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Design and Fabrication of Solar Powered Autonomous Seed Sowing Vehicle

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Abstract: ***At present there is a huge scarcity of skilled manpower in agricultural sector. Farmers have to look for the state of the art technology to carry out the cultivation activities to improve the productivity. A rapid progress in the technology has led to the development of modern techniques in farming and utilizes innovative technologies to overcome problems associated with the conventional methods. This paper addresses the design and fabrication of a seed sowing vehicle which is controlled by a microcontroller and powered by solar panel.***

Keywords: Seed sowing robot, micro controller, solar powered, zigbee control.

I. INTRODUCTION

There is a constantly increasing demand on agriculture to provide the needs of a exponentially increasing population and day by day the overall area used for cultivating the crops is decreasing drastically. The possible solution to this problem is increasing the productivity of the available land by employing advanced cultivation technologies. Another issue which requires utmost attention is that, the contemporary machines used in the agriculture consume power which is produced by burning the fossil fuels to run IC engines or external combustion engines leading to air and noise pollution. As agriculture has extensive scope in activities related to it, with a high potential for robotic applications. Fully autonomous robots can be used in open field applications. Robots are available in several agricultural applications on all development levels, but most of them are in research. Research institutes have made progress in developing automated vehicles for most of the activities in agriculture. Various methods used for sowing in India and fertilizer placement , the terminologies involved, types of existing machineries were studied [1] . Machines used in agriculture which can perform farming operation and useful for small scale farming [2] was developed. Several multipurpose agriculture machines for agriculture are proposed [3-7].

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An improved design of Agricultural robot and smart agriculture implementation was also attempted [8]. Design and prototyping of a robotic vehicle with seed selector[9] was developed towards autonomy in agriculture. Seeding mechanism for agricultural robot was designed [10] Design and development of vacuum seed sowing robot[11]was also proposed. AGRIBOT -RF based farmer friendly agricultural robot with automatic seed dispensing system[12] was developed. Application of solar power for seed sowing, pesticide spraying [13-19] was also reported by many authors. Most of the robots developed are for harvesting. The robots for precise planting which can work autonomously are not yet available. The basic objective is to drop the seeds at required depth and to maintain specified distance between seed to seed. The proposed electromechanical vehicle which is driven by DC motor has four wheels. Depending on the crop the farm is cultivated as per the crop requirement by this machine. The machine can be controlled remotely. To monitor the motion of vehicle, a microcontroller is used which controls the DC motor. Design of seed sowing mechanism is as per farm condition and also it is as per the requirement to accommodate different seeds, so that autonomous vehicle can sow the required size of rows of seed. All the wheels are powered by battery and DC motor. A solar panel included the design will meet the necessary power requirement.

II. MECHANICAL DESIGN ASPECTS

Following are the mechanical aspects are considered for design process

1. Chassis design
2. Wheel selection
3. Seed storage funnel

1) Chassis design:

The chassis is designed keeping in view the size and shape of overall components in the vehicle. The width and breadth are 46cm X 35cm. total height of the vehicle is 28cm. L type channels are used for chassis which are 2cm width and 5mm thick as shown in Fig.1.

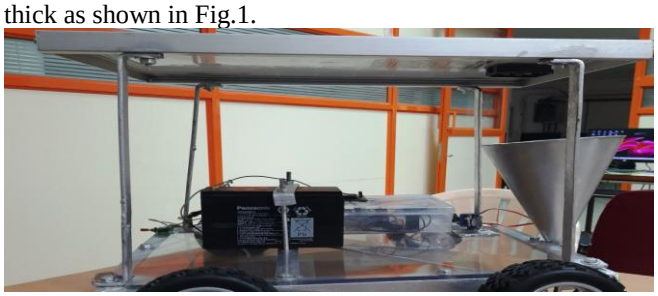

Fig. 1: Chassis

2) Wheel selection:

Vehicle is designed with four wheel, two wheels at the front and another two wheels on the rear side. The diameter of the wheel is 11cm as shown in Fig. 2.

