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Development of An Automated Floor Cleaning Machine for Domestic Application – A Review

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ABSTRACT :

The rapid integration of smart technologies into typical homes has significantly contributed to changes in consumer expectations as well as needs for high levels of automation. There is, therefore a growing concern in convenience, efficiency, and time saving among those who believe that automation leads to improved quality of living conditions. With respect to home upkeep, the act of floor cleaning remains one of the repeated household activities that require time and physical energy. With this project, the challenge is attempted to be solved through the development of an Automated Floor Cleaning Machine for domestic use only. The system integrates a combination of advanced technologies, including micro-controllers, sensors, wireless communication, and robust mechanical components, to offer a versatile, user-friendly solution that automates both dry and wet floor cleaning.The primary goals of this project are to design and implement an autonomous cleaning floor robot with low manual effort and satisfactory cleaning performance. Using Arduino UNO as the main controller, Motor Driver L293D, Geared Motors, and Ultrasonic Sensors, the machine can navigate autonomously around any household environment with minimal human intervention, avoiding the presence of obstacles, performing cleaning actions, etc. This module for Bluetooth connectivity allows the device to be controlled through an application on a smartphone and, therefore, uses a development environment wherein these elements are supposedly assumed to be used within modern smart environments. The design of this machine accounts for both dry sweeping and wet mopping functionalities; most robotic floor cleaners are purely sweeping or solely mopping, thus filling a gap in the market.

Keywords: Motor Driver, Ultrasonic Sensors, Arduino UNO, wet mopping functionalities.

1. Introduction :

The continued advancements in smart home technologies have revolutionized the industry with a new epoch of home automation. With household chores becoming increasingly automated, it is time for solutions that can enable people to integrate into their lifestyles in efficient, time-saving maneuvers without taking too much time on repetitive chores. Such an example is floor cleaning, which, despite technological advancement in home appliances, is still an area with highly underdeveloped automation regarding providing a comprehensive solution that encompasses both dry and wet cleaning needs. Robot vacuum cleaners and robotic mops are actually the only types of existing robotic floor cleaners, focusing solely on a single task: either vacuuming or mopping. Besides, these appliances usually do not have the sophisticated navigation, control, and flexibility that contemporary consumers expect.
A cleaner, more adaptive, and more user-friendly cleaning robot that could autonomously execute cleaning tasks in various household environments has never been needed more. This project responds to this need by designing an automated floor cleaning machine that can handle both dry and wet cleaning tasks.Here introduce the paper, and put a nomenclature if necessary, in a box with the same font size as the rest of the paper. The paragraphs continue from here and are only separated by headings, subheadings, images and formulae. The section headings are arranged by numbers, bold and 9.5 pt. Here follows further instructions for authors.

2. Literature survey :

Different Types of Automated Floor Cleaning Machine

Robots were rapidly increasing trend in present world and the people is so busy with their works so the robots were engaged to do all the works which quite makes the work easier within days [1].The robot employs a combination of ultrasonic and infrared sensors for obstacle detection, with ultrasonic sensors serving as the primary distance measurement tool [2].1The robot's control system is based on an ATmega328 micro-controller, featuring multiple input/output pins for effective operation and control of the cleaning process [3].The proposed system aims to utilize image processing as the primary method for identifying and differentiating between dirt and mud on floors [4].The cleaning robots from the past 10 years were rapidly developed and different types of the automatic cleaning robots were occurred [5]. when it comes into the real life the robot works on the motor mechanism while move from one place another place where the 4 motor are present on the bottom of the robot[6]. the overview is limited to floor cleaning robots and does not include robots for cleaning windows or facades of buildings or production tools [7].The design aims to reduce labour costs significantly. By automating

certain cleaning tasks, the machine is expected to save time and effort, making it a cost-effective solution for both residential and commercial cleaning needs[8]. where it consists of the water where we can also add the required solution the water to do the mopping process [9]. Arduino the paper presents several key conclusions regarding the development and functionality of the automatic floor polisher robot [10]. the bot consists of two ultra sonic sensors where they can see the 180 degrees view [11]. robot can operated both manually and also automatically which this feature can helps the machine to handle in the small areas that where the machine faces problems to clean we can use the software application to handle at the situation[12]. The automation algorithm is designed to optimize the cleaning path, making it a valuable tool for household [13]. robot by using the utilization of the e scrap where they use the aurdino for the control mechanism [14]. removes even if the hard stains on the ground this robot can control using the Bluetooth using a mobile application and it is also very cost-effective robot due to its small body [15].

