Exploration of Multipurpose Electric Vehicle for Agriculture Using IOT

M.V.Ramesh , Ph.D
G.Vijay Kumar , Ph.D
B.Suresh Babu , Ph.D
R.Boopathi , Ph.D
C.Sreekanth , Ph.D
P.Muthukumar , Ph.D
L.Padma Suresh , Ph.D

M.V.Ramesh, Associate Professor, Department of Electrical and Electronics Engineering, Prasad V. Potluri Siddhartha Institute of Technology, Vijayawada, India. G.Vijay Kumar, Professor, Department of Mechanical Engineering, Prasad V. Potluri Siddhartha Institute of Technology, Vijayawada, India. B.Suresh Babu, Professor, Department of Electrical and Electronics Engineering, Shri Vishnu Engineering College for Women, Bhimavaram, India. R.Boopathi, Assistant Professor, Department of Electrical and Electronics Engineering, Shri Krishnaa College of Engineering and Technology, Pondicherry, India. C.Sreekanth, Associate Professor, Department of Electrical and Electronics Engineering, College of Engineering Muttathara CAPE, Thiruvananthapuram, India. P.Muthukumar, Associate Professor, Department of Electrical and Electronics Engineering, Prasad V. Potluri Siddhartha Institute of Technology, Vijayawada, India. L.Padma Suresh, Professor, Department of Electrical and Electronics Engineering, Baselios Mathews II College of Engineering, Kollam, India. Correspondence Dr M.V.Ramesh; vrameshmaddukuri@gmail.com

Objectives: Objective: In this paper suggests a multipurpose portable type agricultural vehicle which can perform many functions of agriculture like seed sowing, water sprinkling and fertilizer spraying using a single agricultural vehicle. In the present scenario the agriculture is becoming of less interest even for the skilled people due to the increase in capital cost and decrease in the selling price. It is the time for introducing different machines with less human interference and also better with automated vehicles. There are different modern machines/tools that are accessible to farmers in order to perform various functions in agriculture. Each machine/tool can perform its own intended function. Methods: This agricultural vehicle is an automated vehicle where the control is based on IOT and can be controlled remotely. The proposed system involves PMDC motors as a driving mechanism and servomotor is used for controlling the output. The entire mechanism is controlled by NImyRIO embedded system. The programming of NImyRIO is developed using LabVIEW which is a visual programming language for easy user interface. Results & Conclusions: This exploration of multipurpose unmanned electric vehicle surely paves the ways to smart implementation scheme to the agriculture society including tobacco plantations.

Key words: Agricultural vehicle; PMDC motor; IOT; LabVIEW; NImyRIO
Tob Regul Sci.™ 2021;7(5-1): 3844-3852
DOI: doi.org/10.18001/TRS.7.5.1.157

The influential weapon to terminate the extreme poverty is agriculture development. The feed is projected 9.7 million people by 2050 by the world bank. The advancement in the agricult ure area is two to four times more operative in nurturing incomes among the poorest related to other sectors. India is a global agricultural power house. It is the world's major maker of milk, pulses, and spices, and has the world's biggest cattle herd (buffaloes), as