Fig. 2: Wheel

3) 3) Seed Storage Funnel:

Seed storage is designed according to hold the seed for planting. This is placed on the chassis frame as shown in Fig. 3. Seed sowing mechanism is arranged at the bottom of this funnel. This mechanism will control the seeds and the spacing between two seeds. According to requirement this can be changed.

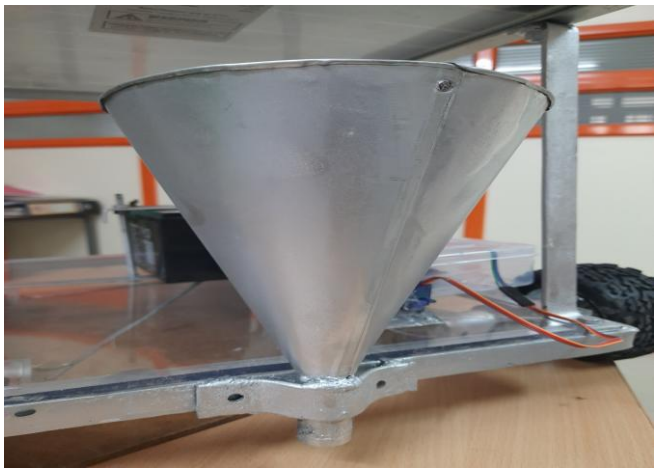

Fig. 3: Seed storage funnel

III. OTHER DESIGN ASPECTS

Following aspects are considered for design process other than mechanical aspects.

1. DC Gear Motor selection
2. Microcontroller
3. Power supply
4. Motor drive
5. Seed sowing mechanism
6. Battery
7. Solar energy
8. Zigbee communication

1) Dc Gear Motor Selection

Torque required for moving the vehicle is provided by electric motor. DC motor is used to drive the device as shown in Fig. 4. DC motors can be found in many different applications such as pumps, vehicles, locomotives etc. A gear is also attached to the motor to produce high torque maintaining low speed and high motor output. DC gear motors provide the required torque through the wheels. Four Motors are coupled to the four wheels of the vehicle. Motor can be controlled in both forward as well as reverse direction. The terminals of DC gear motor are interchanged to change the direction of the vehicle. Motors are fixed underneath the chassis.

Fig. 4: DC Gear motor

2) Micro Controller

Microcontroller is a controlling device. It takes input from the input device it needs to control and device is controlled by sending signals to various components in device and delivers required output at the required instant and to the required component.

ARDUINO UNO: It is a microcontroller module and ATMEGA328 is incorporated with 16 MHz ceramic clock generator. In this, 14 are digital I/O pins in that 6 used for PWM pulse generator, 6 analog pins, USB connection, power jack, ICSP header and reset button are present as shown in Fig. 5. It consists of entire components needed to support microcontroller. It can connect with PC through USB cable to supply the power. AC-to-DC converter or battery can also be used to supply power to Arduino Uno. The advantage of Uno of all other boards is that USB to serial adopter is not used. Instead, Atmega l6U2 is used to (Atmega 8U2 up to version R2) program as a USB-to-serial.

Fig. 5: Arduino Uno board

New Features of the board are as follows
Microcontroller: ATmega328
Input Voltage: 5V
Recommended Voltage: 7-12V
Limits of Input Voltage: 6-20V
Digital I/O Pins: 14 of which 6 are for PWM output
Analog Input Pins: 6
DC Current on I/O Pins: 40mA
DC Current on 3.3V Pins: 50mA
Flash Memory: 32KB of which 0.5KB used by boot loader
SRAM: 2KB
EEPROM: 1KB
Clock Speed: 16MHz

Schematic: Arduino reference design uses Atmega 8, 168 or 328. Present models use ATmega328. The pin configuration is shown below.

Maximum dimensions of Uno are 2.1x2.7 inches. USB and power jack connectors are extended outside the earlier measurement. The board can be attached to base Four screw holes are provided. Gap between the pins 7 and 8 is 0.16".

3) Power Supply

Power supply to the motor and various electronic devices is supplied from power supply board that contains voltage regulators for regulating the voltage and the capacitors are used as filters. The input of this board is 12V DC supply given from the battery.

