

Development of Multi-purpose Agricultural Vehicle

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Abstract - The objective of the paper is to develop "Multi-Purpose Agriculture Vehicle". India has always been known for its agricultural products, quality and one of the key drivers of Indian economy. But since most of the farmers are poor and have smaller farms, there is a need to develop a portable agricultural vehicle which is affordable even for the poor farmers. Also the present agricultural vehicles which are developed have only single functionality i.e. either only seed sowing or water/fertilizer spraying or only ploughing mechanism. The main components of the multi-purpose vehicle are solar panel, battery, DC motor, centrifugal pump. The function of this agricultural vehicle depends on the amount of solar energy that the solar panel receives and this solar energy is used to drive the different parts of the vehicle. The crystal based solar panel is used to charge a rechargeable battery of 12 volts. From the battery the stored electrical energy is sent to DC motor which is used to drive it. The motor converts electrical energy to mechanical energy and this energy is used to perform different operations like water spraying, ploughing, seed sowing with the help of switch control mechanism. The power transmission is done by using various gear mechanisms such as simple spur gear, worm and spur gear mechanisms along with chain and sprocket mechanism. This vehicle reduces the human effort in the field of agriculture and finds a solution to increase the mechanization in the fields. This vehicle is mainly useful for small size farms in order to increase the productivity and runs on solar energy which is renewable and is easily available.

Keywords – Gear, Solar panel, Sprocket mechanism, centrifugal pump, DC motor

I. INTRODUCTION

India is an agriculture based country in which, 70% of people depends on the outcome of farming. The written history of agriculture in India dates back to the Rig-Veda. India ranks second worldwide in farm output. Still, agriculture is demographically the broadest economic sector and plays a significant role in the overall socio-economic fabric of India. In recent years if we compare production rate or efficiencies of Indian farms to other nations then we realize India certainly lagging behind. The main reasons for India to lag behind in the development in the field of agriculture are: Lack of proper mechanization in the farms, Smaller size of farms, Financially poor background of many farmers, Excess efforts required in performing various processes separately, Excess time required for performing individual processes separately, Unorganised farmlands in India. Because the consequence of the above mentioned problems, many farmers cannot afford to purchase heavy agricultural machines (vehicles) due to smaller size of lands and financial constraints. Also, the conventional equipment's and methods often require lot of human effort and multiple operations. Thus, agricultural mechanization is a necessary concept to improve the efficiency and reduce the cost of production.

Multifunctional agricultural vehicle deals with the problems faced by farmers i.e. seed sowing, fertilizers spraying, cultivation and digging. We are looking this project as revolution in small farms in India, which is most uncovered area in this sector, in a cost effective and more efficient way. These vehicles are capable of working 24 hours a day all year round, in most weather conditions. Moreover such a system may have less environmental impact if it can reduce over application of chemicals and high usage of energy, such as diesel and fertilizer, by control that is better matched to stochastic requirements. The inclusion of the solar panels to charge the battery and run the vehicle is also an added advantage by reducing the usage of fossil fuels. The main components of the vehicle are solar panel, battery, DC motor, centrifugal pump. The function of this agricultural vehicle depends on the amount of solar energy that the solar panel receives and this solar energy is used to drive the different parts of the vehicle. The crystal based solar panel is used to charge a rechargeable battery of 12 volts. From the battery the stored electrical energy is sent to DC motor which is used to drive it. The motor converts electrical energy to mechanical energy and this energy is used to perform different operations like water spraying, ploughing, seed sowing with the help of switch control mechanism. The power transmission is done by using various gear mechanisms such as simple spur

gear and worm and spur gear mechanisms along with chain and sprocket mechanism. Our model is designed in such a manner so that it can be run even in small farms and performs the various operations like digging and ploughing, water sprinkling, and seed sowing effectively.

II. METHODOLOGY

The objective of this project is to develop a multipurpose agricultural vehicle which can perform various agricultural operations such as ploughing and digging, seed sowing and water spraying. The vehicle is powered by solar energy, by collecting the energy from the sun and storing it in the battery. Thus, we can reduce the emissions caused by the usage of fossil fuels by utilizing solar energy. The various agricultural operations are controlled by electrical switches, each to drive the vehicle, to run the centrifugal pumps for water supply and to run the seed sowing mechanism.

2.1 Block diagram

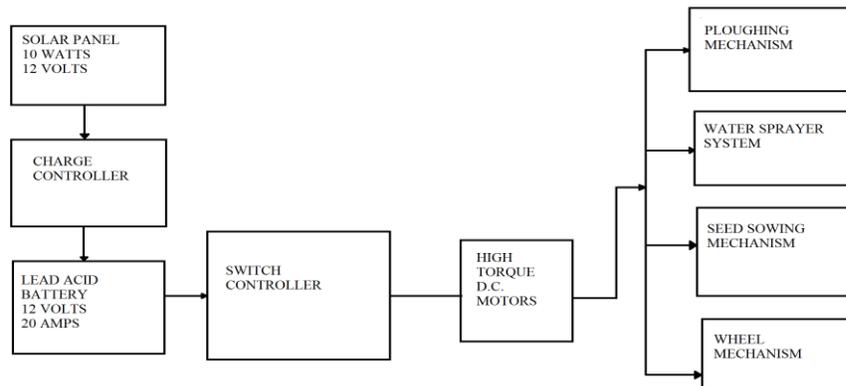


Figure 1. Multipurpose Agricultural Vehicle

2.2 Technical specifications

Solar panel: 1no. 12V photovoltaic cell, 10W

Battery: 1no. 12V, sealed lead acid, 7Ah

D.C. motor (high torque, side shaft) (Wheel forwarding): 1no. 12V, 1amp, 10rpm, internal shaft dia. 8 mm

