Solar Powered Multipurpose Agricultural Robot

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ABSTRACT

In Modern world, Automation robot is used in many of the fields such as defence, surveillance, medical field, industries and so on. In this paper, the robot system is used to develop the process of cultivating agricultural land without the use of man power. The aim of the paper is to reduce the man power, time and increase the productivity rate. All the basic automation robot works like harvesting, feeding, crop cutting and so on. Here the designing systems like plough the land, sowing the seed and navigate the vehicle motion are preferred by this autonomous robot using microcontroller. Based on movement of this robot in the land, the android app helps in thereby performs turning the position of robot either in left or right or forward direction.

Keywords: Solar panel, ARDUINO, feeding, harvesting, crop cutting

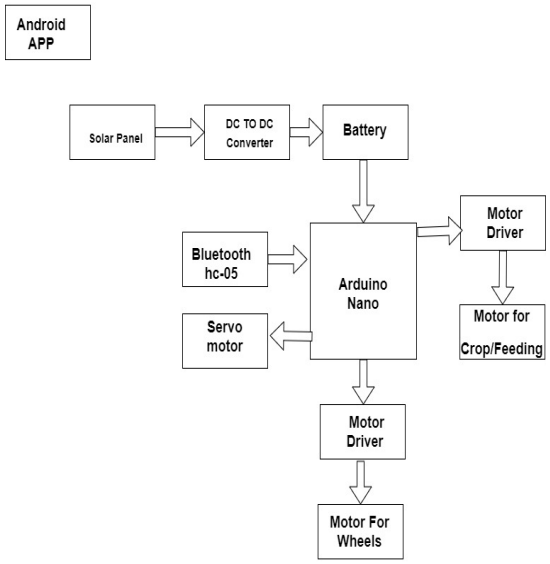
INTRODUCTION

India is agrarian economies and most of rural populations depend on agriculture to earn their livelihood. The farming methods at present are manual or semi-automatic with high involvement of labours. In the recent years, the number of labour availability is reducing continuously along with increase in their wages .There is a requirement of higher productivity. Hence the device is to be designed which helps farmers to overcome the stated problem.

Aimed at increasing the productivity and reducing the labour involved, the robot is designed to execute the basic functions required to be carried out in the farms. The robot starts its function by plough the field, then sows the seeds in the plougharea and to sow the seeds in the land and to cut the crops.

To reduce the human effort and increase the yield. The ploughing of firm and plantation of seeds and cutting crops is automatically done by using dc motor. The distance between the two seeds are controlled and varied by using microcontroller. When the robot reaches the end of the field we can change the direction with the help of android operation. The whole process is controlled by microcontroller. Ploughing of firm and seed plantation and cutting crops is our day to day life is done by tractor in farms. But it requires more time & the man power shortage is faced continuously. The main requirement of automation is to reduce man power in our country; the buzzword in all industrial firms generally involves electrical, electronic component as well as mechanical part. Automation saves a lot of tedious manual work and speeds up the production processes.

BLOCK DIAGRAM



WORKINGCIRCUIT DIAGRAMS:

Working:

The power is driven from the solar panel is converted to DC and is stored in the Lithium Battery. The output of the battery is connected to the Arduino Board input feed using a 7805 Voltage Regulator. The on and off power is regulated by a switch. The DC and Servo motors are connected to the output pins of Arduino Nano.

The device is controlled using an Android App. The app is featured with 4 buttons which represent the forward/backward/left and right movements of the device. For example, if the forward button is pushed a value of 'A' is sent from the app to the Arduino through the HC-05 module. The module has to be paired initially with the device through the app. The device when receives the string 'A', moves forward. Likewise for the back, right and left buttons.