well as the biggest area beneath wheat, rice and cotton. It is the second largest maker of rice, wheat, cotton, sugarcane, farmed fish, sheep & goat meat, fruit, vegetables and tea. The progression of agriculture in India is quite notable over the past few decades. The agriculture sector is being successful in steep rising for the demand of diet. The role of increase of land area in agricultural industry was dropped as the days goes on and there is an increase in production in past two decades due to increased productivity. Involvement in the overall growth of agricultural is in progress and has been widespread. Increase in productivity helps to feed the poverty, enhance the income and provide employment directly or indirectly. The success in Indian way of cultivation is linked with series of steps. The main causes for the increase in cultivation in this era are the improvement in the variety of modern crop, increase of input usage and investments for the irrigation projects. The growth in the Green Revolution technology areas that is having key impact is declining these days. The technology has been helped agriculture either it may be on the field or it may be off the field[1]-[2]. The off the field technologies are useful for monitoring and commanding (Example: Drones and Quadcopters). But on the filed technologies are useful for cropping, yielding and etc. (Example: unmanned Vehicle and robots).Drone is one type of unmanned aerial vehicle and Quadcopter is subset of Drone which is having four rotors, whereas the robots are guided my artificial intelligence techniques [3]-[4]. The New technologies are necessary for improving the yielding limits, efficiently utilize the inputs, expand more ecologically with higher value of crop patterns. Simultaneously, it is urgent to concentrate and improve the potential of rain collection and in areas having lesser ability. Considering the wide area of environmental setting and cultivators, Indian cultivation is facing a wide variety of necessities, opportunities and visions. The target in the future is to be fastener, broader and better embattled. There has been lot of attention given to automate the different tasks in agriculture and many authors have tried to design vehicles which can combine different operati on related to farming. Many multipurpose agricultural robotic vehicles are presented. Several new techniques can be used in farming to have higher growth in yielding of crops. Automatic control techniques having latest technology in electronics making use of microcontroller and GSM, GPS etc., can reduce the man power was studied [5]. A drip irrigation system with fully automatic used to control and monitor by incorporating ARM9 processor was developed [6]. Here Sensors are utilized to observe the moisture content in soil and the content of moisture in the soil make automatic turn ON or OFF of valves of system at various time intervals. Automatic Seed Plantation Robot based on mechanical and electronic platform which performs advanced agriculture process was presented to cultivate the farm by automated method, depending on crop [7]. A robot that is capable of executing various operations like seed dispensing, ploughing , picking fruit and spraying pesticide with manual control also whenever required and keep eye on humidity using humidity sensors was developed[8]. A remote controlled robot using GPS for remote operation to perform operations like spraying, weeding, moisture sensing, scaring of bird and animal, keeping vigilance etc. was fabricated [9]. A robot using micro controller for ploughing the land, sowing the seeds and watering plants and spraying fertilizers was reported [10]. Use of Bluetooth communication to interface controller and android though UART protocol for controlling a robot for pesticide spraying was developed [11]. Ploughing, seeding, cutting of crop, pesticide spraying by using one multipurpose equipment was proposed [12]. A better design of machine used specially for sowing pigeon pea, soybean, groundnut, maize, Bengal gram etc. was proposed [13]. Digging and Seed sowing robot with various ground contours to implement digging, sowing of seeds and watering the ground while closing was developed [14]-[17]. M.Ayaz et al[15]. says that the fast development of the Internet-of-Things (IoT) based technologies reshaped closely every industry comprising “smart agriculture” which stirred the industry from statistical to quantitative methodologies. The importance on smarter, better, and more well-organized crop growing practices is compulsory in order to reach the rising food request of the cumulative world population. Many software’s and hardwares (Embedded systems) have been used to implement a vehicle for agriculture applications.

MyRIO is a real-time embedded evaluation board prepared by National Instruments. myRIO affords educators with an embedded, WiFi-enabled solution to deliver an engaging approach to learning controls, investigating mechatronics, and designing imaginative capstone improvements. In this paper demonstrate the multipurpose vehicle for agriculture using Internet of Things. The functioning of this vehicle is controlled by NImyRio.

It's experiential and scientifically confirmed that practical learning helps students in retaining information for a lengthier period of time. In this paper helps the students to get comfortable with equipment's while implementing the new techniques for inevitable agriculture applications. The technological task implemented in real time experiments can help to improve the under graduate and post graduate students observation/implementation skills.

In this paper organizes as follows, section 2 describes about the electrical components used in this project. Section 3 describes vehicle control mechanisms. Section 4 describes the Experimental exploration of vehicle in agriculture field and section 5 concludes the effectiveness of the electric vehicle.

DESIGN OF THE VEHICLE

Mechanical design

The important components of the seed sowing robot are frame, wheel axle, shaft, suspension link etc. Table 1 shows the dimensions of the vehicle for fabrication. CATIA V6 CAD software is used to design the 3D Design for seed sowing and the detailed diagram is shown in Figure 1. The design is based on farm condition and the requirement and so there will be uniformity in sowing the seeds.

Description of Electrical components

The basic electrical components used in the multipurpose agricultural robot are

i) Drive motor, ii) Motor driver and iii) Servo motor.

(i) Drive Motors:

PMDC Johnson motor is selected as drive motor. It's a DC motor run with DC supply containing metal gear-box to drive the motor shaft with a mechanical commutated electric motor. The merits of this motor is its compactness and its Torque Vs Speed characteristics. The motor shaft comes in side and has six M3 mounting holes as shown in Figure 2. The motor shaft is equipped with metal bushes that make the shaft with less maintenance. A hole is present on the motor shaft for better coupling. The motor runs smoothly in the voltage range of 6V to 18V DC and gives 500 RPM at 12V supply. Torque is of 1 kg-cm at 500 rpm. They are suitable well for installing in robots/ robotic platform and also used in several automation applications.

