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Automatic Solar Panel Cleaning Robot

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Abstract: *Solar energy, which is one of the renewable energy sources, has an important role in meeting the increasing electrical energy demand of our globe.Extracting maximum energy from the sun continuously reduces installation costs and makes it easier to meet the demand for peak electrical power. Physical condition such as muddy rain, snow, and dusting take place between the solar panel and the sun. this situation results in a reduced electric power extraction level that affect the cost of production. The efficiency and rate of production can be increased technically with a clean solar panel surface. Therefore, it is also very important to keep the solar panels clean as well as the maximum power point tracking devices. In this study, a solar panel cleaning robot (SPCR)has designed and tested in real time. The designed dual-motor and crawler robot moves horizontally and the cleaning brush runs on the vertical axis. in addition, the length of the solar panel array can be detected by position switches to keep the SPCR in the desired working area.*

Keywords: Solar, Clean Energy, Solar Cleaning, Robot, Mobile Robot. etc

I. INTRODUCTION

Each and every the need for electric energy is increasing tremendously.Most conventional sources like thermal power and nuclear power are commercially used to generate electric power but those power plants result in emission of unwanted gas into the atmosphere and create many problems for both the environment and people. But, non-conventional methods like solar energy, wind energy, tidal energy is eco-friendly, in which solar power generation is effective and has cost benefit.In a solar panel, some constraint such as dust, humidity, and wrong tilt affect the throughput. In automated solar PV panels rotation, solar PV panel cleaning aims for automation and is widely used to reduce the barriers against the maximum throughput as well as efficiency. This paper reveals all the direct and indirect constraints which will affect the efficacy of the automated solar energy generation system. Here, it deeply explains the hurdles in cleaning solar panels automatically.

1.1 Structure Of Solar Panel Cleaning Robot:

This solar panel cleaning robot aims to maintain the efficiency of solar power production by making sure of the cleanliness of solar panels without putting human at risk. Cleaning solar panel reduces dust, debris and other contaminants such as leaves and bugs which could further reduce efficiency. As climate change and global warming threaten our planets future, finding a sustainable way to fulfil our energy requirements is becoming increasingly crucial.
The proposed solar panel cleaning robot is used to remove the dirt and dust deposited on the solar panel thus helping the solar panel to absorb the maximum quantity of energy.

II. RELATED WORK

1 Overview of solar panel cleaning method: The continuous cleaning and monitoring of solar panels after installation on a roof or at a remote solar farm is difficult. The solar panel currently be cleaned using a variety of techniques, including the traditional method of brushing away dust, coating processes, and robotic cleaning devices. This process has been automated since cleaning with manual brushes and water is incredibly time and labor-consuming and costly for industrial solar installation. An automated cleaning system for solar panels is composed of an autonomous unit using sensors and a controller and a cleaning mechanism unit that can be watered or waterless. Solar panels can clean several methods of removing dust. Following are the part of three- solar panel cleaning methods: 1) Natural Cleaning 2) Manual Cleaning 3) Automatic Cleaning

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2. Natural Cleaning: Natural removal of dust includes wind, gravity, rain, and dew. To effectively utilize gravity, PV arrays have to be turned vertically or inclined at a high angle during the night time, rainfalls, or during dust storms. This requires powered (and possibly automated) turning mechanism. Mechanical means include brushing, blowing, vibration, and ultrasonic driving.

2.1 Rain: Cleaning your solar panels is easy. In fact, rain does a gread job of cleaning your solar panel for you. Otherwise, in some time of heavy dust or other resional issue, you may have to rins your solar panels to clear the dust and debris.

2.2 Wind: High wind can effectively clean large dust particles. High speed wind decrease the temperature and the ambient relative humidity of the PV panel. High speed wind reduces the moisture and increases the dryness of the PV panel surface reducing dust deposition.

