Journal of Image Processing and Intelligent Remote Sensing
ISSN: 2815-0953
Vol: 04, No.03, April-May 2024
http://journal.hmjournals.com/index.php/JIPIRS
DOI: https://doi.org/10.55529/jipirs.43.14.25

Solar Based Floor Cleaning Robot Using IOT

K. Nirosha[1], K. Sai Harshini[2*], K. Divya[3], K. Nikitha Reddy[4], P. Snigdha Reddy[5]

[1,2,3,4,5]Assistant Professor, Department of Artificial Intelligence, Vidya Jyothi Institute of Technology, Hyderabad, Telangana, India.*

Email: [1]nirosha.kunduru@gmail.com, [3]kolupuladivya@gmail.com, [4]kothagadinikitha@gmail.com, [5]snigdhareddy2509@gmail.com
Corresponding Email: [2]saiharshinikatroju@gmail.com*

Received: 28 November 2023 **Accepted:** 14 February 2024 **Published:** 01 April 2024

Abstract*: *This project introduces a new type of robot, Solar-Powered Autonomous Floor Cleaning Robot in response to the increasing demand of sustainable and energy-efficient solutions in robotics. The robot is designed to move on its own indoors, outdoors and clean different types of floors while getting power from solar panels that are integrated into its body. By using this method, it tries to reduce the impact on the environment that comes with conventional cleaning methods as well as increase the efficiency of floor maintenance generally.The primary objective of the proposed robot is to address the challenge of maintaining optimal efficiency in solar energy harvesting by ensuring the cleanliness of solar panels in industrial environments. The robot incorporates autonomous navigation and cleaning capabilities, employing advanced sensors and artificial intelligence algorithms to detect and navigate around obstacles while efficiently cleaning the solar panel surfaces.The robot's design emphasizes modularity and scalability, allowing it to adapt to diverse industrial environments and solar panel configurations. Equipped with cleaning brushes and a water-efficient system, the robot ensures thorough cleaning without causing damage to the solar panels. Additionally, the integration of real-time monitoring capabilities enables remote tracking of cleaning operations and assessment of overall system performance.

Keywords: Solar Panel, Rf Module, Floor Cleaning Robot, Autonomous Robot, Ultrasonic Sensor, Proximity Sensor.

1. INTRODUCTION

Cleaning is vital work surmised each put. Now and then, errands are clear, other times, they're difficult. There are times we enlist people to clean and compensate them monetarily. But, there are dangerous places too, unsafe for humans. Not every place can have a human. Some spots have vast floor areas and need more than one person to clean. In those situations, we need a method to cope with these issues. Advancement in science gives us a solution, a robot, but it

Copyright The Author(s) 2024.This is an Open Access Article distributed under the CC BY license. (http://creativecommons.org/licenses/by/4.0/)

Journal of Image Processing and Intelligent Remote Sensing
ISSN: 2815-0953
Vol: 04, No.03, April-May 2024
http://journal.hmjournals.com/index.php/JIPIRS
DOI: https://doi.org/10.55529/jipirs.43.14.25

still needs a human to operate it[1].Overcoming staffing issues needs more tech apparatuses. The cleaning machine is helpful for cleaning up floors and open air ranges in clinics, homes, stores, transport stops, and open spaces. These days, both indoor and open air cleaning play a imperative part in our lives. Squander transfer is basic for our wellbeing and reduces the require for human labor. Whereas different floor cleaning machines exist, our made machine is clear in plan, basic to utilize. Anybody can effortlessly work this machine[2]. Thus it is exceptionally valuable in healing centers, any expansive range space .Cleaning is quick and reasonable. It is cheap to maintain. Various machines are commonly used. Operating the Floor cleaner is simple. No special training is needed to use it safely.