Working Principle of Different Automated Floor Cleaning Machine

Cleaning a floor is an essential process for maintaining an environmentally hygienic and healthier living space. In the modern era, automatic floor cleaning systems have become increasingly important as they offer efficient, convenient, and effective solutions to keep homes and workplaces clean with minimal human intervention [16]. A floor-cleaning robot designed to replace traditional housekeeping services. During the project, various new technologies were employed to coordinate the robot's functions. The robot is built around an Arduino UNO, a micro-controller board based on the ATmega328P, featuring 14 digital input/output pins, 6 analog inputs, a 16MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button [17].The system integrates an *Arduino* for control, *IR sensors* for object and edge detection, and a *UV lamp* for germ sterilization. The cleaning mechanism combines a *vacuum* and *sweeper*, effectively collecting dirt, while a *sprinkle* system distributes cleaning solution, followed by a *mop* to wipe the floor, ensuring a thorough clean. This dual-functionality approach offers both efficiency and convenience in floor cleaning [18].floor cleaner that operates without an external power source, using mechanical components like a *cylindrical nylon brush* (30 inches long, 1.5-inch outer diameter), *mild steel front wheel axle* (36 inches, 1.5-inch diameter), and *synthetic rubber wheels* (24 inches diameter). The system also incorporates *cast iron sprockets* (9.9 inches diameter) connected to a chain, and a *polyester mop* (30x18 inches). A *spur gear* with straight teeth connects the sprockets, ensuring smooth, consistent motion for efficient cleaning [19]. A smart floor cleaning machine controlled via a mobile app. The system includes a *Wi-Fi RX module* for wireless communication, allowing remote control through smartphones. A *vacuum cleaner* removes dust and debris, while *ultrasonic sensors* detect obstacles and measure distances. The *motor* and *motor driver* enable movement, and a mobile phone serves as both the control interface and monitoring device, providing real-time updates and allowing users to manage cleaning operations remotely [20].The *hTrihex* platform, an *autonomous self-reconfigurable floor cleaning robot* capable of transforming into three configurations—straight, chevron, and closed—enabling it to clean hard-to-reach areas like corners and spaces with complex geometries. The robot uses *LIDAR* and *IMU sensors* for autonomous navigation and mapping, utilizing tiling-based path planning for optimal coverage. Its shape-shifting ability and advanced control systems make it suitable for both domestic and industrial environments, with future improvements focused on enhancing the cleaning module and reducing wheel slip [21].*Arduino-based smart vacuum cleaner robot* designed for automatic dry dust cleaning. The system uses a *motor driver* to control two *gear motors* attached to wheels for movement, while *ultrasonic sensors* detect obstacles, enabling the robot to stop, avoid, or navigate around them. The *Arduino Uno* serves as the central controller, managing all tasks. The robot is controlled via a mobile app, offering an efficient and intelligent solution for floor cleaning [22]. A robotic system for *automatic waste segregation* and *floor cleaning*, which can operate in both manual and autonomous modes. The system uses *ultrasonic* and *optical sensors* to detect obstacles and identify waste types (dry or wet), with an *Arduino Uno* as the central controller. The robot moves in a *zigzag pattern* to maximize coverage and is controlled via an *Android app* with a *Wi-Fi module*. The system leverages IoT and robotics to simplify cleaning and waste segregation, with future improvements focusing on AI-based waste sorting and better handling of uneven surfaces [23]. A solar-powered multifunctional floor cleaning machine designed to operate in both wet and dry conditions. It uses solar energy to charge a 12V battery, powering components like brushes, vacuum suction, and a water spray pump for cleaning, scrubbing, and mopping. The machine reduces human effort and environmental impact by using renewable energy, offering a sustainable solution for floor cleaning. Its versatile functions contribute to improved cleanliness and public health, even in rainy conditions [24].A steam-based floor cleaner designed for Indian households, aiming to reduce detergent use and water wastage. The machine combines a steam boiler (2-4 bar pressure) for effective dirt and bacteria removal, a vacuum cleaner for pre-cleaning, and a rotating scrubber for drying the floor. It incorporates a water tank for steam generation and uses a mild steel frame for durability. The design is cost-effective, with future improvements proposed for automation and enhanced material optimization, potentially incorporating renewable energy sources like solar power [25]. A four-wheel independently controlled steering and driving (4WISD) mechanism for a reconfigurable floor cleaning robot, aimed at improving its flexibility and navigation in tight and unstructured spaces. The system uses independent wheel control, Herkulex servos for steering, micro-DC motors with encoders for speed control, and spring-loaded hinges for adapting to uneven terrain. The decentralized control system includes an MCU, motor controllers, and a Bluetooth module for external communication. The design enhances the robot's ability to navigate complex environments, with future improvements focused on module locking mechanisms and closed-loop control to reduce movement errors [26]. A voice-controlled floor cleaning robot with Android application integration, aiming to simplify household cleaning through hands-free operation. The robot is controlled via voice commands from an Android app, which communicates with the robot through Bluetooth or Wi-Fi. It uses a microcontroller (e.g., Arduino or Raspberry Pi) to process commands, and features motors, obstacle detection sensors, and cleaning mechanisms like brushes, a vacuum, and optional mopping. The system allows remote control, automates cleaning tasks, and reduces manual intervention, making it convenient and efficient for users [27]. A floor cleaning robot powered by solar-assisted renewable energy, aiming to improve efficiency and sustainability. The robot features omnidirectional wheels for enhanced mobility, a range of sensors for obstacle detection and floor analysis, and multifunctional cleaning mechanisms like brushes, a vacuum system, and microfiber mops. Solar panels charge a rechargeable lithium-ion battery, while a smart power management system optimizes energy use. The system also includes wireless connectivity, a user-friendly interface, and built-in safety mechanisms for autonomous, eco-friendly operation [28]. A cost-effective autonomous vacuum floor cleaning robot aimed at making cleaning technology accessible to households in third-world countries. The robot integrates a vacuum cleaning system with advanced navigation techniques, including a GPS module for improved location awareness. It uses a Raspberry Pi for processing and an Arduino Mega to control the robot's functions. The system autonomously maps and cleans indoor spaces, requiring minimal human intervention. The prototype