2.3 Manual Cleaning: This method requires a human operator to clean manually with the help of mope or any wipers with suitable support structures as shown in fig.2.1. The quality of the cleaned surface is judged by the visual method by the operator himself for a satisfactory level or till the dust particles get wiped out completely. The process is found to be very tedious and challenging as the solar power plants consist of several panels installed at height of 12 to20feet or more from the ground. The time required and the safety of the person and panel are under threat. To clean the panels manually the fluids like cleaners or gels have to be used which act upon the panel and reduce the surface transparency if cleaning is not proper. There are quite chances of physical damage to the PV panels which cannot be avoided.

2.4 Water Soft Cloth Wipping: In this case use a soft spong or micro- fiber cloth or a very soft bristle, non- conductive, nonabrasive brush. Rinse the module subsequently with a plenty of water. Never, ever scratch/ scrub the surface of the solar panel to remove stains. This irreversibly damage the ARC i.e 'Anti- Reflective Coating' on the glass of the panel.

3. Automatic Cleaning: Solar panel attracts atmospheric dust and this dust can build up over time to compromise the panel's efficiency resulting in reduced power output significantly. At solabot, we recommend using automatic solar panel cleaners to maintain panel efficiency and achieve optimum power output. Automated systems are more convenient and affordable than wet cleaning, especially if the client has large PV plant. The initial automatic solar panel cleaning system price might seem like a hefty investment but it would be worth the value if you consider it for the long term. When people of dust in cleaning system, they want safe and efficient system. The Solabot team explain everything a client needs to know before making a purchase decision. Here's a brief introduction to how an automatic solar panel cleaner works. Automatic Cleaning is divided into three methods, (e.g) using microcontroller, IOT, Arudino.

3.1 Using Microcontroller: The solar PV modules are generally employed in dusty environments which is the case in tropical countries like India. The dust gets accumulated on the front surface of the module and blocks the incident light from the sun. It reduces the power generation capacity of the module. The power output reduces as much as by 50% if the module not cleaned for a month. In order to regularly clean the dust, a automatic cleaning system has been designed, which senses the dust on the solar panel and also clean the module automatically. This automated system is implemented using 8051 microcontroller which controls the DC gear motor. This mechanism consist of a sensor(LDR). While for cleaning the PV modules, a mechanism consist of a sliding brushes has been developed. In terms of daily generation , represented automatic- cleaning scheme provides about 30% more energy output when compared to the dust accumulated PV module.

3.2 Using IOT: In this case, water is forcedly spray from up to down and simultaneously wiper wipe solar panel and dirty water flows it away at the bottom edge of the solar panel. In this case, the sprinkler sprinkles the water on the panels which is cleaned by the brushes moving on the panels. The water for the sprinkler is drawn from a water reservoir but if this system is installed at canal top solar plants then no added water reservoir is required as it can draw water from the canal for cleaning purpose.

3.3 Using Arudino: Solar power is mainly harnessed from photovoltaic (PV) panels which are arranged multiple arrays in a solar farm or solar system. Though, power generation from solar PV solar system is characterised by uncertain efficiency, many countries with high insulation prefer solar as alternative way of generating clean energy. However, the efficiency of energy generated from PV panels is affected by the accumulation of dust and debris, even on one panel in an array. This condition leads to the need for regular cleaning of the surface of PV panels. Current labour- based

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cleaning method for photovoltaic arrays are costly in time, water and energy uses as well as lacking in automation capabilities. To overcome this problem, a fully automated solar panel cleaning system with/without water is proposed. Hence, in this project we designed of a robot for automated cleaning of the surface of PV panel is presented. The design utilize an arduino controller system to control the robot movement during the cleaning process.