(ii) Motor Driver:

L298N Motor driver module is used as motor driver which is shown in Figure 3. They are utilized to drive and interface the motor. These driver circuits can be effortlessly interfaced with motor and the choice of the driver depends on motor type and their specifications. These circuits consist of current amplifiers and serve as an interface between controller and motor in the circuit. Motor driver IC is made with the integration of various components. The input of the motor driver is of low current signal. The purpose of driver is to amplify the current from low current signal to high current signal. This high current signal i.e. output is then connected to motor. The motor may be brushless DC motor, brushed DC motor, stepper motor, other DC motors etc. table 2 shows the specifications of motor driver.

Fig.1 3D design of seed sowing vehicle designed in CATIA V6 design software.

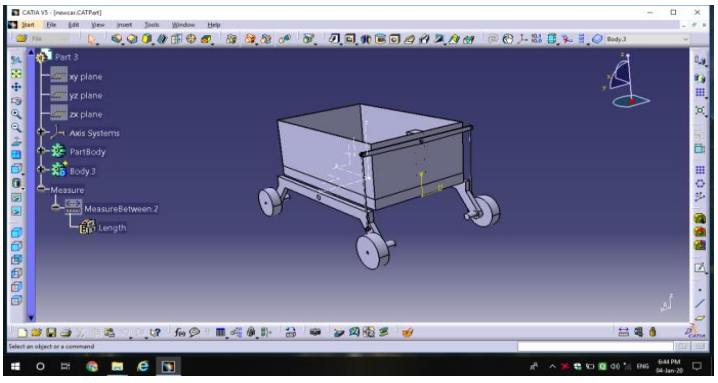

Table 1
Dimensions Of Various Parts Of The Machine

Name of the Parts	Dimensions
FRAME	Length – 520mm, Width – 400 mm, Thickness – 40 mm
WHEEL AXLE	Length of Horizontal part - 600 mm, Angle of Inclination - 130 mm
SHAFT	Length – 440 mm, Diameter – 20 mm
SUSPENSION LINK	Length - 488.4 mm, Diameter of large hole – 10 mm, Diameter of small hole – 7.5 mm

Table 2
Specifications of Motor driver

Parameter	Specifications
Current	2 A
Voltage	7 to 24 V DC
Logic Control	Standard TTL Logic Level
Heat-Sink availability	Yes
LED Indicators	4 Direction LED indicators, Power-On LED indicator
Control pin	Enable and Direction Control pins are available

Motor Driver

L298N Motor driver module is used as motor driver which is shown in Figure 3. They are utilized to drive and interface the motor. These driver circuits can be effortlessly interfaced with motor and the choice of the driver depends on motor type and their specifications. These circuits consist of current amplifiers and serve as an interface between controller and motor in the circuit. Motor driver IC is made with the integration of various components. The input of the motor driver is of low current signal. The purpose of driver is to amplify the current from low current signal to high current signal. This high current signal i.e. output is then connected to motor. The motor may be brushless DC motor, brushed DC motor, stepper motor, other DC motors etc. table 2 shows the specifications of motor driver.

Fig 2: PMDC Johnson motor

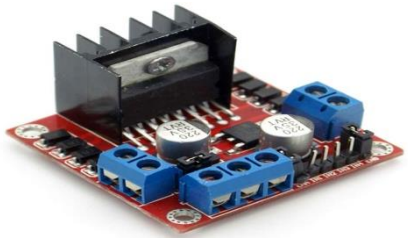

Fig 3: L298N Motor driver

Servomotor

MG996 Servo motor is special type electric motor which is able to push/ rotate the load with high accuracy. Servomotor is used to move the load with a specific angle or distance. It is just a motor that run with servomechanism. If supply is DC to the motor it is called DC servo motor and if is powered with AC it is called AC servo motor. Torque-weight ratio of servo motor is very less. Owing to these special features they can be used in various light weight applications like RC helicopters/ planes, toy car, Machine, Robotics etc. table 3 shows the specifications of Servomotor

Lead Acid Batteries

Figure 4. shows the Lead Acid Batteries designed & developed in 1980s. The major applications of these bulky batteries are in automobiles due to the fulfillment of requirements in high current used in heavy motors. The Lead Acid battery composition will change in the states of charge and discharge. A mixture of Pb-ve and PbO2+ve as electrodes and H2SO4 as electrolyte will be in charged state where as PbSO4 and water in discharge state.