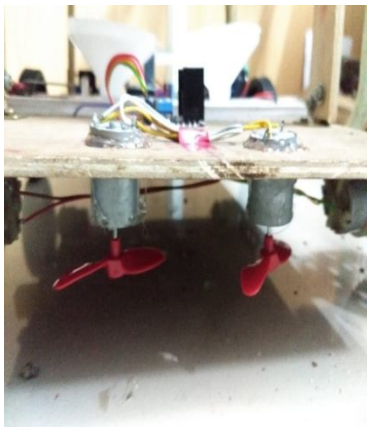
WORKING OF SOLAR BASED ULTIPURPOSE AGRICULTURAL ROBOT USING ANDROID APP

The power is driven from the solar panel is converted to DC and is stored in the Lithium Battery. The basic aim of this project is to develop a multipurpose machine, which is used for ploughing the soil[1], seed sawing, and crop cutting is also done in this robotic operation with least changes in accessories with minimum cost. This whole system of the robot works with the battery and solar power.

The basic frame is made for the robot with 4 wheels connected and driven the wheels with dc motor.

- One end of the farm, cultivator is fitted which is also driven by dc motor and design is made to plough the soil.
- Funnel is made by the sheet metal, to store the seeds and the seeds flow through the funnel through the drilled hole on the shaft to the ploughed soil.
- Solar panel is placed on top of the robot and is connected to the battery for charging the battery.

- Thus the max efficiency is utilized from the sun by the solar panel and to the battery.
- On the front the crop cutting blades are available to cut the crop.
- The whole robot requires the 12v battery to operate the system.
- Toggle switches are used to control the operation of the vehicle.



TYPES OF PLOUGHS:

- Wooden plough
- Subsoil plough
- Foot plough
- Steam plough
- Horrow plough
- Ard plough
- Loy plough

HARDWARE COMPONANTS

COMPONANTSREQUIRED:

1. HC-05 Bluetooth module
2. Arduino Nano
3. L298D driver
4. Solar panel
5. DC motors
6. Servo Motors
7. Mobile app
8. 3S Li battery
9. Manual Switch
10. Fiber sheet
11. Ply wood
12. Clamps
13. Nuts and Bolts
14. Wires
15. Wheels
16. Voltage regulator
17. Resister
18. LED Bulb
19. Capacitor
20. Rectifier

Generations of Solar Cells

First Generation: Crystalline Silicon Solar Cell Technology

First generation solar cells are the larger, silicon-based photovoltaic cells. Silicon's ability to remain a semiconductor at higher temperatures has made it a highly attractive raw material for solar panels. Silicon's abundance, however, does not ease the challenges of harvesting and processing it into a usable material for microchips and silicon panels. Solar cells, use silicon wafers consisting of Silicon or Germanium that are doped with Phosphorus and Boron in a pn-junction. Silicon cells have a quite high efficiency, but very pure silicon is needed, and due to the energy-requiring process, the price is high compared to the power output. Crystalline Silicon-Solar Cells-dominate 80-90%

of solar cell market due to their high efficiency, despite their high manufacturing costs.

Second Generation: Thin Film Solar Cell Technology

Second generation solar cell, also known as thin-film solar cell (TFSC) or thin-film photovoltaic cell (TFPV), is made by depositing one or more thin layers (thin films) of photovoltaic material on a substrate. They are significantly cheaper to produce than first generation cells but have lower efficiencies. The great advantage of thin-film solar cells, along with low cost, is their flexibility and versatility to be used in varied environments. This has led to aesthetically pleasing solar innovations such as solar shingles, solar glass and solar panels that can be rolled out onto a roof or other surface. The most successful second generation materials have been cadmium telluride (CdTe), copper indium gallium selenide(CIGS), amorphous silicon and micro amorphous silicon. The thickness range of such a layer is wide and varies from a few nanometers to tens of micrometers. These materials are applied in a thin film to a supporting substrate such as glass or ceramics reducing material mass and therefore costs. It is predicted that second generation cells will dominate the residential solar market.