successfully demonstrates affordable and efficient autonomous cleaning, with potential for further development in sensors and power management [29]. An automatic smart mop for floor cleaning that can operate autonomously or via manual control through an Android device. The robot is powered by a 12V lithium-ion battery and controlled by a motor controller, with precise movement provided by stepper motors. It uses infrared and ultrasonic sensors for obstacle detection, while a submersible mini water pump ensures the mop remains wet for effective cleaning. The robot can clean a 3.048 m × 3.048 m room in about 13 minutes and offers both automatic and manual operation modes via Bluetooth. The low-cost design makes it an affordable and efficient alternative to commercial products [30].A smart solar-powered floor cleaning machine aimed at reducing reliance on external power sources while providing efficient, autonomous cleaning. The system uses a microcontroller to manage operations, with proximity and IR sensors for obstacle detection and navigation. DC motors powered by a motor driver enable movement, while a solar panel charges a battery to ensure continuous operation. The robot's cleaning mechanism includes brushes or suction devices, and a buzzer signals when obstacles are detected [31].

Different Field of Application Of Automated Floor Cleaning Machine

It can clean corners and is useful in homes, public places, and factories [32]. Small, light, and portable, making it useful for homes, offices, and other places. The machine has parts like a wiper, mop, brushes, and a DC motor [33]. Operate automatically or be controlled via a cell phone, using sensors to avoid obstacles. The robot is basic and cost-effective, with future recommendations for features like GSM remote control and solar panel cleaning [34]. It runs on basic batteries and is coded to move and avoid obstacles. For hardware, it uses an Arduino UNO, DC motors, batteries, and a sensor. The software part uses Arduino coding to control the movement and avoid obstacles. As it cleans, the car moves around obstacles automatically [35]. The vacuum has sensors to help it move around. It adjusts its cleaning based on how dirty the floor is. vacuum cleaner makes cleaning easier. It works well in smart homes. Saves time and effort [36]. This makes it very helpful for people who find cleaning difficult. The robot fixes many problems in older models and makes cleaning easier [37]. The idea is to help reduce human effort in areas where cleaning can be difficult or dangerous, such as nuclear plants [38]. The robot's cleaning efficiency is around 80%. In manual mode, the user selects left, right, or centre, and this information is displayed on a smartphone screen. The robot then receives this data to operate [39]. It is great for busy homes or for anyone who needs help with cleaning. It works well in places like hospitals, schools, and offices, making it easy to maintain cleanliness [40]. It uses Arduino-Uno and Motor driver L293D for operation. The cleaner works well for both indoor and outdoor use. As energy sources get limited, solar power offers a good solution [41]. A smartphone app lets users control the robot's functions. portable and has a rechargeable battery. The robot combines vacuuming and mopping to clean well [42]. The machine combines several features, including a vacuum cleaner, mop, wiper, and heating coil, to handle different cleaning tasks like mopping, drying, and vacuuming. Its simple design makes it easy to operate and move around [43]. The machine's compact and lightweight design makes it easy to operate, reducing the need for manual labour and improving cleaning efficiency [44]. Both machines demonstrate the potential of technology to solve everyday cleaning problems, emphasizing the importance of combining smart design with functionality to create practical, user-friendly solutions [45]. For instance, the high RPM motor causes vibrations, and the use of two vacuum pumps leads to energy inefficiency. Future updates aim to address these issues by making the motor detachable and optimizing the vacuum system for better performance and cost efficiency [46].