III. METHODOLOGY

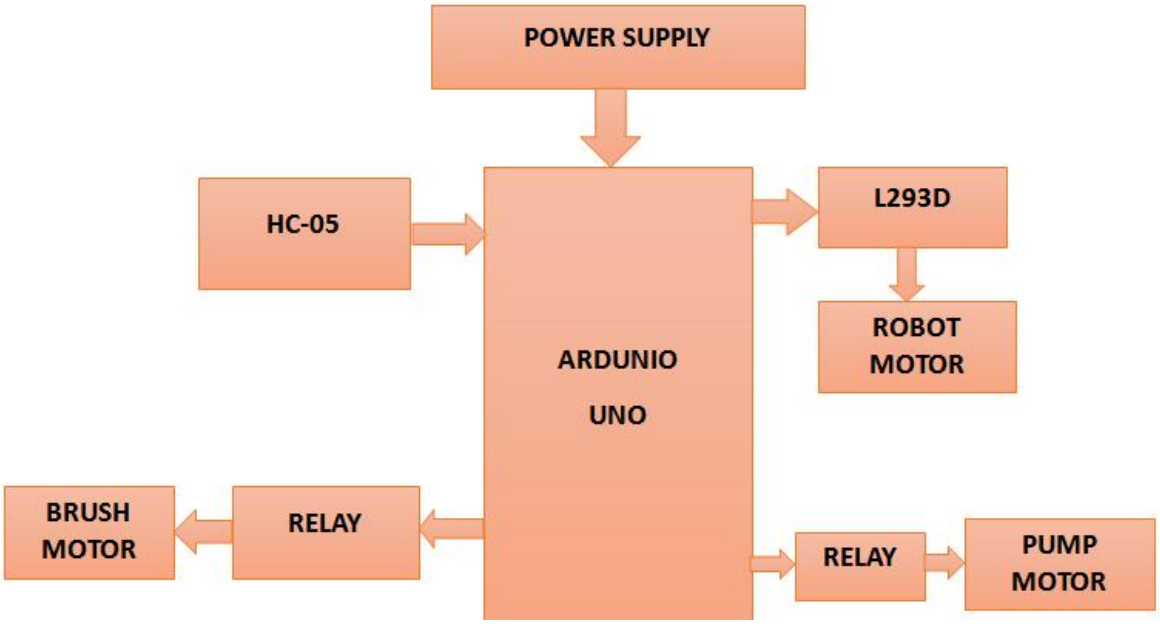

Fig. 3.1 Basic block diagram of solar robot.

In this controller the Arduino given 12 V, 1.3 A. Power supply and the fix power source battery. HC-05 is wireless Bluetooth controller. We can also use Bluetooth model communication the controlled remote communication for the Arduino (micro-controller) remote controlling purpose the Bluetooth model in mobile app and mobile app connected to the Bluetooth model wireless connection.

Arduino uno is the heart of the project. In this project program will be done Arduino id software. It is also controlling the relay and motor driver circuit. L293D is a motor drive it is used to controlling the four-gear motor for driving the motor and the forward, backward, reverse, left, right position of the robot car. L293D also use the water pulling to pump motor.

Real driver uses for the on/off the motor in this project we used two relays. Relay control by the Arduino.

3.1 Algorithm

Step 1: Overall Collection of information about the project and also about its software and hardware.
Step 2:Design of its hardware part.
Step 3:Robot operating system and other functioning.
Step 4:Controlling action of hardware through the Arduino.
Step 5:Simulation of all projects.
Step 6:Final result.
Step 7:Prototype.