Third Generation: Dye-Sensitized Solar Cell Technology

The electrochemical dye solar cell was invented in 1988 by Professor Graetzel of Lausanne Poly-technique, in Switzerland. The "Graetzel" dye cell uses dye molecules adsorbed in nano-crystalline oxide semiconductors, such as TiO2, to collect sunlight. Dye cells employ relatively inexpensive materials such as glass, Titania powder, and carbon powder. Graetzel's cell is composed of a porous layer of titanium dioxide nano-particles, covered with a molecular dye that absorbs sunlight, like the chlorophyll does in green leaves. Third generation solar cells are the cutting edge of solar technology. These solar cells can exceed the theoretical solar conversion efficiency limit for a single energy threshold material. Current research is targeting conversion efficiencies of 30-60% while retaining low cost materials and manufacturing techniques. Third generation contains a wide range of potential solar innovations including multi-junction solar cells, polymer solar cells, nano-crystalline-nano-wire cells, quantum dot solar cells and dye sensitized solar cells.

BATTERY:

Battery are a collection of one or more cells whose chemical reactions create a flow of electrons in a circuit. All batteries are made up of three basic components: an anode (the '-' side), a cathode (the '+' side), and some kind of electrolyte (a substance that chemically reacts with the anode and cathode).

When the anode and cathode of a battery is connected to a circuit, a chemical reaction takes place between the anode and the electrolyte. This reaction causes electrons to flow through the circuit and back into the cathode where another chemical reaction takes place. When the material in the cathode or anode is consumed or no longer able to be used in the reaction, the battery is unable to produce electricity. At that point, your battery is "dead."

Batteries that must be thrown away after use are known as **primary batteries**. Batteries that can be recharged are called **secondary batteries**.

Types of Batteries

NICKEL CADMIUM BATTERIES

The active components of a rechargeable NiCd battery in the charged state consist of nickel hydroxide (NiOOH) in the positive electrode and cadmium (Cd) in the negative electrode. For the electrolyte, potassium hydroxide (KOH) is normally used. Due to their low internal resistance and the very good current conducting properties, NiCd batteries can supply extremely high currents and can be recharged rapidly. These cells are capable of sustaining temperatures down to -20°C. The selection of the separator (nylon or polypropylene) and the electrolyte (KOH, LiOH, NaOH) influence the voltage conditions in the case of a high current discharge, the service life and the overcharging capability. In the case of misuse, a very high-pressure may arise quickly. For this reason, cells require a safety valve. NiCd cells generally offer a long service life thereby ensuring a high degree of economy.

NICKEL METAL HYDRIDE BATTERIES

The active components of a rechargeable NiMH battery in the charged state consist of nickel hydroxide (NiOOH) in the positive electrode and a hydrogen storing metal alloy (MH) in the negative electrode as well as a potassium hydroxide (KOH) electrolyte. Compared to rechargeable NiCd batteries, NiMH batteries have a higher energy density per volume and weight.

LITHIUM ION BATTERIES

The term lithium ion battery refers to a rechargeable battery where the negative electrode (anode) and positive electrode (cathode) materials serve as a host for the lithium ion (Li+). Lithium ions move from the anode to the cathode during discharge and are intercalated into (inserted into voids in the crystallographic structure of) the cathode. The ions reverse direction during charging. Since lithium ions are intercalated into host materials during charge or discharge, there is no free lithium metal within a lithium-ion cell. In a lithium ion cell, alternating layers of anode and cathode are separated by a porous film (separator). An electrolyte composed of an organic solvent and dissolved lithium salt provides the media for lithium ion transport. For most commercial lithium ion cells, the voltage range is approximately 3.0 V (discharged, or 0 % state-of-charge, SOC) to 4.2 V (fully charged, or 100% SOC).

SMALL SEALED LEAD ACID BATTERIES

Rechargeable small sealed lead acid (SSLA) batteries, which are valve-regulated lead acid batteries, (VRLA batteries) do not require regular addition of water to the cells, and vent less gas than flooded (wet) lead-acid batteries. SSLA batteries are sometimes referred to as “maintenance free” batteries. The reduced venting is an advantage since they can be used in confined or poorly ventilated spaces.

There are two types of VRLA batteries,

- Absorbed glass mat (AGM) battery
- Gel battery (“gel cell”)

An absorbed glass mat battery has the electrolyte absorbed in a fiber-glass mat separator. A gel cell has

the electrolyte mixed with silica dust to form an immobilized gel.