Table 3
Specifications Of Servo Motor

Parameters	Specifications
Operating Speed	0.17sec / 60^0 (4.8V no load) 0.13sec / 60^0 (6.0V no load)
Weight	55gms
Connector Wire	Heavy Duty, 11.81"
Dimension	40mm x 19mm x 43mm
Gear Type	All Metal Gears
Stall Torque	13 kg-cm at 4.8V, 15 kg-cm at 6V
Voltage	4.8 - 7.2Volts

NImyRIO

myRIO is principally, it is a type of microcontroller developed by National Instrument (NI) and also known as NImyRIO as shown in Figure 5. . The block diagram shown in Figure 6 helps to know the internal structure of a device. The various softwares are needed for programming NImyRIO. LabVIEW development system, real time module and myRIO toolkit are the softwares.Windows 10/8.1/7 windows serer 2008/2012 are the supported operating systems for NImyRIO.

The NImyRIO Features are

- ✓ 6 analog outputs, 10 analog inputs, 40 digital input/output lines
- ✓ Xilinx FPGA and dual core RAM cortex A9 zynq processor
- ✓ LEDs, Wireless, push buttons, accelerometer on-board
- ✓ Programmable with LabVIEW or C language

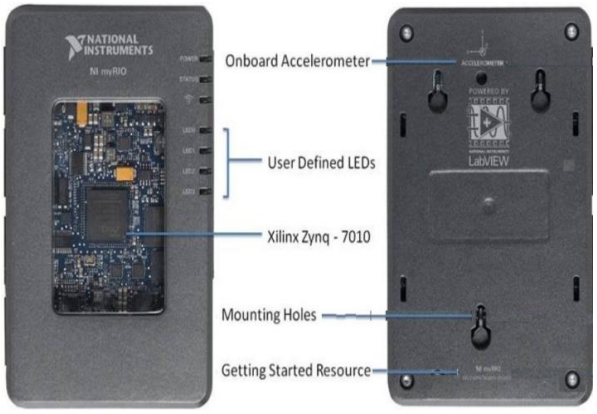

Fig. 5. NI myRIO

VEHICLE CONTROL

The block diagram provides a clear vision of overall system as shown in Figure 7. The main heart of this agricultural robot is NI MyRIO to which each and every module is being connected and interfaced. The four driving motors of the vehicle are interfaced to the NImyRIO through two motor driver circuits. The left side motors of the vehicle are connected to one drier circuit and the right side motors are connected to the other. The servo motor with the driving circuit is connected directly to NImyRIO. The vehicle is driven through the hot-spot produced by the MyRIO. The vehicle is controlled by the above system without a need of human interactions. Battery bank supplies the power to the system components present. Figure 8 shows flowchart of the complete functionality.