With the expanding request for domestic mechanization, the appropriation of household robots is advancing. The reason of this extend is to plan and execute a Floor Robot Independent that will make cleaning forms more comfortable and effective, killing the require for manual vacuum cleaners. This extend points to create a vacuum robot model that will have a few criteria that are user-friendly.Conventional floor cleaning machines are broadly utilized in commercial places such as airplane terminals, railroad stations, clinics, transport stands, and shopping centers. In any case, these machines require electrical vitality for their operation and are not user-friendly[3]. In India, especially in summer, there's a control emergency, and most floor cleaning machines are not utilized successfully, especially in transport stands. The integration of solar-based floor cleaning robots in industries represents a significant leap towards sustainability and efficiency in maintenance practices[4]. These robots, equipped with advanced cleaning technologies and powered by solar energy, offer a dual benefit of reducing environmental impact and enhancing operational effectiveness. In industrial settings, where cleanliness is paramount for safety and efficiency, these robots autonomously navigate through diverse floor surfaces, efficiently removing dirt, debris, and contaminants. The use of solar power ensures extended operational periods and reduces the reliance on traditional power sources, aligning with industries' growing emphasis on eco-friendly solutions. Furthermore, the autonomous nature of these robots minimizes human intervention, allowing workers to focus on more specialized tasks while the robots handle routine cleaning operations. This integration not only contributes to a cleaner and safer industrial environment but also showcases a commitment to sustainable practices in line with global environmental goals.

In this manner, there's a need to extend a low-cost, user-pleasant ground cleansing machine. In this extend, we proposed a solar-powered mobile-operated floor cleaning machine that can be an elective to routine floor cleaning machines. The floor cleaning machine will be planned to be energy-efficient and naturally neighborly. The proposed floor cleaning machine will be planned to utilize renewable vitality, which is copious in most nations, will have less natural affect, and will be simple to develop for commercial utilize. The proposed solar floor cleaner robot project will be implemented using an RF remote, ultrasonic sensors, solar panels, a 12-volt battery, an L293D motor driver, DC motors, a cleaner motor, and a relay. The RF remotewill be the main controller of the robot, and it will control the motors and sensors. The ultrasonic sensors will detect obstacles in the robot’s path and send a signal to the microcontroller to change the robot’s direction. Solar panels juice up the battery, which runs

Copyright The Author(s) 2024.This is an Open Access Article distributed under the CC BY license. (http://creativecommons.org/licenses/by/4.0/)

Journal of Image Processing and Intelligent Remote Sensing
ISSN: 2815-0953
Vol: 04, No.03, April-May 2024
http://journal.hmjournals.com/index.php/JIPIRS
DOI: https://doi.org/10.55529/jipirs.43.14.25

the robot. The L293D motor driver handles DC motors and the cleaner motor. The relay swaps power from solar to battery and back.
In conclusion, the sun oriented floor cleaner robot venture will contribute to the improvement of a low-cost, user-friendly, and ecologically inviting floor cleaning machine. The venture will too illustrate the possibility of utilizing renewable vitality for commercial applications.

2. LITERATURE REVIEW

Rupali Shinde.et.al., "Automatic Floor Cleaner with UV Cleansing System", The creators in this paper gives an InSite of an programmed floor cleaner with UV sanitization framework which employments an Arduino uno microcontroller as the most controller the framework moreover contains ultrasonic as well as infrared sensors for deterrent evasion framework. The cleaning robot too has sprinkler system incorporated to it to attain wet mopping of the floor. The independent cleaner framework incorporates a UV cleansing framework which utilize a driven based UV strip light framework to realize sanitization of the floors. Here the creators make utilize of UVC ultra violet light for the cleansing framework. A Bluetooth gadget (HC-06) is connected to the machine that gets the information from the portable conjointly it can transmit the information. It changes over the serial harbour into Bluetooth.[1]

Raveena Ishalavath M. et. al., "Plan and Improvement of an Mechanized Floor Cleaner Robot for Residential Application "The creators in this paper gives an InSite on the advancement of an mechanized floor cleaner robot utilizing IEEE guidelines the most onboard computer the creators utilized may be a raspberry pi3 microcontroller. Ultrasonic sensors are utilized to distinguish deterrents before the robot and to maintain a strategic distance from the impediments. The floor cleaner robot employments a Bluetooth controller for inaccessible access of the robot. There are cleaning brushes additionally a wiping brush fitted to the robot for cleaning and wiping of the floor. There's an LCD screen coordinates to the bot which gives the genuine time plan of the operations done by the bot and corresponding buzzers gives an sound flag comparing to the operations status of the floor cleaner robot.[2]

