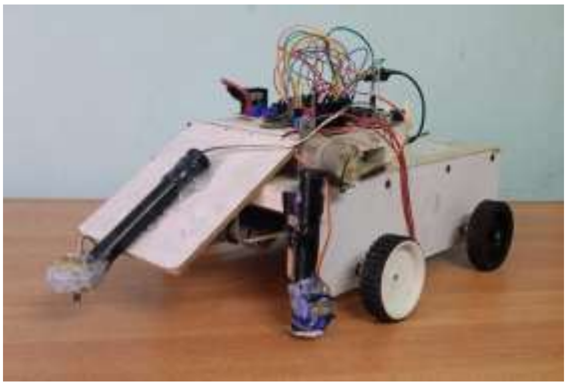

Fig-10: Robot Built for Agriculture

5. CONCLUSIONS

An initial outcome of this study indicates that most of these systems that which work autonomously are more flexible than traditional systems. The benefits of reduction in labor costs and restrictions on the number of daily working hours significantly improved. Thus it has made possible to automate the most significant working routines. The project presents a low cost, low power & simple system for device control. This system will have high application in farming, gardening and Agro University.

By implementing this system, agricultural, horticultural lands, gardens can be irrigated. Thus, this system is cheaper and efficient when compared to other type of automation system. In large scale applications, high sensitivity sensors can be implemented for large areas of agricultural lands. Thereby reducing the stress on farmers.

REFERENCES

[1] https://www.robotics.org/blog-article.cfm/Robotics-in-Agriculture-Types-and-Applications/74.

[2] ieeexplore.ieee.org/document/6139624.

[3] https://www.researchgate.net/publication/254048454_Agribot_-_A_multipurpose_agricultural_robot.

[4] Agriculture Robotics in Japan Nobutaka Ito ProfessorDept. Of Bioproduction and Machinery Mie University, Japan, IEEE International Workshop on Intelligent Robots and Systems IROS '90

[5] Amrita Sneha.A,, ―Agricultural Robot for Automatic Ploughing and Seeding,‖ 2015 IEEE International Conference on Technological Innovations in ICT for Agriculture and Rural Development (TIAR 2015)

[6] Timo Blender, ―Managing a Mobile Agricultural Robot Swarm for a Seeding Task,‖ 978-1-5090-3474-1/16/$31.00 ©2016 IEEE

[7] Tim Mueller-Sim, Merritt Jenkins, Justin Abel, and George Kantor, the Robotanist: A Ground-Based Agricultural Robot for High-Throughput Crop Phenotyping2017 IEEE International Conference on Robotics and Automation (ICRA) Singapore, May 29 - June 3, 2017.

[8] Richard Crowder, Electrical Drives and Electromechanical systems, Elsevier, 2013

[9] Mehta V. K. and R. Mehta, Principles of Electrical and Electronics, S. Chand & Company Ltd., 1996.

[10] Theraja B. L. and A. K. Theraja, A Text Book of Electrical Technology, S. Chand & Company Ltd., 2008.

[11] Pillai.S,K A first course on Electric drives, Wiley Eastern Limited, 1998.

BIOGRAPHIES

Ajesh A is currently B.Tech final year student of Abdul Kalam Technological University. He is interested in coding program and robotics

Anandhu K S is currently B.Tech final year student of Abdul Kalam Technological University. He is interested in designing and program coding

Jelvin Raju is currently B.Tech final year student of Abdul Kalam Technological University. He is interested in electronics and program coding

Jerin Saji is currently B.Tech final year student of Abdul Kalam Technological University. He is interested in mechanics and automation