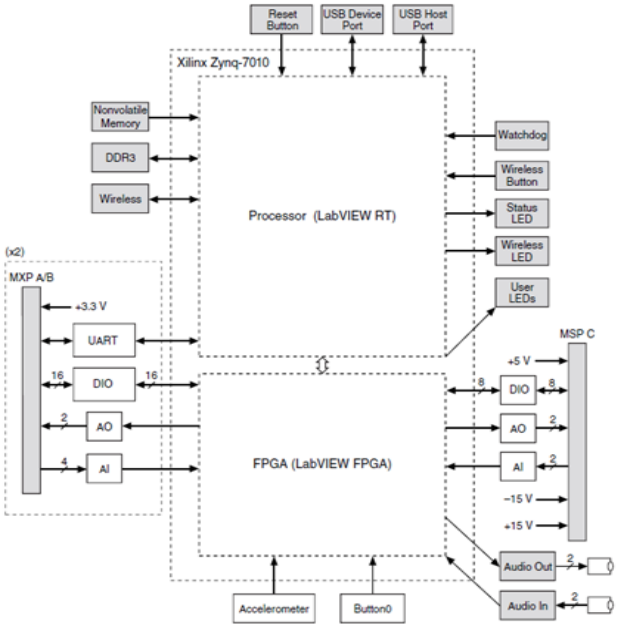

Fig. 6. Internal Block diagram of the NImyRio

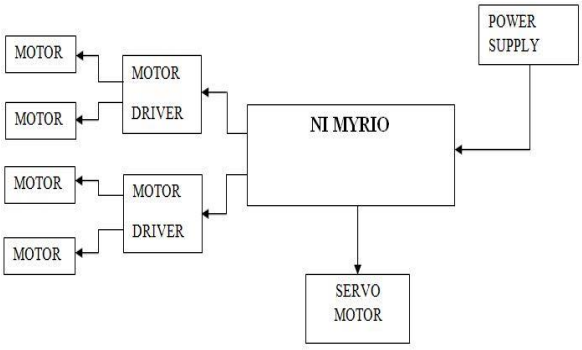

Fig. 7. Block diagram of the overall system

LabVIEW Software

LabVIEW is software can interface with hardware in the systems engineering used for the applications which require testing & controlling by intelligent measurements with high speed. The environment development in the system design using graphical programming language can be done by Laboratory Virtual Instrument Engineering Workbench platform established by National Instruments. This language

is called as G-code. Windows, Linux are the Operating systems used to run the software. LabVIEW program is written in C++, .NET Framework.

(i) Design Patterns in LabVIEW

Design pattern is a multi usable solution to solve engineering problem in software. It gives the developer to start at a point and help in improving readability, efficiency, maintainability and scalability. Usage of this type of pattern helps developer to easily expand the application and reuse the own development and can add new features. Once a good architecture is created for your company, templates can be built to reuse the architecture for future projects. No architecture is considered as best but may be useful to start with any of the design patterns or deviations in them. A good architecture is one which is fitted the best for your application and the combination for different design patterns. Simple design patterns include State Machine, Event Handler, Master/Slave, Producer /Consumer. In this paper state machine is used from basic design patterns.

(ii) State Machine

A while loop is contained in a case structure where the State Machine is available in LabVIEW which is shown in Fig 9. The present cases are executed in this structure is calculated from the output of previous case by the control of selector input. Shift register is used to control the order of case execution. The wiring of the output of one case to the subsequent case and the input of the case selector from the shift register of left hand side is determinate.

LabVIEW Front Panel Design

The movement of the vehicle is monitored in the LabVIEW through the following design patterns. Figure 10 describes the forward motion. In Figure 11 indicates the left movement. Similarly in Figure 12 shows the right movement and the servomotor operation is described in Figure 13.

LabVIEW Programming

LabVIEW is programming environment easy to build programs through graphical scheme. The program development with execution is more interactive designed for researchers, engineers, scientists, and etc., This environment works systems having Microsoft softwares and various embedded platforms. G code is more effective, reliable and fast. It is designed for analyze data, measurement and present results to user. LabVIEW has multipurpose graphical user interface and easy to program. It is also superlative for presentation of ideas, simulations, common programming or for teaching basic concepts in programming. The block diagram for movement of vehicle using LabVIEW programming language is presented in Figure 8. And the block diagram for servomotor mechanism is represented in Figure 14.