SSLA batteries include a safety pressure relief valve. As opposed to flooded batteries, a SSLA battery is designed not to spill its electrolyte if it is inverted.

In this project we have use the type of battery is lead acid battery.

Lead Acid Battery

Definition: The battery which uses sponge lead and lead peroxide for the conversion of the chemical energy into electrical power, such type of battery is called a lead acid battery. The lead acid battery is most commonly used in the power stations and substations because it has higher cell voltage and lower cost.

Construction of Lead Acid Battery

The various parts of the lead acid battery are shown below. The container and the plates are the main part of the lead acid battery. The container stores chemical energy which is converted into electrical energy by the help of the plates.

Container – The container of the lead acid battery is made of glass, lead lined wood, ebonite, the hard rubber of bituminous compound, ceramic materials or moulded plastics and are seated at the top to avoid the discharge of electrolyte. At the bottom of the container, there are four ribs, on two of them rest the positive plate and the others support the negative plates.

The prism serves as the support for the plates and at the same time protect them from a short-circuit. The material of which the battery containers are made should be resistant to sulfuric acid, should not deform or porous, or contain impurities which damage the electrolyte.

Plate – The plate of the lead-acid cell is of diverse design and they all consist some form of a grid which is made up of lead and the active material. The grid is essential for conducting the electric current and for distributing the current equally on the active material. If the current is not uniformly distributed, then the active material will loosen and fall out.

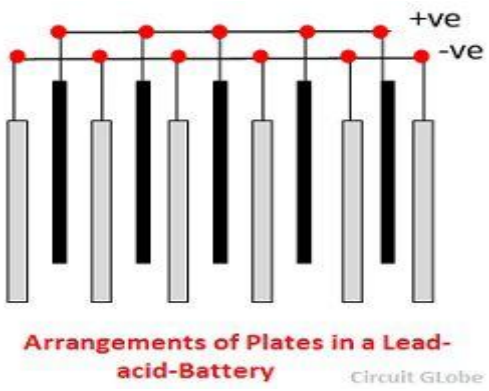


Fig: Arrangements of plates in a lead acid battery

The grids are made up of an alloy of lead and antimony. These are usually made with the transverse rib that crosses the places at a right angle or diagonally. The grid for the positive and negative plates are of the same design, but the grids for the negative plates are made lighter because they are not as essential for the uniform conduction of the current.

The plates of the battery are of two types. They are the formed plates or plante plates and pasted or faure plates. Plante's plates are used largely for stationary batteries as these are heavier in weight and more costly than the pasted plates. But the plates are

more durable and less liable to lose active material by rapid charging and discharging. The plantes plate has low capacity weight-ratio.

Faure process is much suitable for manufacturing of negative plates rather than positive plates. The negative active material is quite tough, and it undergoes a comparatively low change from charging and discharging.

L298D MOTOR DRIVE:

The L298N is a dual H-Bridge motor driver which allows speed and direction control of two DC motors at the same time. The module can drive DC motors that have voltages between 5 and 35V, with a peak current up to 2A.

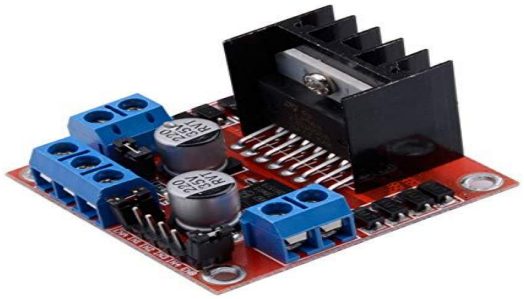


Fig:L298D MOTOR DRIVE

Let's take a closer look at the pinout of L298N module and explain how it works. The module has two screw terminal blocks for the motor A and B, and another screw terminal block for the Ground pin, the VCC for motor and a 5V pin which can either be an input or output.