Recent advancement in automated floor cleaning machine :

Electric wash motor frame, Capacitor, Coconut husk, Flat wire, Coconut husk floor scrub brush, Male plug Reused speaker stand, Wheels, Reused floor polisher handle, Bolt and nut, Galvanized iron, Welding rod [47]. The floor wiper robot described in the research paper primarily operates on the principles of autonomous navigation, sensor-based obstacle detection, and actuation control [48]. The machine is powered manually through a pedal operated mechanism, similar to how one would pedal a bicycle [49]. The vacuum operates by creating suction, which pulls dust, leaves, litter, and other waste into the machine's collection system [50]. The focus is on overcoming the limitations of fixed-morphology robots by enabling adaptable designs that can perform efficiently across varying operational requirements and terrains. They proposed a three-layered heuristic framework for designing re configurable systems [51]. This robot aims to simplify the transition between floor and wall cleaning, reduce human intervention, and provide an efficient cleaning solution for both tasks [52]. This automated process ensures efficient cleaning, saves water, and reduces energy use, keeping public toilets clean and hygienic. It can work automatically or be controlled manually, offering flexibility and control [53]. The machine is intended to enhance work efficiency by automating cleaning tasks, thereby reducing human effort and minimizing associated costs [54]. By incorporating smartphone connectivity, it adapted the robot to modern living spaces, ensuring compatibility with increasingly automated and interconnected environments [55]. The work also focuses on validating the effectiveness of the robot's shape-shifting ability through experimental comparisons with commercially available platforms[56]. The smart floor cleaner robot could be locally manufactured, and its scheduling feature, controlled through computing, Android, and Windows apps, made it more affordable and user-friendly [57]. The design allows for future enhancements, such as integrating Artificial Intelligence for smart navigation or voice control compatibility with systems like Alexa or Google Assistant [58]. This method reduces dependency on fuel or electricity and is more suitable for environments with energy constraints. The review emphasizes the potential of simple, cost-effective, and eco-friendly mechanisms for cleaning applications [59]. The goal is to provide an affordable alternative to imported robotic cleaners, addressing the needs of both consumer and office environments [60]. The use of passive IR sensors is replaced with ultrasonic sensor and is the major feature of this robot. GSM module helps to enhance its performance by proper communication between user and robot [61].

Conclusion :

Automated floor cleaning machines have transformed the cleaning sector into one of efficiency, ease of use, and versatility. There are many varieties among such machines, which include robotic vacuum cleaners, robotic mops, industrial floor scrubbers, and hybrid models, each made to cope with needs during the process of cleaning. Wherein, in robotic vacuums and mops, high precision navigation systems along with sensors like LiDAR, infrared, or

ultrasonic technologies create maps for place-avoidance and cleaning in a predefined area. Mechanized scrubbers of industrial floor machines are often taken into an area, applying diverse mechanical brushes, powerful suction systems accompanied by detergent-based solutions for large-scale cleaning operations in commercial or industrial environments.

Their working logic forms in automation of parts, assembly of motorized parts, suction technology, water spewing mechanism, and sensor-guided navigation. For instance, vacuum cleaners apply the principle of centrifugal forces or roller brushes for dust collection. In robotic mops, they have inbuilt water sprays and microfiber pads that clean wetly. They avoid exploitation of smart algorithms and AI-driven decision-making with IoT to make smooth cleaning without getting any hassle of the time consumed for it.

Automated floor cleaning machines apply to diversifications running in broad cuts. They apply either in offices, shopping malls, or even airports for convenience and efficiency with the healthy environment. They also apply to industrial settings where the heavy-duty cleaning equipment required is needed. They apply in health care, educational institutions, and even warehouses just to sanitize and ensure safety.

New technologies have revolutionized automated cleaning in this industry. The machines become smarter and more resourceful through advanced technologies such as AI-based path optimization, real-time mapping, and voice command integration. The primary features that deal with modern-day concerns for convenience, health, and sustainability include self-emptying bins, UV-C disinfection, and eco-friendly modes of cleaning. Machines enabling 5G and IoT connectivity allow remote monitoring and control, while their modular design makes maintenance easy and customisation possible. Thus, automated floor cleaning machines represent a sharp cut into innovation, efficiency, and versatility in catering to various cleaning requirements. With advancements in technology taking them to be more adaptive, reliable, and environment-friendly in their approach, further development shall make them promise quite high standards of hygiene and cleanliness in both domestic as well as industrial space and make them indispensable to modern living

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