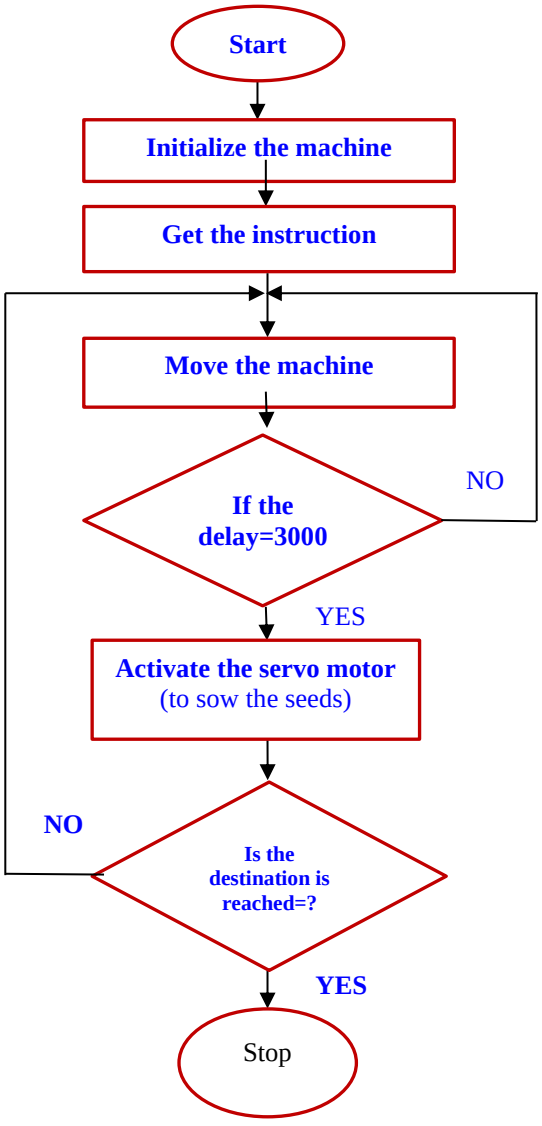

Fig. 8. flow chart of the complete functionality

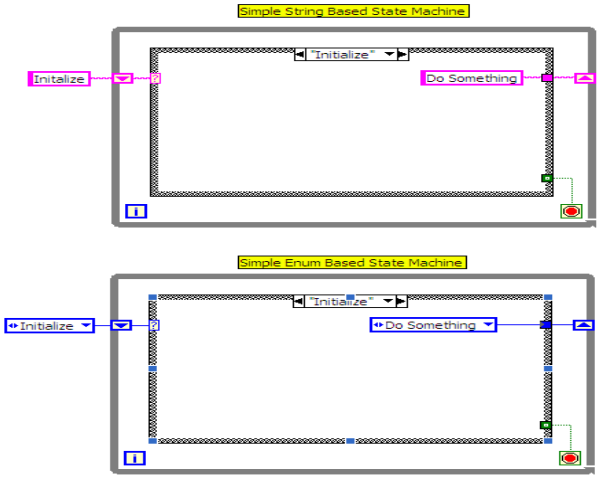

Fig. 9. State Machine in Labview

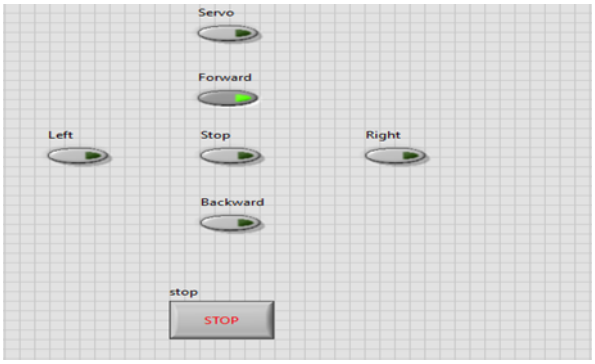

Fig. 10. Front Panel for Forward Motion

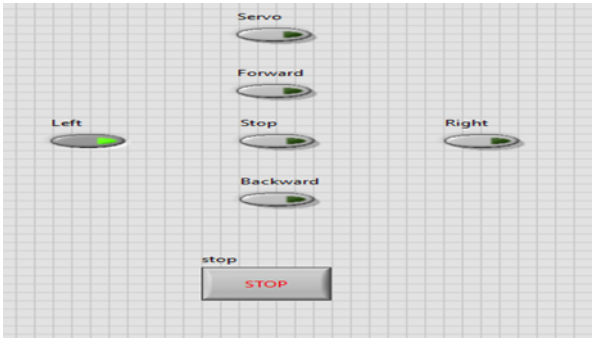

Fig. 11. Front panel for Left Movement

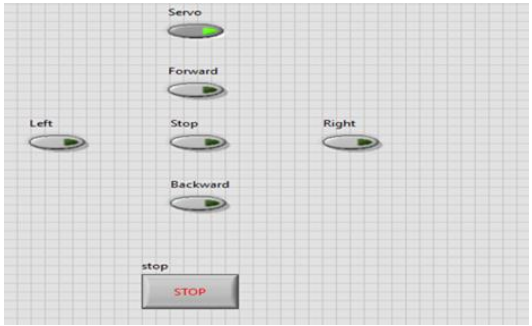

Fig. 12. Front Panel for Right Movement

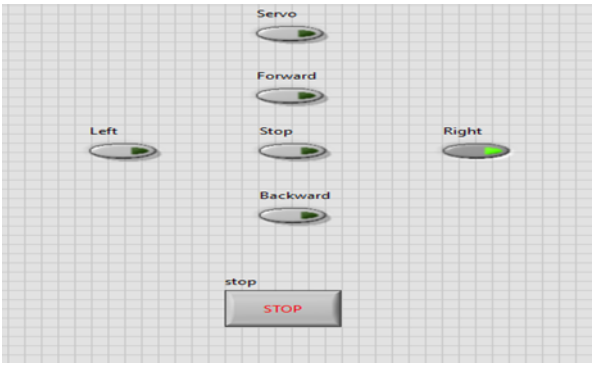

Fig. 13. Front Panel for Servomotor mechanism

IMPLEMENTATION AND RESULTS

The mechanical components of multipurpose vehicle described in the section 2 are welded in such a way so as to fabricate the body consisting of frame, wheel axle, connecting rod and four wheels. Seed hoppers (Buckets) are providing by two chambers for storing the seeds. The rocker-bogie framework is used for providing the suspension as shown in Figure 15, for the vehicle so that the vehicle will maintain its balance even when the surface has ups and downs, which generally is the case while operating the vehicle in the actual fields. Separate chambers are designed for keeping the electronic circuitry and the battery which powers the vehicle as shown in Figure 15. The seed releasing mechanism is kept at the bottom of the seed hopper which controls the flow of seeds and facilitates the vehicle in sowing the seed at proper location maintain the defined space between two seed buckets. The proper iron doors are provided both seed buckets and circuits chamber. Four PMDC Johnson motors are used to drive the vehicle and a servo motor is used for seed sowing mechanism. NI myRIO controller is the controlling part of vehicle. LabVIEW environment is utilized to run the controller. The vehicle is controlled remotely by IOT and NImyRIO acts as the interfacing part between IOT and the vehicle. Figure 16 shows the side view of the servo motor mechanism.