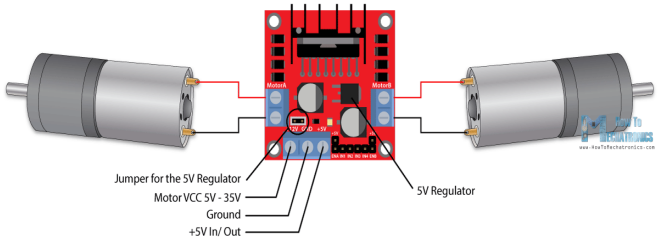


Fig:L298D MOTOR DRIVE input or output

This depends on the voltage used at the motors VCC. The module have an onboard 5V regulator which is either enabled or disabled using a jumper. If the motor supply voltage is up to 12V we can enable the 5V regulator and the 5V pin can be used as output, for example for powering our Arduino board. But if the motor voltage is greater than 12V we must disconnect the jumper because those voltages will cause damage to the onboard 5V regulator. In this case the 5V pin will be used as inputs as we need connect it to a 5V power supply in order the IC to work properly.

We can note here that this IC makes a voltage drop of about 2V. So for example, if we use a 12V power supply, the voltage at motors terminals will be about 10V, which means that we won't be able to get the maximum speed out of our 12V DC motor.

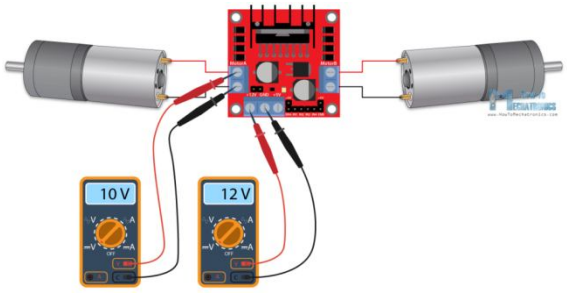


Fig: voltage input

Next are the logic control inputs. The Enable A and Enable B pins are used for enabling and controlling

the speed of the motor. If a jumper is present on this pin, the motor will be enabled and work at maximum speed, and if we remove the jumper we can connect a PWM input to this pin and in that way control the speed of the motor. If we connect this pin to a Ground the motor will be disabled.

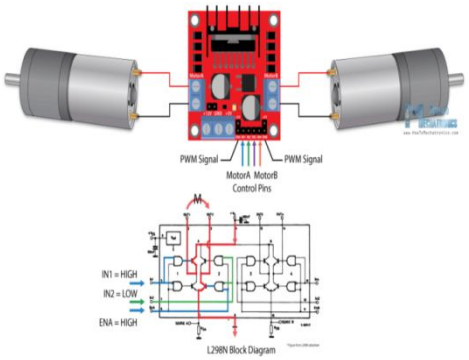


Fig: voltage input and out put

Next, the Input 1 and Input 2 pins are used for controlling the rotation direction of the motor A, and the inputs 3 and 4 for the motor B. Using these pins we actually control the switches of the H-Bridge inside the L298N IC. If input 1 is LOW and input 2 is HIGH the motor will move forward, and vice versa, if input 1 is HIGH and input 2 is LOW the motor will move backward. In case both inputs are same, either LOW or HIGH the motor will stop. The same applies for the inputs 3 and 4 and the motor B.

Arduino in L298N drive:

Now let's make some practical applications. In the first example we will control the speed of the motor using a potentiometer and change the rotation direction using a push button. Here's the circuit schematics.

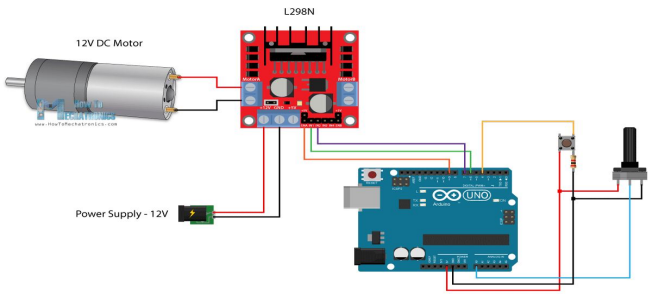


Fig:L298D MOTOR DRIVE CONNECTION TO ARDUINO

So we need an L298N driver, a DC motor, a potentiometer, a push button and an Arduino board.