Kushal.NL, Hamara Chaudhuri.et.al., "Autonomous Floor Cleaning Bot.",In this paper the creators allow an InSite on an Independent floor cleaning bot which has an independent as well as manual mode. The manual mode of the floor cleaning bot is through a phone app. The bot uses an Arduino mega microcontroller as the most computer on onboard. The floor cleaning bot too employments a laser time of flight sensors for obstacle avoidance as well as ultrasonic sensors also comes into play. The bot is fueled by a two 12v lithium polymer battery. The bot moreover employments a automated vacuum cleaner to realize more exact cleaning of the floors. In manual mode the development of the bot is by means of an android phone application for the development of the bot.

Leel, A. S. AbGhafar, et.al.,' Autonomous multi-function floor cleaning robot with Zig Zag algorithm'[4-6] The creators in this paper put forward the plan and development of an autonomous floor cleaning robot. the fundamental computer on board the bot is an Arduino microcontroller. This robot comprises of three ultrasonic sensors, one infra-red (IR) sensor and two brushes before it to guarantee successful cleaning [8- 10]. The bot employments a custom

Copyright The Author(s) 2024.This is an Open Access Article distributed under the CC BY license. (http://creativecommons.org/licenses/by/4.0/)

Journal of Image Processing and Intelligent Remote Sensing
ISSN: 2815-0953
Vol: 04, No.03, April-May 2024
http://journal.hmjournals.com/index.php/JIPIRS
DOI: https://doi.org/10.55529/jipirs.43.14.25

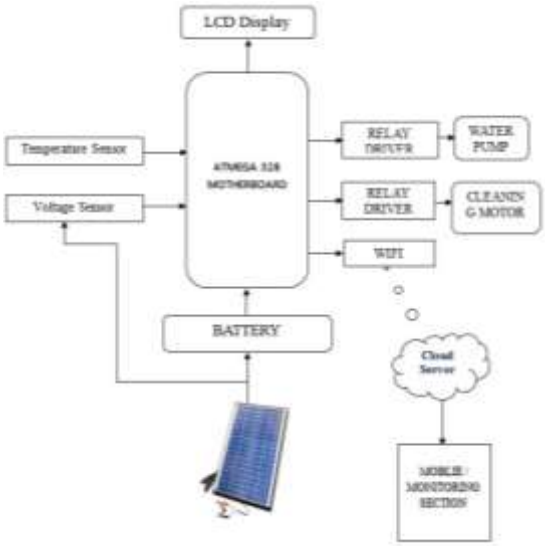
outlined zig zag-based calculation which accomplishes most extreme zone coverage.This independent multi-function floor cleaning robot has lower fetched compared to existing vacuum robot on the racks and is appropriate for domestic and little preface utilization [11-15].

AKASH NAGTODE, et.al., "He made a solar-powered floor cleaner. His extend centers on a cleaning framework that employments sun oriented light. He took advantage of PV boards that alter vitality particles, called photons, into control. This green vitality is what powers his cleaning machine."

M RANJIT KUMAR et. al.,A Floor Cleaning Robot can offer assistance control costs. Conventional floor cleaners are basically utilized in air terminals, prepare stations, clinics, transport stations, shopping centers, and other commercial ranges. But they're fueled by power and aren't user-friendly. In India, especially in summer, control cuts commonly happen. This implies floor cleaners frequently go unused, particularly in transport stations. In this consider, we show and analyze a floor cleaning machine utilizing reasonable commercially accessible computer program. Through limited component investigation, we discover that the stretch level in physically worked floor cleaning machines is inside middle of the road limits.

3. METHODOLOGY

A. Architecture



The basic movement of the robotic car involves the integration of several key components. These incorporate a dual-axis accelerometer, four 10k potentiometers, an LM324 OP-AMP IC, an HT12E+HT12D encoder-decoder match, an Inquire RF transmitter and recipient combine, an L293D Engine Driver IC, two DC engines, two wheels, a castor wheel, chassis, breadboards, and wires. Additionally, the components required for the RF remote control include connecting wires, buttons, an RF receiver module, an RF transmitter module, and LEDs.