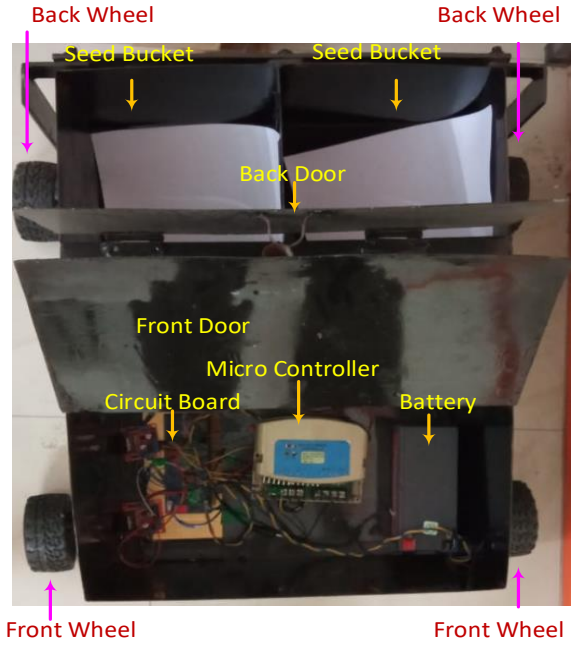

Fig 15: Top View of vehicle

Fig 16 Seed sowing robot (Side View)

CONCLUSIONS

An automatic agricultural multipurpose vehicle has been designed and implemented for seed sowing dispensed in the soil in a proper sequence and carrying out other activities related to agriculture like water sprinkling and fertilizer spraying using a single agricultural vehicle. An automatic sowing of seeds in the field in a proper sequence resulted in proper germination of seeds. The vehicle is controlled with embedded system along with IOT and can be controlled remotely. The usage of multipurpose vehicle reduces the labor requirement, reduces time and also wastage of seeds in a much amount. This can be implemented for other applications by making slight changes in the electrical & mechanical design. A plough can be set under the vehicle so that it can also be used for ploughing and by keeping a camera at the front a weed cutter can also be included as an another application. The project can be used for various types of crop such as paddy, fruit crops, sugarcane etc. The vehicle can also be designed with chain drive instead of a wheel. Hence, it is suitable and applicable for real-time agricultural field and it the vehicle prototype seemed to be smart for students, which is a highly anticipated educational impact. This type of controlled autonomous vehicle can still be improved with more controlling environment. This experimental exploration of multipurpose unmanned electric vehicle surely paves the ways to the smart implementation scheme to the agriculture tobacco plantation society.