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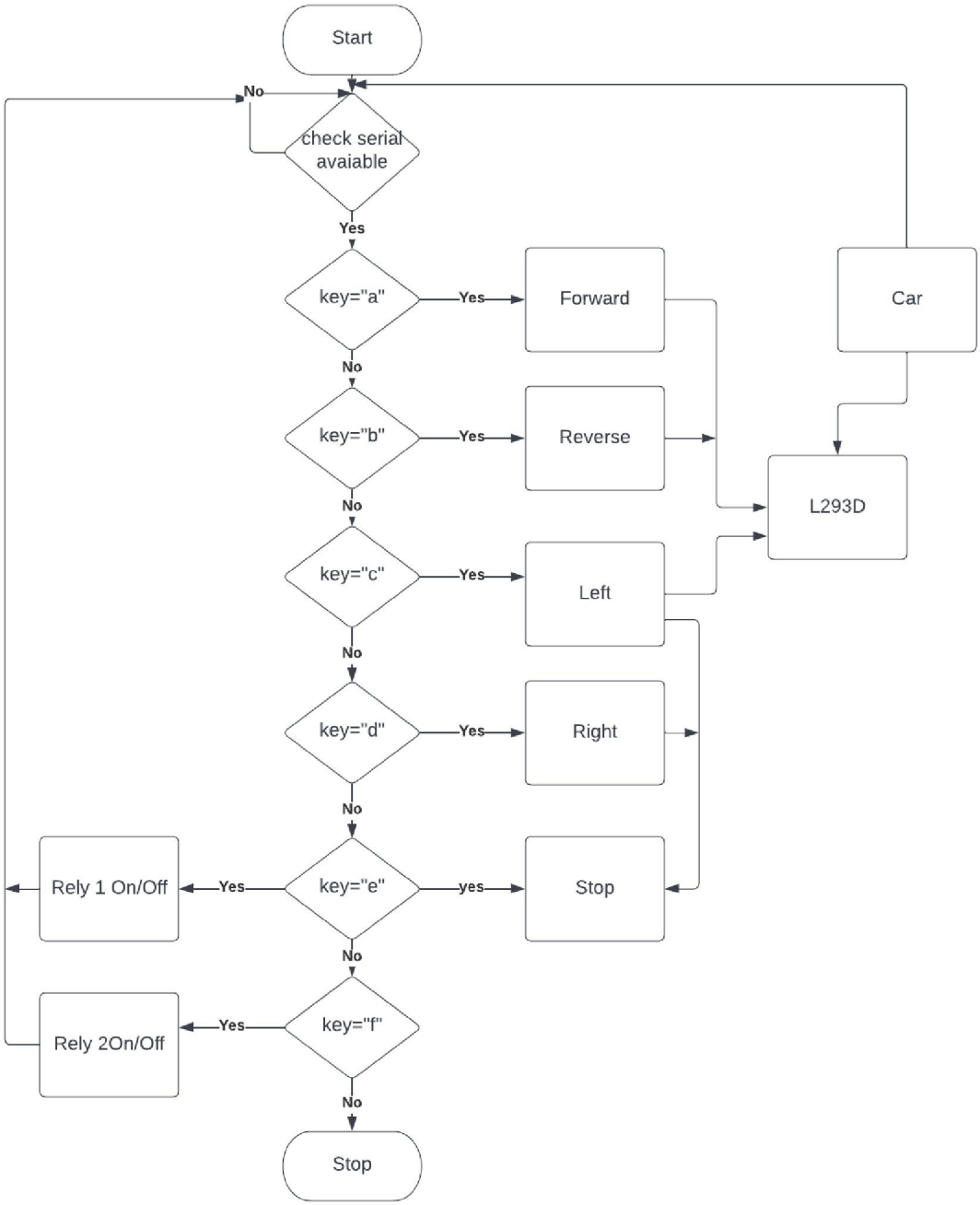
3.2 Flowchart



IV. RESULT AND DISCUSSION

In this controller the Arduino given 12 V, 1.3 A. Power supply and the fix power source battery. HC-05 is wireless Bluetooth controller. We can also use Bluetooth model communication the controlled remote communication for the Arduino (micro-controller) remote controlling purpose the Bluetooth model in mobile app and mobile app connected to the Bluetooth model wireless connection.