Copyright The Author(s) 2024.This is an Open Access Article distributed under the CC BY license. (http://creativecommons.org/licenses/by/4.0/)

Journal of Image Processing and Intelligent Remote Sensing
ISSN: 2815-0953
Vol: 04, No.03, April-May 2024
http://journal.hmjournals.com/index.php/JIPIRS
DOI: https://doi.org/10.55529/jipirs.43.14.25

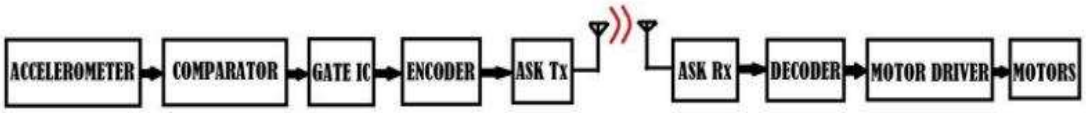


Figure. 1

The system's block diagram is illustrated in Figure 1, providing an overview of the microcontroller-less accelerometer-controlled robotic car. The accelerometer used is a MMA7361L three-axis module, but the system utilizes only the x and y axes for its operation. This sensor produces analog output proportional to tilt angles or orientation, enabling the robotic car to respond to changes in its position.

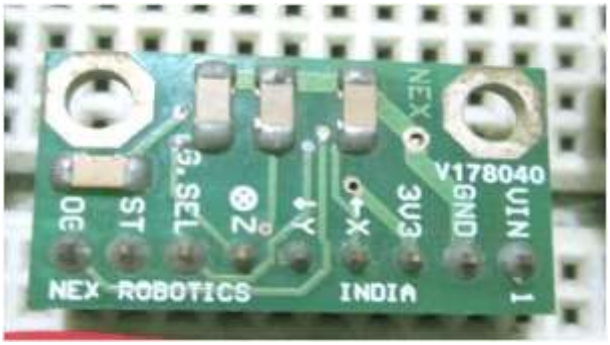
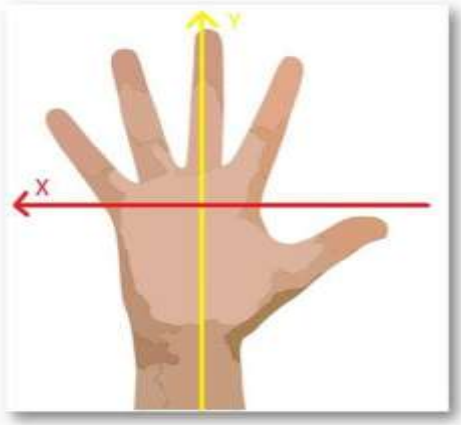


Figure. 2 Image showing MMA7361L Accelerometer Module

The LM324 OP-AMP IC, consisting of four operational amplifiers, functions as comparators.Each operational amplifier's input is associated to the accelerometer's yield, whereas the other inputs are connected to particular potentiometers. These potentiometers are tuned to create the desired computerized yield for four diverse combinations, comparing to forward, in reverse, right, and cleared out developments. The analogy of the hand is used to explain the positive and negative Y directions and the perpendicular X axis



.

Figure. 3 Picture appearing Accelerometer Axis's on a plane with reference to hand

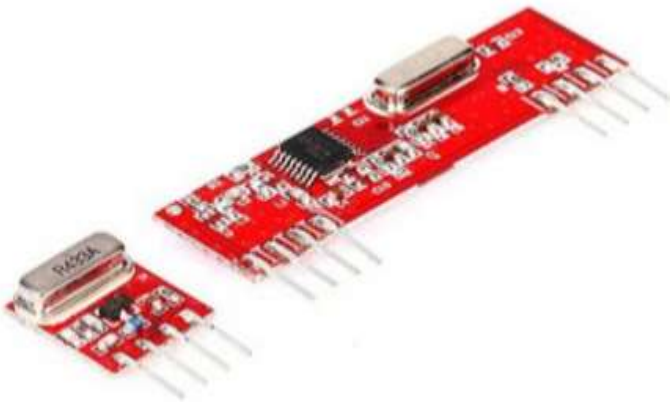
Copyright The Author(s) 2024.This is an Open Access Article distributed under the CC BY license. (http://creativecommons.org/licenses/by/4.0/)

