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DESIGN AND ANALYSIS OF SOLAR PANEL CLEANING ROBOTIC ARM

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Abstract
The fundamental objective of our project is to design and analyse the robotic arm employed for solar cleaning process. Usually, solar panels have an high durability and it long last upto 25-30 years performance without any maintenance. So, the water used for this purpose is very huge gallons of water are being used for this maintainance. In order to reduce the wastage of gallons of water , the robotic arm is to be made and be used for cleaning of solar panel by wiper and Sprinkler. It takes very less litres of water to clean the dust. Thus, by a continuous movement of robotic arm cleans the panel efficiently to increase it's efficiency. This can be solved by fully automated permanent setup solar panel cleaning system with water. It uses soft powerful nylon brushes to clean the panels and has a sprinkler controlled by solenoid valve. In conclusion, it is found that robotic cleaning and heat reduction can help in maintain the solar panel efficiency. In future it can be provided as a permanent cleaning robot at time of installation along with panel frame, dust detection sensor, temperature sensor and camera surveillance, connected centrally.

Introduction
Your solar panels need to be exposed to sunlight in order to produce power. However, unless you live somewhere with high amounts of smog, dust, dirt or sand blowing around, solar panel cleaning is generally not necessary. In most cases, occasional rain will be enough to naturally and safely keep your solar panels clean and free of debris that could lower production. It may be a good idea to freshen up your panels occasionally if you live in an area with heavy particulates in the air. Here are answers to some of the top questions solar panel system owners have about cleaning solar panels and how to do it safely.

Fig 1.1: Row of solar panel

Solar panels work by allowing light into the solar cells. The more light that hits a panel, the more power it will generate. Due to the upwards angle of solar panels, they are more prone to bird droppings and a build-up of general dust and dirt that does not wash off with just rain. This reduces the amount of light hitting the panel and reduces its output. As the projected energy figures claimed by solar panel manufacturers and installers are based on the optimum performance of clean solar panels, this build-up of dirt can adversely affect the panel's ability to meet those projections. So it is important to clean solar panels in order to protect and maintain your investment. Regular solar panel cleaning will also hel`p you to make the most of the government feed-in tariff. While solar panel cleaning in the UK is relatively new, in other parts of the world solar panel cleaning has been around for a long time. Early adopters of the technology soon realised that if their solar panels were not cleaned regularly, they would not run at their optimum performance. There has been study in the U.S. suggesting solar panel cleaning is not necessary in some of their climate, but it is proved that solar panel cleaning is necessary in the UK.

Methods and Experimental Work

The proposed solar panel cleaning robot moves with a guide way and movable support on the solar panel and sprinkle water in the required area of the panel with the help of a pump. Its operation is controlled by a microcontroller. The robot rolls along the guide way of each array with the help of wheels. The wheels are made to rotate at 500 rpm which is driven by a motor. The driving motors are connected to the motor driver circuit which is in turn controlled by the microcontroller board. The microcontroller board plays a vital role in automating and controlling the solar panel cleaning robot. The action performed by the robot is linear motion in the forward and backward directions. These actions are fed into the microcontroller board with the help of a suitable program. The water is sprayed through the mist nozzles from the water container with high pressure created by the solenoid valve. Tracks and guide ways provide the necessary support and transport of the system. The robot is elevated to the same height as that of the solar panels and is placed on the support which is at the same inclination as that of the solar panels.

GEAR MECHANISM

Gears are a very useful type of transmission mechanism used to transmit rotation from one axis to another. As I mentioned previously, you can use gears to change the output speed of a shaft. Say you have a motor that spins at 100 rotations per minute, and you only want it to spin at 50 rotations per minute. You can use a system of gears to reduce the speed (and likewise increase the torque) so that the output shaft spins at half the speed of the motor. Gears are commonly used in high load situations because The teeth of a gear allow for more fine, discrete control over movement of a shaft, which is one advantage gears have over most pulley systems. Gears can be used to transmit rotation from one axis to another, and special types of gears can allow for the transfer of motion to non-parallel axes.

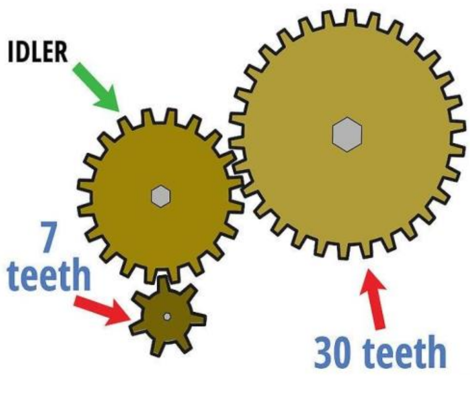

Fig 2.1 Gear mechanism

GEAR TRAIN

As its name suggests, a "gear train" can also be made from a long sequence of gears — not just a single driver gear and a single driven gear. In these cases, the first gear remains the driver gear, the last gear remains the driven gear, and the ones in the middle become "idler gears." These are often used to change the direction of rotation or to connect two gears when direct gearing.It would make them unwieldy or not readily available. Let's say for example purposes that the two- gear train described above is now driven by a small seven-toothed gear. In this case, the 30-toothed gear remains the driven gear and the 20-toothed gear (which was the driver before) is now an idler gear.