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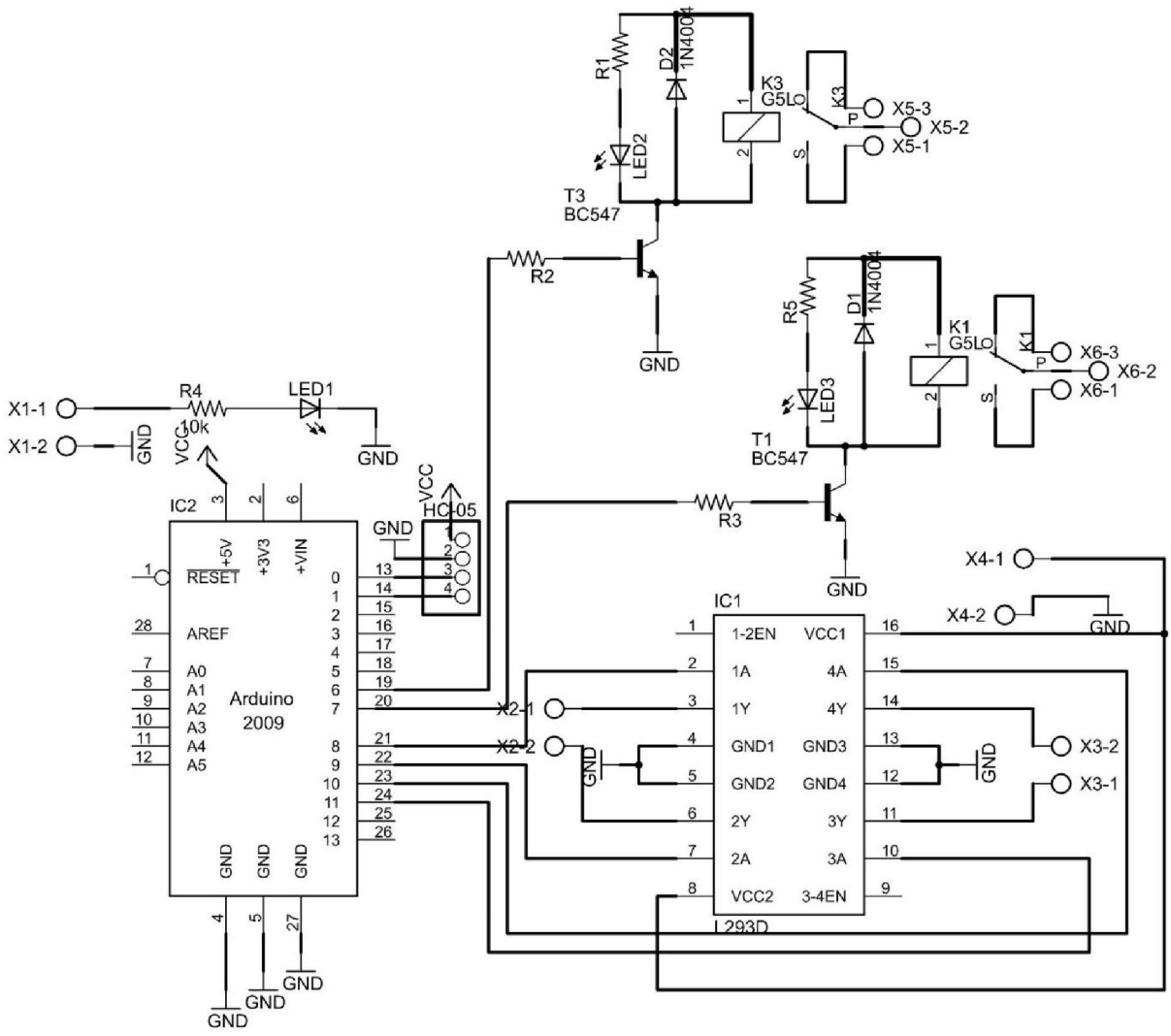

Fig. 5.1 Circuit Diagram of Automatic Solar Panel Cleaning Robot

Relay driver use for the on/off the motor in this project we used two relays. Relay control by the Arduino.

Fig. a Without Cleaning Solar Panel

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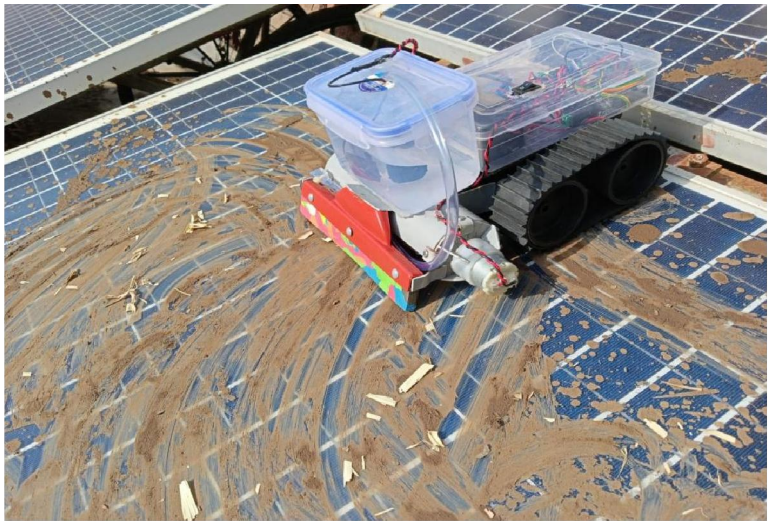