Torque developed by high torque D.C. motor: 25-45 kgf

D.C. motor (Seeding mechanism): 1no. 12V, 60rpm

D.C. motor (worm and spur gear mechanism) (Ploughing mechanism): 1no. 60 rpm, 12V

Centrifugal pumps (spraying): 2 no. 12V, 1500 rpm

Mechanical frame: 1 no. length 30in., width 15in.

Chassis material: 1in.x1in. Square pipe

Wheels: 4 no. dia. 16 in.

Total weight capacity of the vehicle: 20 kg

Weight of the vehicle: 8-10 kg

2.3 Components

The main components used in the multipurpose agriculture vehicle are:

1. Chain Drive mechanism
2. Seed sowing unit
3. Water supply unit
4. Ploughing mechanism
5. Power supply unit
6. D.C. Motor
7. Chassis

2.3.1 Chain Drive mechanism

Sometimes the power is output by simply rotating the chain, which can be used to lift or drag objects. In other situations, a second gear is placed and the power is recovered by attaching shafts or hubs to this gear. By varying the diameter of the input and output gears with respect to each other, the gear ratio can be altered.



Figure 2. Chain Drive mechanism

The agricultural vehicle is driven by a dc motor. Two sprockets are coupled together using a chain drive. The dc motor is coupled to a sprocket which is mounted on the rear axle. Due to the rotation of the motor the sprockets rotate and rotate the rear axle. The rotation of the rear axle rotates the wheels which drive the vehicle forth.

2.3.2 Seed sowing unit

The seed sowing unit is made of three different parts. The first part is the seed container in which all the seeds are placed. The second part is a shaft upon which two spur gears is mounted containing a scoop like structure instead of the teeth.



Figure 3. Seed sowing unit

This scoop like structure ensures that each seed is scooped properly by the wheel and deposited to the deposition point marked by a funnel corresponding to each wheel. The seeds are directed through a pipe attached to the end of the funnel which directs the seeds to the soil at the end of the ploughing tool.

2.3.3 Water supply unit

A centrifugal pump converts input power to kinetic energy by accelerating liquid in a revolving device - an impeller. The most common is the volute pump - where fluid enters the pump through the eye of the impeller which rotates at high speed.



Figure 4. Water supply unit

The fluid accelerates radially outward from the pump chasing and a vacuum is created at the impellers eye that continuously draws more fluid into the pump. The water in the supplying unit is impelled out of the tub to the required point of the crops through the rubber tubes provided at the end of the nozzles provided at the outlet of the centrifugal pump. Two centrifugal pumps are provided at either sides of the supply unit to supply water on the either sides of the vehicle when it is moved across the farms. The amount of water supplied is controlled by control switches which are made connected to the centrifugal pumps and the battery unit. The water supply unit used here is nearly 5 litres capacity which runs on the centrifugal pumps running at 12V and a speed of 500rpm.

2.3.4 Ploughing mechanism

The ploughing mechanism is mounted near the frontal part of the vehicle such that the seeds can be sowed into the ploughed path of the soil.



Figure 5. Ploughing mechanism

The worm and spur gear mechanism is used to facilitate the movement of the jaws of the ploughing tool into the soil. The worm gear is turned using a D.C. motor which turns the spur gear or the worm wheel such a way that the small axel upon which the ploughing tool is mounted is moved up and down. The D.C. motor coupled to the worm gear is also connected to a switch controller mechanism, powered by the battery. This mechanism is used for power transmission in two perpendicular directions. The horizontal rotary motion of the shaft on which the ploughing tool is mounted can be converted in to the vertical motion of the tool.

2.3.5 Power supply unit

The power supply unit of this agricultural vehicle consists of a solar panel and a battery. The solar panel used is of 12V and provides a power of 10W. The solar panel is directly connected to the battery, charging it when it is left in the sun. The energy which is stored in the battery using the solar panel can be retrieved to run the vehicle and also the other auxiliaries in the absence of sun.



Figure 6. Power supply unit

To work, photovoltaic cells need to establish an electric field. Much like a magnetic field, which occurs due to opposite poles, an electric field occurs when opposite charges are separated. To get this field, manufacturers "dope" silicon with other materials, giving each slice of the sandwich a positive or negative electrical charge. In this vehicle the use of charge controller is eliminated as the power required to run the vehicle is low, which in turn decreases the current requirement from the battery. A couple of other components of the cell turn these electrons into usable power. Metal conductive plates on the sides of the cell collect the electrons and transfer them to wires. At that point, the electrons can flow like any other source of electricity.