VOLTAGE REGULATOR:

A voltage regulator is a system designed to automatically maintain a constant voltage level. A voltage regulator may use a simple feed-forward design or may include negative feedback. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages.

Electronic voltage regulators are found in devices such as computer power supplies where they stabilize the DC voltages used by the processor and other elements. In automobile alternators and central power station generator plants, voltage regulators control the output of the plant. In an electric power distribution system, voltage regulators may be installed at a substation or along distribution lines so that all customers receive steady voltage independent of how much power is drawn from the line.

RECTIFIER:

A rectifier is an electrical device that converts alternate current(AC), which periodically reverses direction, to direct current (DC), which flows in only one direction. The process is known as rectification, since it "straightens" the direction of current. Physically, rectifiers take a number of forms, including vacuum tube diodes, mercury arc values, stacks of copper and selenium oxide plates, semiconductor diodes, silicon control rectifier and other silicon-based semiconductor switches. Historically, even synchronous electromechanical switches and motors have been used. Early radio receivers, called crystal radios, used a "cat's wisker" of fine wire pressing on a crystal of galena (lead sulfide) to serve as a point-contact rectifier or "crystal detector".

Resistor

A resistor is an electrical component that limits or regulates the flow of electrical current in an electronic circuit. Resistors can also be used to provide a specific voltage for an active device such as a transistor.

CAPACITOR

A capacitor is a tool consisting of two conductive plates, each of which hosts an opposite charge. These plates are separated by a dielectric or other form of insulator, which helps them maintain an electric charge. There are several types of insulators used in capacitors. Examples include ceramic, polyester, tantalum air, and polystyrene. Other common capacitor insulators include air, paper, and plastic. Each effectively prevents the plates from touching each other. A capacitor is often used to store analogue signals and digital data. Another type of capacitor is used in the telecommunications equipment industry. This type of capacitor is able to adjust the frequency and tuning of telecommunications equipment and is often referred to a *variable capacitor*.

DC MOTOR:

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic; to periodically change the direction of current flow in part of the motor.

DC motors were the first type widely used, since they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight brushed motor used for portable power tools and appliances. Larger DC motors are used in propulsion of electric vehicles, elevator and hoists, or in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.

FIBER SHEET:

A polymer is generally manufactured by step-growth polymerization or addition polymerization. When combined with various agents to enhance or in any way alter the material properties of polymers, the result is referred to as a plastic. Composite

plastics refers to those types of plastics that result from bonding two or more homogeneous materials with different material properties to derive a final product with certain desired material and mechanical properties. Fibre-reinforced plastics are a category of composite plastics that specifically use fibre materials to mechanically enhance the strength and elasticity of plastics.

PLAY WOOD:

Plywood is a material manufactured from thin layers or "plies" of wood veneer that are glued together with adjacent layers having their wood grain rotated up to 90 degrees to one another. It is an engineered wood from the family of manufactured boards which includes medium-densityfibreboard (MDF) and particle board (chipboard).

APPLICATIONAS

- These multipurpose agricultural robots are mainly used in farming lands.
- It can also be used in green houses to plough the land and harvesting can also be done.
- It can also be used in nurseries for various purposes like seed sawing, ploughing the land for cultivating.

CONCLUSION

In agriculture, by using the solar powered multi-purposerobot. We can easily reduce the farmer efforts and time.The machine required less man power and less timecompared to traditional method. We hope this will satisfythe partial thrust of Indian agriculture. So in this way we can overcome the labor problem that is the need of today's farming in India.

In this robot ploughing, sowing seeds and cutting crops operations can also be done. It is simply controlled easily in android phone Bluetooth operation and simple to operate and to do the work.

FUTURE SCOPE

In this paper author tried to present related work of agricultural robot as labor problem can be reduced as compared to the manual and tractor based sowing time, energy required for this robot machine is less. At the same time by using solar energy environment pollution can also be reduced. Rests of modules are pending, such as flow chart ,programming, graph plots and output result of the agricultural robot. It will publish in next paper. In future this can be controlled based on Internet of Things (IOT) such as GPS and Wi-Fi controllable devises

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