Fig. b Cleaning Processing Start of The Solar Panel

Fig. C Cleaning Processing of Solar Panel

Fig. d After Cleaning of The Solar Panel

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The proposed solar panel cleaning system is automatic system. The architectural design is seen in this system including solar panel, cleaning shaft. A 250W solar panel model is used here. The output of the solar panel depends on the sunlight. The output voltage of the converter is set at 12V dc. Therefore, the variation of the sunlight does not have any effect on the output voltage two reference lines are set for the movement of the cleaning shaft. Each line consists of two motors and wheels. When the sunlight comes out, microcontroller and LDR measure the value and the whole system is designed in a such a way that the system will start its operation at the beginning of the day typically between 10-11 am. Every morning, the proposed system tracks the sunlight first starting its operation even though there are no dust on the panel surface. Therefore, the proposed system is effective for any type of dust. Figure d shows that the full experimental setup of the proposed solar panel cleaner.

Experimental result validate that the proposed solar panel cleaning system works efficiently at desired level. System efficiency and numbers of swept depending on the type of sand. The efficiency of the system is around 87%, 91%, 92% and 96% for sand 1, sand2 and sand 3 respectively. The proposed system works with water. The proposed system is inexpensive and made with handy components. Performance comparison of the proposed solar panel during normal, dust and dust wiped condition is showed in table.

Condition	Output Voltage [V]
Normal with dust	36.2
Sand 1	33.7
Sand 2	33.9
Sand 3	34.3
Sand 4	34.5
After cleaning	36.4

Table 5.1 Condition and Output Voltage

It is evident from table 5.1 that the proposed solar panel cleaning system provides almost same amount of voltage after cleaning.

VI. DISCUSSION

The robot worked at the departmental level. When visitors came to the department, they could easily obtain information from the robot. The robot had delivered precise information in both audio and visual formats, making for an amazing experience for the visitors. We anticipated that the robot would perform best in a busy environment due to its capacity to avoid obstacles. However, when the robot encounters additional impediments, it becomes confused and becomes trapped in place. The functioning of the robot is restarted after a time interval. The robot proved successful in imparting knowledge to the guest. As soon as the robot received the visitor's instruction, it began working on it. If the visitor expects information in visual form, the robot will present it on screen in visual form, and if the visitor expects information in audio form, the robot will deliver it in audio form. Robot has provided material in both formats at many spots.

VII. CONCLUSION

In this project, a fully assembled solar panel cleaning robot has been developed. The control algorithm and cleaning sequence are established with the Arduino platform. The robot is designed to be fully powered by rechargeable batteries. The experiment and verification results demonstrated the functionality of the cleaning robot to performed its duty. The solar output power is successfully restored to it’s maximum power capacity after the cleaning process, even though there are slight losses due to some glitch error in the system. The 50% improvement at the output current as well as the maximum power before and after cleaning reveal that the robot guarantees the effectiveness of the developed robot.

VIII. FUTURE SCOPE

The device that is developed, reduce the number of works needed to clean the arrays significantly. Future development would be done to optimize the system to be smaller lighter and easier to assemble in high volume and to become more

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use- friendly. The next focus will be on diversifying the robot functionality by include automatic inspection, communication and self-diagnostic features. The panels since the cleaning head is in direct contact with very individually panel. Soil spots just under the glasses surface will indicate a section of panel that remains uncleaned and will prompt the cleaner to make other past if needed.

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