Journal of Image Processing and Intelligent Remote Sensing
ISSN: 2815-0953
Vol: 04, No.03, April-May 2024
http://journal.hmjournals.com/index.php/JIPIRS
DOI: https://doi.org/10.55529/jipirs.43.14.25



Figure. 4 Picture appearing Accelerometer Axis's in three measurements with reference to hand

The hardware setup, as depicted in Figure 3.1.6, involves assembling all the necessary components for constructing the robotic car. Modules play an important role in controlling the robotic movements.





Copyright The Author(s) 2024.This is an Open Access Article distributed under the CC BY license. (http://creativecommons.org/licenses/by/4.0/)

Journal of Image Processing and Intelligent Remote Sensing
ISSN: 2815-0953
Vol: 04, No.03, April-May 2024
http://journal.hmjournals.com/index.php/JIPIRS
DOI: https://doi.org/10.55529/jipirs.43.14.25



Figure. 5 Pictures of Components required for making Automated Car

Moving on to the remote cleaning engines segment (Segment 3.2), the framework utilizes a point-level controlling strategy for observing water levels in a tank. Eight distinctive focuses along the tank's stature are chosen, with sensors situated at each point and wired to address inputs of a extraordinary parallel-to-serial (212) advanced encoder. This encoder produces an 8-bit computerized number based on the water level detected by the sensors. The encoded information is transmitted wirelessly to a inaccessible getting conclusion through 433MHz UHF transmitter and recipient modules working in ASK/OOK mode.

At the getting conclusion, a serial-to-parallel (212) decoder is utilized to translate and recognize transmitted information when the decoder's address lines coordinate the gotten information. A uncommon computerized counter persistently produces and bolsters a well-defined list of 8-bit numbers to the decoder address lines. When a coordinate is met, the decoder produces a substantial transmission (VT) flag and yields a 4-bit information sent from the encoder to its information yield lines. The coordinated 8-bit number is shown by eight LEDs, each speaking to a particular bit of the address lines and demonstrating the coherent status of a specific sensor. This data permits spectators to effectively judge the water level within the tank by watching the status of the pointer LEDs. Furthermore, any two of the eight advanced address bits can be utilized by a relay-controlling circuit to naturally turn on/off the hand-off, subsequently controlling the water pump to preserve the water between two indicated levels.

System Design

The solar-based floor cleaning robot, designed with a comprehensive system, presents significant potential for industrial applications, particularly in large-scale indoor environments. In an industrial context, the robot's system design aligns with the need for efficient and sustainable floor cleaning practices.

The integration of a solar panel as the primary power source is particularly advantageous for industrial settings. The continuous exposure to ambient light within manufacturing plants or warehouse facilities ensures that the robot can operate for extended periods without the need for frequent recharging. This feature significantly enhances the robot's autonomy, making it well-suited for large industrial spaces where consistent and uninterrupted cleaning is crucial.

The industrial use of this robot is further enhanced by its robust cleaning mechanism. The downward-facing fan, powered by the solar-charged battery, enables the efficient removal of

Copyright The Author(s) 2024.This is an Open Access Article distributed under the CC BY license. (http://creativecommons.org/licenses/by/4.0/)

Journal of Image Processing and Intelligent Remote Sensing
ISSN: 2815-0953
Vol: 04, No.03, April-May 2024
http://journal.hmjournals.com/index.php/JIPIRS
DOI: https://doi.org/10.55529/jipirs.43.14.25

dust and debris from expansive floor areas. The autonomous navigation system, guided by obstacle detection sensors, ensures that the robot can navigate through cluttered or dynamic industrial environments, maintaining cleanliness without compromising operational efficiency.