4) Motor Drivers

Driving force of Microcontroller is not sufficient to drive the motor. The output current of the microcontroller is to be amplified to drive the motor. A driver is to be connected as an interface between the microcontroller and motor. L293D is a motor driver IC that is used in this circuit. The circuit for the power supply with filters, heat sinks and driver board of the motor is shown in Fig.6

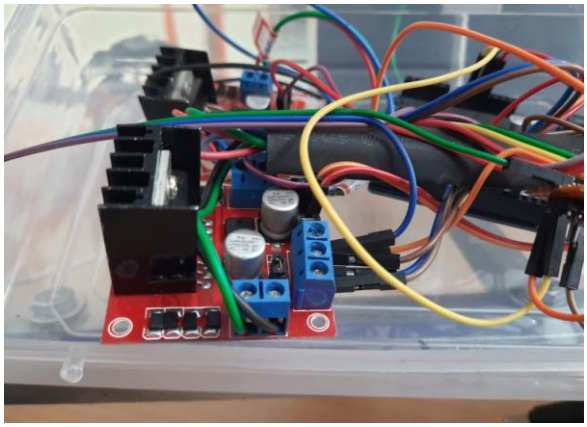

Fig. 6: Power supply board

5) Seed Sowing Mechanism

Servomotor is a special motor used to control laying the seeds. This motor can be controlled by Aurdino Uno specifying the instant of releasing the seeds from the funnel. I rotates clock wise as well as counter clock wise for opening & closing. The diagram of Servomotor is shown in Fig.7

Fig.7: Seed sowing mechanism

6) Battery

Batteries can be divided into two major categories. Primary are a disposable once. It cannot be recharged once used. Secondary can be rechargeable again once used. Depending on battery type, charging and discharging can be done number of times. Alkaline, Mercury, Silver-Oxide and Zinc carbon batteries are examples of primary batteries. Lead-Acid and Lithium batteries are examples of secondary battery. Lithium battery is rechargeable and has high energy density and is more durable but more expensive compared to lead battery. In this project Lead-Acid battery is used. The current and voltage values provided by each cell usually are 700mA and 1.5V respectively. These are disseminated in various standard cylindrical shapes. In this project, 12V, 7.5Ah lead acid battery is used as shown in Fig. 8.

Fig. 8: Battery

7) Solar Energy

Solar energy is a device that generates power through renewable sources i.e. solar energy. Solar PV cell panels are commonly used to generate electric energy. It receives photon power from sun and converts into electrical energy. This technology is mostly classified as passive and active solar which depends on the controlling, conversion and distribution of solar energy. Solar PV panels convert light into electricity. “They are called solar panels” as majority and powerful source for light is available at Sun, called Sol by astronomers. Particular scientists called as Photo Voltaic (PV) i.e. "light-electricity”. The term “solar panel” refers to absolute environmental friendly mechanism which takes sunlight and converts into useful energy like “electrical or thermal”. The other name is used interchangeably with the name "module". Panel is referred to as group of modules connected together as an outer installed unit. Two most important types of solar modules are one which is used for domestic or commercial are Solar PV modules that generate electricity and the other is the solar thermal collectors that convert solar energy into heat. Solar modules generate electricity with very little impact on environment when compared to other forms of electricity generation.

CONCENTRATED SOLAR POWER

Concentrated Solar Power (CSP) structure concentrate on sun energy with reflective arrangement like mirror structures to produce heat and generate electric power. CSP also can be called as “concentrating solar power”, “concentrated solar thermal”. This system generates electrical power by means of mirrors / lenses focusing huge area of sun rays or thermal power into a small area. Electricity is produced as the concentrated beam is transformed to heat. It drives a thermal engine (typically a steam turbine) coupled to electrical power generator or a thermo chemical reactor. There are four types of CSP schemes. Parabolic channel and linear Fresnel schemes center sunlight into linear receiver. The additional two technologies are dish engine and power tower that focuses on sunlight to an end.