2.3.6 D.C. motor

An Electric DC motor is a machine which converts electric energy into mechanical energy. The working of DC motor is based on the principle that when a current-carrying conductor is placed in a magnetic field, it experiences a mechanical force. The direction of mechanical force is given by Fleming's Left-hand Rule and its magnitude is given by $F = BIL$ Newton. There is no basic difference in the construction of a DC generator and a DC motor. In fact, the same D.C. machine can be used interchangeably as a generator or as a motor.



Figure 7. D.C. Motor

Like generators DC motors are also classified in to shunt-wound, series-wound and compound-wound motors are seldom used in ordinary applications because all electric supply companies furnish alternating current. However, for special applications such as in steel mills, mines and electric trains, it is advantageous to convert alternating current into direct current in order to use dc motors. The reason is that speed/torque characteristics of D.C. motors are much more superior to that of a.c. motors. Therefore, it is not surprising to note that for industrial drives, D.C. motors are as popular as 3-phase induction motors.

2.3.7 Chassis

The mechanical frame of the vehicle is made of mild steel rods of rectangular tube section. A chassis consists of an internal vehicle frame that supports an artificial object in its construction and use, can also provide protection for some internal parts. An example of a chassis is the underpart of a motor vehicle, consisting of the frame.



Figure 8. Chassis

If the running gear such as wheels and transmission, and sometimes even the driver's seat, are included, then the assembly is described as a rolling chassis. The mechanical frame has the length of 3feet, width of 2 feet and height of 15 feet. The complete chassis consists of four wheels, two mounted on each of the front and rear axles. The wheels are driven by the chain drive mechanism where the driving sprocket is rotated by a DC motor. The chassis is also customised in such a way that it can hold both water supplying unit and the seed carrying unit. The water supplying unit is placed at the bottom while the seed supplying unit is placed above it. The battery is placed near the rear axle of the vehicle. The solar panel is placed on the top of the vehicle to facilitate better exposure of the panel to the sun rays.

2.4 Working of prototype model

The agricultural vehicle is used for various purposes like water spraying, seed sowing, ploughing and digging. The agricultural vehicle consists of solar panel which receives the energy from the sun directly. The solar panel converts the solar energy into electrical energy by ejecting electrons and hole in the p-n junction by photo voltaic effect of semiconductor material. A lead acid battery is attached to the solar panel which stores this electrical energy in the form of chemical energy. The lead acid battery is connected to a switch control mechanism .This is further connected to various other mechanisms like seed sowing, ploughing mechanism and the water supply mechanism. In the seed sowing mechanism, the battery is connected to the D.C. motor which is coupled to a small axle. The D.C. motor converts the electrical energy from the battery to mechanical energy by the principle of electromagnetic induction. To this axle, two spur gear-like wheels are attached upon which scoop-like structures are attached at regular intervals on its periphery. The scoop ensures that the seeds will be dropped at required positions in the soil during the running condition.



Figure 9. Prototype model of multipurpose agricultural vehicle

In the ploughing mechanism, the battery is connected to the D.C. motor. This D.C. motor is connected to the worm and spur gear mechanism. This mechanism is used for power transmission in two perpendicular directions. The horizontal rotary motion of the shaft on which the ploughing tool is mounted can be converted into the vertical motion of the tool. In the water supply mechanism, the electrical energy from battery is used to run the centrifugal pumps by a switch control mechanism. The centrifugal pump propels the water from the water storage to the required points near the crops.

III. RESULT AND DISCUSSION

The “Multi-Purpose Agriculture Vehicle” aims to perform various agricultural operations. The developed model runs successfully performing all the agricultural operations, i.e. ploughing and digging, seed sowing and water sprayer both simultaneously and individually with the help of electrical switches. Also the use of solar power to run the vehicle is an added advantage being a renewable source of energy. Thus, being a multi-utility vehicle, it has other advantages like reduced manpower, increased rate of productivity and better efficiency as it is battery operated. It is cost effective which is affordable even for the poor farmers. Also by the use of effective seeding mechanism, the wastage of the seeds is reduced. The electrical switch mechanism makes it much easy to operate for the farmers. The vehicle can also be used for material handling and hence makes it feasible to move heavy loads.

IV. CONCLUSION

The “Multi-Purpose Agriculture Vehicle” aims to perform various operations of the agriculture, which are accomplished by using various components like solar panel, centrifugal pump, D.C. motor and motion transmission mechanisms. The various components required for building the multipurpose agricultural equipment has been designed as planned. Multipurpose agricultural vehicle is single system which can perform multi operations like sowing, water sprayer, ploughing and digging. It can also be used for local transportation purpose for material handling. Multipurpose agricultural vehicle will reduce external charges like fuels; electricity etc. and this will be helpful for poor farmers. Multipurpose agricultural vehicle is a single system which contains multi attachments. The equipment weight is around 8 to 10 kg thus it can be carried easily in farmland. The equipment can do the work of 4 labours a day which reduces the labour cost of the farmer.

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