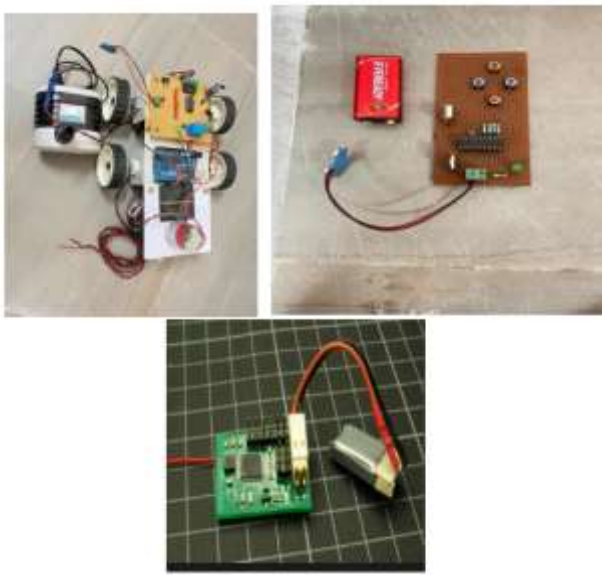


Figure. 6 Images Showing used to Control and all the components used clean

The incorporation of an RF remote control system adds a layer of adaptability to the robot's functionality. Industrial users can customize cleaning modes, initiate or stop cleaning operations remotely, and manually control the robot's movements based on specific cleaning requirements. This user-friendly interface enhances the versatility of the robot in addressing diverse industrial floor cleaning needs.



Figure. 7 Image Showing Solar Based Floor Cleaning

Moreover, the obstacle detection sensors play a crucial role in preventing collisions with machinery, equipment, or other obstacles present in industrial settings. This feature not only ensures the safety of the robot but also minimizes the risk of damage to valuable assets within the facility.

Copyright The Author(s) 2024.This is an Open Access Article distributed under the CC BY license. (http://creativecommons.org/licenses/by/4.0/)

Journal of Image Processing and Intelligent Remote Sensing
ISSN: 2815-0953
Vol: 04, No.03, April-May 2024
http://journal.hmjournals.com/index.php/JIPIRS
DOI: https://doi.org/10.55529/jipirs.43.14.25

In summary, the solar-based floor cleaning robot, with its sustainable power source, efficient cleaning mechanisms, and user-friendly interface, proves to be an ideal solution for industrial floor cleaning. Its autonomy, adaptability, and obstacle avoidance capabilities make it well-suited for addressing the unique challenges posed by large-scale industrial environments, contributing to enhanced cleanliness and operational efficiency within these settings.

4. RESULTS AND DISCUSSION

A. Accelerometer Output

Underneath are the values I got from my sensor when in typical position and after that after tilting the sensor as appeared within the chart above.
Now depending on these voltage values, we have to be tune the potentiometers to urge the proper computerized output. Consider the taking after graph

Voltage Reading	Tilt Direction				
(In Volts)	No Tilt	Forward	Backward	Right	Left
X	1.65	Na	Na	2.3	1.1
Y	1.65	2.2	1.1	Na	Na

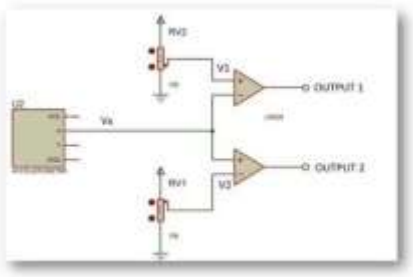


Figure. 8 Circuit Diagram of Accelerometer and circuitry for sensing analog voltage for X axis

Presently depending on these voltage values, we have to be tune the potentiometers to induce the proper advanced yield. Consider the taking after graph Here Vx is the analog voltage coming from the X yield; V1 and V2 are yield voltages of the potentiometers. Keep in mind V2 > V1. The circuit takes after the underneath table:

Conditions	Output 1	Output 2
Vx > V2	Low	High
Vx < V1	High	Low
V2>Vx>V1	Low	Low

So we have to be alter V1, V2 values (utilizing the potentiometer) based on the perusing we got and the over table.You can see a exhibit within the video at the conclusion. I connected LEDs to the yield pins to see its state.Similarly we do this for Y yield also.Then we would get the underneath 4-bit yield from the LM324 IC:

Copyright The Author(s) 2024.This is an Open Access Article distributed under the CC BY license. (http://creativecommons.org/licenses/by/4.0/)

Journal of Image Processing and Intelligent Remote Sensing
ISSN: 2815-0953
Vol: 04, No.03, April-May 2024
http://journal.hmjournals.com/index.php/JIPIRS
DOI: https://doi.org/10.55529/jipirs.43.14.25

Tilt	O1	O2	O3	O4
Forward	1	0	0	0
Backward	0	1	0	0
Right	0	0	1	0
Left	0	0	0	1

B. Motor Driver Result

We'll be utilizing L293D engine driver which can control two engines bidirectionally. The reason we utilize a motor driver is since circuits (most of them)/ microcontroller work at a diverse voltage level when compared to the engine and they cannot give sufficient current to the engines. L293D has 4 inputs and 4 yield terminals. Here could be a table appearing the input combinations and comparing yields.

Inputs				Motor Direction		Robot's Motion
I1	I2	I3	I4	Left Motor	Right Motor	
1	0	0	1	Anti-Clockwise	Clockwise	Forward
0	1	1	0	Clockwise	Anti-Clockwise	Backward
1	0	1	0	Anti-Clockwise	Anti-Clockwise	Right
0	1	0	1	Clockwise	Clockwise	Left

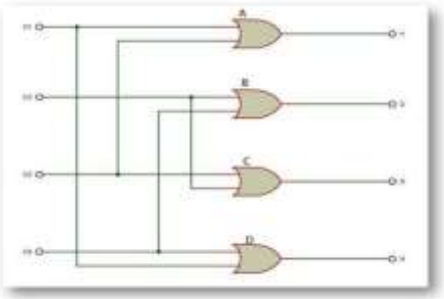


Figure. 9 Circuit Diagram of Gates

Door A, I1 = O1 + O3
Entryway B, I2 = O2 + O4
Door C, I3 = O3 + O2
Door D, I4 = O4 + O1

5. CONCLUSION

A new low cost environment friendly floor cleaning robot model is created which is highly used at industries, factories and outdoor spaces. Our model goes in places where a human cannot enter such as high polluted areas or rooms filled with poisonous gases. It uses solar panel to convert solar energy to electrical energy and run the robotic car. Our proposed methodology includes two basic remote controls i.e one with accelerometer using hand gestures and other with Rf remote. You can use it as per your convenience. WE have attached a fan

Copyright The Author(s) 2024.This is an Open Access Article distributed under the CC BY license. (http://creativecommons.org/licenses/by/4.0/)

Journal of Image Processing and Intelligent Remote Sensing
ISSN: 2815-0953
Vol: 04, No.03, April-May 2024
http://journal.hmjournals.com/index.php/JIPIRS
DOI: https://doi.org/10.55529/jipirs.43.14.25

beneath the robotic care which turns on after every cleaning work and dries of the area . It does both wet and dry cleaning.

Future Scope: Here are some concise innovations that can be added to solar-based floor cleaning robots in the future. Advanced AI and Navigation, Enhanced artificial intelligence for better route planning and obstacle avoidance. Swappable Cleaning Modules, Modular design for customizable cleaning attachments. Self- Emptying Dust Bins, Automated dustbin emptying to reduce user intervention. Multi-Surface Compatibility, Improved adaptability to various floor types and conditions. UV-C Disinfection, Integrated UV-C disinfection for enhanced cleaning and hygiene. Longer Battery Life, Improved energy storage for extended cleaning sessions. Waterless Cleaning, Dry cleaning capabilities to conserve water. Remote Monitoring and Control, IoT-enabled remote control and monitoring. Self-Diagnostics, Self-detection of issues and self-repair features .Solar Efficiency, Enhanced solar panel technology for increased energy generation. Data Analytics, Data collection and analytics for performance optimization. Smart Home Integration. These innovations can make solar-based floor cleaning robots more efficient, versatile, and user friendly.