All these technologies are used to convert sunlight to heat energy to utilize in thermal driven engine. CSP has capability of storing sun heat in form of thermal energy for utilizing when sun is not shining. Incorporating heat energy storage schemes cost of power generated from CSP can really be decreased and provide solar power depending on demand even during cloudy or at night times. The Energy conservation department is supporting R&D projects by funding to design and develop new heat transfer liquids that operate at extremely high temperatures of upto 2,350 degrees Fahrenheit. The projects on the process to increase efficiency and to decrease cost is also considerable.

8) Zigbee Communication

Zigbee is a communication device shown in Fig.9, is used in Personal Area Network (PAN) / device to device network. It can connect small packet devices. It has, low data rate, low power consumption, low cost, short transmission range, Scalability, Reliability, flexible protocol design. In this project, Digi XBee S2C is being used as an interface between PC and various components in the circuit. It is also used for controlling the various devices in the circuit.

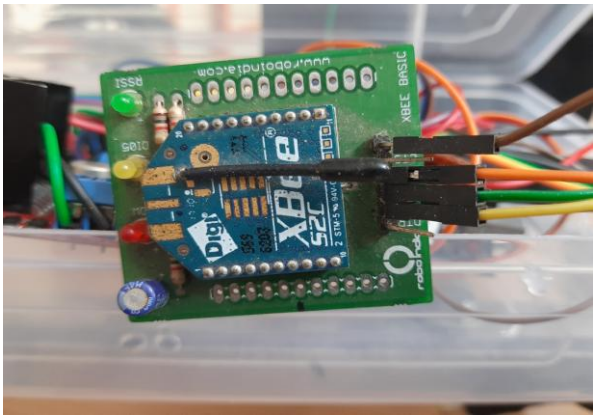

Fig. 9: XBee device

The flowchart for the program developed in Arduino Uno for controlling of DC gear motors and servomotor is indicated in Fig. 10.

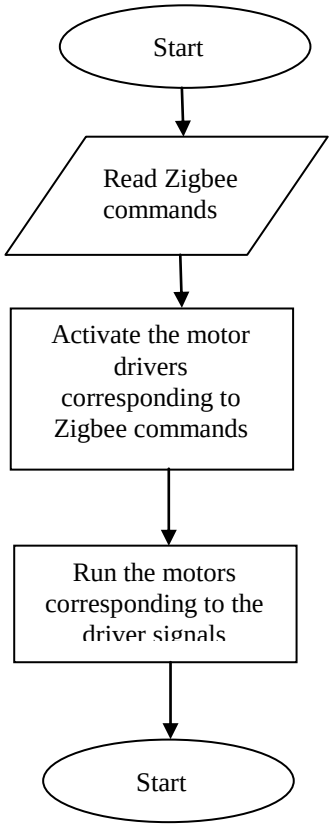

Fig.10 : Flowchart for Arduino Uno programming

9) Fabrication of seed sowing vehicle:

The vehicle is fabricated using the chassis made of M S sheet four aluminum tires with rubber casing are fitted. Each tire is powered by a DC gear motor. Aluminum material is used for storage funnel. Acrylic sheet is used as a base on which the electronic circuitry such as arduino uno board, drive power supply board, XBee device and battery are mounted. A 20W 12V solar panel is fitted above the chassis. Seed sowing mechanism is placed at the bottom of funnel. The fabricated setup is shown in Fig. 11(a) and 11(b).

Fig. 11(a) : Solar powered autonomous seed sowing vehicle

Fig. 11(b) : Solar powered autonomous seed sowing vehicle

IV. CONCLUSION

The designed autonomous vehicle is used for sowing the seeds. It is observed that the seeds have been sowed in a proper sequence. For efficient farming this vehicle can be utilized. The conventional farming accuracy is less. But utilizing this system will improve the accuracy and reduces demand for skilled labor. Compared to conventional method the sowing can be done rapidly with greater accuracy. The advantage with this seed sowing machine is that it can be programmed for any field conditions using microcontroller programming via PC or mobile, so as to make it perform the function autonomously.

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