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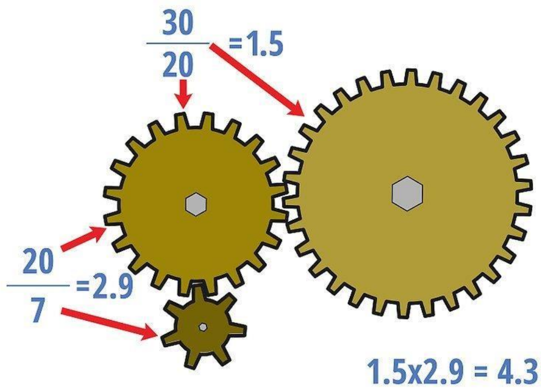

Fig 2.2 Gear chain

RELAY PRINCIPLE

It works on the principle of an electromagnetic attraction. When the circuit of the relay senses the fault current, it energises the electromagnetic field which produces the temporary magnetic field. This magnetic field moves the relay armature for opening or closing the connections. The small power relay has only one contacts, and the high power relay has two contacts for opening the switch.

The inner section of the relay is shown in the figure below. It has an iron core which is wound by a control coil. The power supply is given to the coil through the contacts of the load and the control switch. The current flows through the coil produces the magnetic field around it. Due to this magnetic field, the upper arm of the magnet attracts the lower arm. Hence close the circuit, which makes the current flow through the load. If the contact is already closed, then it moves oppositely and hence open the contacts. The pole and throws are the configurations of the relay, where the pole is the switch, and the throw is the number of connections. The single pole, the single throw is the simplest type of relay which has only one switch and only one possible connection. Similarly, the single pole double throw relay has a one switch and two possible connections.

Bearing – The bearing may be a single ball, multi-ball, pivot-ball and jewel bearing. The single ball bearing is used for high sensitivity and low friction. The multi-ball bearing provides low friction and greater resistance to shock.

Electromechanical design – The electromechanical design includes the design of the magnetic circuit and the mechanical attachment of core, yoke and armature. The reluctance of the magnetic path is kept minimum for making the circuit more efficient. The electromagnet is made up of soft iron, and the coil current is usually restricted to 5A and the coil voltage to 220V.

Terminations and Housing – The assembly of an armature with the magnet and the base is made with the help of spring. The spring is insulated from the armature by moulded blocks which provide dimensional stability. The fixed contacts are usually spot welded on the terminal link.

SOLENOID VALVE MECHANISM

The solenoid valve is constituted by the solenoid coil and magnetic core. It is the valve body containing one or several holes. When the coil is get through or cut off with power, the operation of the magnetic core will result in that the fluid passes through the valve body and is cut off, so asto reach the goal of changing the fluid direction. The electromagnetic component of the solenoid valve is constituted by the fixed iron core, movable iron core, coil and so on. The valve body is constituted by the slide valve core, slide valve harness and spring base. The solenoid coil is installed on the valve body directly while the valve body is enclosed in the seal pipe, so as to constitute a simple and compact combination

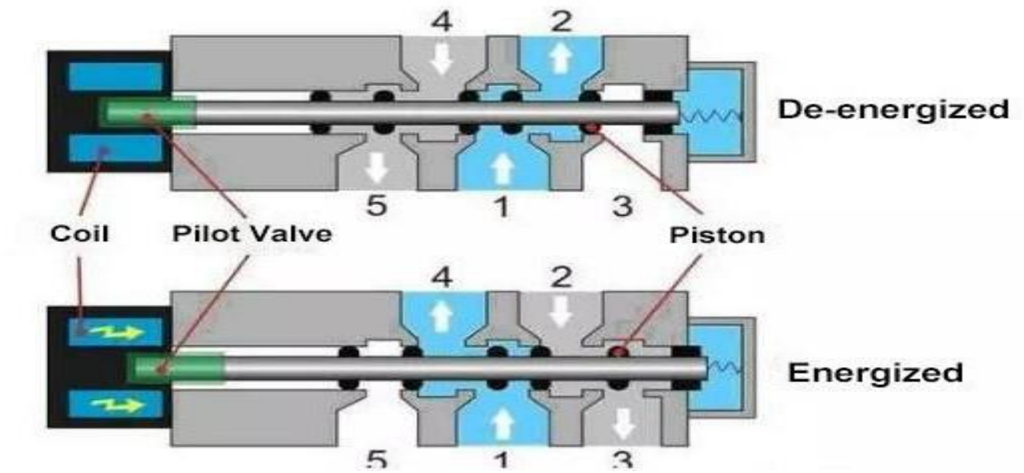

Fig 2.4 Solenoid valve mechanism

How a solenoid valve works?

The solenoid valve has an enclosed chamber inside and ventilated holes in different positions. Every hole is connected with different oil pipes. The chamber has a piston in the middle. The two sides are two pieces of electromagnets. The electrifying magnetic coil will attract the valve body to its side, so that different oil outlets will be opened or closed through controlling the movement of the valve body. However, the oil inlet is constantly open. The hydraulic oil will enter into different draw-off pipes.

Conclusion

Dust accumulation on PV panels can significantly reduce their power output. While the Geographic region is solar-energy rich, the desert conditions are quite dusty threatening the PV systems power generation potential. The robotic system proposed by us providesa simple way to tackle this challenge effectively. Although promising results will be obtained. Here we are going to set a newbenchmark by using latest technology and replacing the conventional methods of cleaning the solar panels. We are saving water, time and money. In general, the technique used by other method explain above total cost of solar panel maintenance goes around 5% of total plant cost annually but cleaning done by robot reduced it by 2%. The robot of this kind can clean the solar farm as and when require very easily without man power thus saving the cost and wastage of water.

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