References

1. UM RaoMogili, B B V LDeepak. Review on Application of Drone Systems in Precision Agriculture. Procedia Computer Science, Volume 133, 2018, p. 502-509.
doi:https://doi.org/10.1016/j.procs.2018.07.063
2. Barbedo, J.G.A. A Review on the Use of Unmanned Aerial Vehicles and Imaging Sensors for Monitoring and Assessing Plant Stresses. Drones 2019, 3, 40. doi:https://doi.org/10.3390/drones3020040.
3. Nuijten, R.J.G.; Kooistra, L.; De Deyn, G.B. Using Unmanned Aerial Systems (UAS) and Object-Based Image Analysis (OBIA) for Measuring Plant-Soil Feedback Effects on Crop Productivity. Drones 2019, 3, 54.
doi:https://doi.org/10.3390/drones3030054
4. Heim, R.H.J.; Wright, I.J.; Scarth, P.; Carnegie, A.J.; Taylor, D.; Oldeland, J. Multispectral, Aerial Disease Detection for Myrtle Rust (Austropuccinia psidii) on a Lemon Myrtle Plantation. Drones 2019, 3, 25. doi:https://doi.org/10.3390/drones3010025
5. Abdullah Tanveer, Abhishek Choudhary, Divya Pal, Rajani Gupta, Farooq Husain. Automated Farming Using Microcontroller and Sensors. International Journal of Scientific Research and Management Studies, Vol. 2, no.1, pp. 21-30, 2015.
6. GayatriLondhe, S.G. Galande. Automated Irrigation System by Using Arm Processor. International Journal of Scientific Research Engineering & Technology, vol.3, no.2, pp. 254-258, 2014.

doi: http://www.jetir.org/papers/JETIR1712091.pdf

7. Prashant G. Salunkhe , Sahil Y. Shaikh , Mayur S. Dhable , Danis I. Sayyad , Azeem S. Tamboli. Automatic Seed Plantation Robot. International Journal of Engineering Science and Computing, vol.6, no.4, pp.4661-4663, 2016.

doi: https://doi.org/10.4010/2016.1065

8. S. A. Amrita, E. Abirami, A. Ankita, R. Praveena and R. Srimeena. Agricultural Robot for automatic ploughing and seeding. 2015 IEEE Technological Innovation in ICT for Agriculture and Rural Development (TIAR), Chennai, 2015, pp. 17-23, doi: https://doi.org/ 10.1109/TIAR.2015.7358525.
9. Nikesh Gondchawa1 , R. S. Kawitkar. IOT Based Smart Agriculture. International Journal of Advanced Research in Computer and Communication Engineering, vol.5, no. 6, pp. 838-842, 2016.
10. P.Usha, V.Maheswari, V. Nandagopal. Design and Implementation of Seeding Agricultural Robot. Journal of innovative research and solutions, vol. 1, no. 1, pp. 138-143, 2015.
11. Siddhi S. Mane, Nikita N. Pawar, Sneha A. Patil, Prof. D.O. Shirsath. Automatic Farmer Friendly Pesticide Spraying Robot with Camera Surveillance System. International Research Journal of Engineering and Technology, vol. 07, no. 05, pp.5347- 5349, 2020.
12. Narendrapatel, Himanshupatel, Utsavpatel, Dilippatel, Parth shah. Development of Multipurpose Agriculture Machine. International Journal of Advanced Engineering and Research Development, Special Issue SIEICON-2017.

doi:https://doi.org/10.1016/j.matpr.2020.11.094

13. Abdulrahman, MangeshKoli, UmeshKori, Ahmadakbar. Seed Sowing Robot. International Journal of Computer Science Trends and Technology, vol. 5, no. 2, pp. 131-143, 2017.
14. Shwetha S. and Shreeharsha G. H. Solar Operated Automatic Seed Sowing Machine. International Advanced Research Journal of Advanced Agricultural Sciences and Technology, vol. 4, no. 1, pp. 67-71, 2015.

https://www.ripublication.com/ijaerspl2018/ijaerv13n6spl_45.pdf

15. M. Ayaz, M. Ammad-Uddin, Z. Sharif, A. Mansour and E. M. Aggoune. Internet-of-Things (IoT)-Based Smart Agriculture: Toward Making the Fields Talk. in IEEE Access, vol. 7, pp. 129551-129583, 2019,

doi: https://doi.org/10.1109/ACCESS.2019.2932609.

16. E Guzma´n-Ramı´rez, I Garcı´a, E Guerrero and C Pacheco. An educational tool for designing DC motor control systems through FPGA-based experimentation. The International Journal of Electrical Engineering & Education, vol. 52, 1: pp. 22-38. , First Published February 19, 2015.p. 1-17.

doi: https://doi.org/10.1177/0020720915571237

17. C. G.HARRISON and P. L. JONES. A Creative Class Project Based On VHDL, Synthesis And FPGA Design. Int. J. Elect. Enging. Educ.. Vol.34, p. 370-375. 1997.

doi: https://doi.org/10.1177/002072099703400408