6. REFERENCES

1. Prof. Rupali Shinde1, Prof. Soniya Joshi², VishwajeetMore, “automatic ground cleaner with UV Disinfection system”, IJARIIEISSN(O)-2395-4396 Vol. 6,no.5, 2020.
2. B. Raveena Ishalavath M. et. al, “layout and development of an automatic ground cleaner robotic for home utility”, worldwide magazine of Engineering studies &technology, 2020.
3. Begum, Shahida, Reshma Banu, Ali Ahamed, and B. D. Parameshachari. "A comparative examine on enhancing the performance of solar electricity vegetation thru IOT and predictive facts analytics." In 2016 worldwide convention on electrical, Electronics, conversation, laptop and Optimization techniques (ICEECCOT), pp. 89-91. IEEE, 2016.
4. C. Alex and A. Moscaritolo, “The excellent robotic Vacuums for 2020,” PCMag,2020. [Online]. to be had: https://www.pcmag.com/alternatives/thebest-robotvacuuiiLS?check uuid—zero I j rZgWN XhmA1 ocC i7Zl IXevj&test version-b .
5. A. okay. Bordoloi, F. Islam, J. Zaman, N. Phukan, and N. M. Kakoty, “A ground cleaning robotic for home environments,” in ACM global convention intending collection, vol. part F132085, pp. 1-5, 2017.
6. Chetan thakur, Senthil Kumar, Vaisakh KP, Sayanth A Kumar, Gaurav Dasgupta, faraway managed self reliant floor cleansing robotic , worldwide magazine of new era and Engineering (IJRTE)ISSN:2277-3878, vol. 8, no. 2S11, September 2019.
7. M. Jain, P. S. Rawat, J. Morbale, “automated floor cleaner”, global studies magazine of Engineering and technology (IRJET), vol. 4, no. 4 , 2017.
8. N. Kawasaki and U. Kiencke, ”fashionable platform for sensor fusion on advanced driver help gadget using Bayesian network,” IEEE sensible automobiles Symposium, 2004, Parma, Italy, 2004, pp. 250-255. doi: 10.1109/IVS.2004.1336390
9. Rekha Raja, Ashish Dutta, and KS Venkatesh, New capacity area method for hard terrain direction planning the use of genetic set of rules for a 6-wheel roverRobotics and self reliant structures,quantity- 72,pages-295– 306,2015,Elsevier

Copyright The Author(s) 2024.This is an Open Access Article distributed under the CC BY license. (http://creativecommons.org/licenses/by/4.0/)

Journal of Image Processing and Intelligent Remote Sensing
ISSN: 2815-0953
Vol: 04, No.03, April-May 2024
http://journal.hmjournals.com/index.php/JIPIRS
DOI: https://doi.org/10.55529/jipirs.43.14.25

10. Mohammad Sazzadul Hoque, Md Mukit, Md Bikas and Abu Naser An implementation of intrusion detection gadget the use of genetic algorithm, ar Xivpreprintar Xiv:1204.1336,2012
11. Sung JY., Guo L., Grinter R.E., Christensen H.I. (2007) My Roomba Is Rambo: Intimate home appliances. In: Krumm J., Abowd G.D., Seneviratne A., Strang T. (eds) UbiComp 2007: Ubiquitous Computing. UbiComp 2007. Lecture Notes in pc technology, vol 4717. Springer, Berlin, Heidelberg. 17
12. H. Lee, et al., research roadmap of smart robots, foundation of Korea commercial generation, 2005, pp. 224-225.
13. Household Vacuum Cleaners marketplace evaluation by using Product (Upright, Canister, critical, robot, Drum, moist/dry), And segment Forecasts To 2022.Grand View research. file identity: 978-1-68038- 553-three
14. Household Vacuum Cleaners marketplace global enterprise evaluation, size, proportion, boom, traits, and Forecast, 2018 2026.Transparency market research. Rep identification : TMRGL442
15. W.Y. Jeong and okay.M. Lee. CV-SLAM: a new ceiling imaginative and prescient-based SLAM approach. In Int. convention on sensible Robots and structures (IROS), August.2 hundred

Copyright The Author(s) 2024.This is an Open Access Article distributed under the CC BY license. (http://creativecommons.org/licenses/by/4.0/)