**Smart Glass Cleaning Robot**

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**ABSTRACT - The Glass Cleaning Robot for High-Rise Buildings represents a pioneering venture into the domain of vertical maintenance, seeking to revolutionize the traditional methods of high-rise window cleaning. As urban landscapes evolve with towering structures and expansive glass facades, the challenges associated with the upkeep of these architectural marvels demand innovative solutions. Our project addresses this demand through the development of an autonomous robot designed specifically for the cost-effective and efficient cleaning of glass surfaces in high-rise buildings. The key objectives encompass enhancing safety by minimizing human exposure to potential hazards associated with high-altitude window cleaning. In conclusion, our project stands at the intersection of safety, efficiency, and technological innovation, aiming to redefine standards in high-rise building maintenance.**

***Keywords:*** *Glass Cleaning Robot, High – Rise Buildings, Arduino UNO microcontroller, 1450 KV BLDC, 200 RPM N20 Motor, L298N Motor Driver.*

**INTRODUCTION**

In the ever-evolving landscape of urban architecture, where towering structures define skylines and shape cityscapes, the challenge of maintaining the pristine appearance of high-rise building exteriors looms large. Window cleaning in these soaring structures poses a unique set of challenges, from accessibility and safety concerns to the sheer scale of the task. In response to these challenges, we proudly present our groundbreaking project—the "Glass Cleaning Robot for High-Rise Buildings with Wheeled Locomotion. High-rise buildings, with their towering glass facades, symbolize modernity and architectural prowess. However, the upkeep of these architectural marvels often involves daunting tasks, none more precarious than the maintenance of expansive glass surfaces. Traditional methods of window cleaning in such structures are not only labour - intensive but also come with inherent safety risks for human workers navigating vertiginous heights. Our project delves into this critical domain, seeking to redefine the norms of high-rise building maintenance. By introducing an autonomous Glass Cleaning Robot, we aim to address the challenges posed by traditional methods, offering an innovative solution that combines technological prowess, cost-effectiveness, and a commitment to ensuring the safety of workers and the integrity of architectural excellence.

**Cost-Effective Glass Cleaning:**

* Our foremost objective is to engineer a cost-effective robot designed specifically for the efficient cleaning of glass surfaces in high-rise buildings. By providing an economical alternative, we aim to make building maintenance more accessible and sustainable.

**Enhanced Safety Protocols:**

* The project places a strong emphasis on human safety. With a vision to minimize risks associated with high-altitude window cleaning, the introduction of a robotic solution is poised to create a safer working environment.

**Augmented Cleaning Efficiency:**

* Traditional window cleaning methods are not only labour-intensive but are also time-consuming. The Glass Cleaning Robot is conceived to enhance the efficiency of the cleaning process by eliminating the need for human rest intervals, resulting in a continuous and meticulous cleaning regimen.

While fatalities in high-rise window cleaning are statistically rare, the project stems from a deep-rooted commitment to further reducing the exposure of human workers to potential hazards. By harnessing robotic technology, we aim to strike a balance between human safety and the pressing need for an efficient, cost-effective, and streamlined approach to high-rise window maintenance.

**Problem statement:**

* There are more than 363 high rise buildings in Coimbatore and more than 5600 tall buildings in all over india which comprises of buildings with glass windows.
* Workers or Cleaners struggle to clean the glasses at heights and work with a fear of falling from the height.
* Its dangerous for humans work at such heights which could cause dizziness due to lack of oxygen at heights, falling from such heights could cause deaths, inefficient cleaning due to long cleaning times, etc.
* Humans get tired of cleaning for long time and often they are reluctant to go to such heights.

**Existing Methodology:**

Manual Cleaning:

* Traditional Squeegees: Window cleaners use handheld squeegees to manually clean glass surfaces. This method is effective but requires skilled labour and time.
* Rope Access: Professional window cleaners use ropes and harnesses to access and clean windows on high-rise buildings.
* Water-Fed Pole Systems: Water-fed pole systems use extendable poles with brushes at the end to scrub and rinse windows. Purified water is usually fed through the pole, and the windows are left to air-dry, minimizing the need for manual drying.
* Cradle Systems: Some high-rise buildings are equipped with cradle systems that allow workers to be suspended from the roof, providing access to windows. These systems are controlled manually.



Fig: Worker Hanging in a cradle

Automated Robotic Systems:

* High-Rise Window Cleaning Robots: Specialized robots designed for cleaning tall buildings are equipped with cleaning tools and are often remotely controlled. They can move vertically and horizontally on the building's facade.
* Magnetic Climbing Robots: These robots use magnetic wheels or suction cups to cling to the window surface as they move. They are controlled by an operator and are suitable for vertical glass surfaces.
* Aerial Platforms: Aerial work platforms, such as cherry pickers or scissor lifts, are used to lift workers to the necessary height for window cleaning. These platforms are controlled by an operator.
* Drones: Unmanned Aerial Vehicles (UAVs) or drones equipped with cleaning mechanisms can be used for cleaning windows on high-rise buildings. However, this method is still in the experimental stage in many places.
* Nano-Coatings: Nano-coatings can be applied to glass surfaces to make them self-cleaning. These coatings use hydrophobic or photocatalytic properties to repel dirt and break down organic matter.
* Pneumatic Platforms: Pneumatic platforms use air pressure to lift the cleaning platform to the required height. They are suitable for both horizontal and vertical surfaces.
* Building-Integrated Cleaning Systems: Some modern buildings incorporate cleaning systems directly into their design. This may involve automated systems that move along tracks built into the structure.
* Ultrasonic Cleaning: Ultrasonic cleaning systems use high-frequency sound waves to remove dirt and debris from glass surfaces. This method is more common in industrial settings.

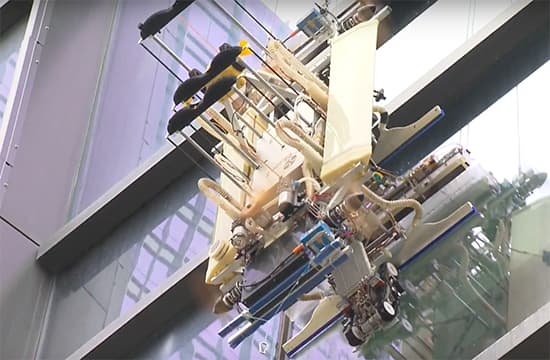


Fig: Automated robotic washer using support cradles for hanging

**Proposed Methodology:**

* This project aims to provide a low-cost cleaner robot for cleaning glasses in a high rise building so that the workers or cleaners don’t have to reach great heights and struggle to clean the glasses in such heights.

**The Specifications of the robot include:**

* Microcontroller: Arduino Mega 2560 with 16MHz clock speed.
* Motors: 1450 KV BLDC motor for vacuum suction and downforce generation, 200 RPM N20 motor for powering the wheels. All these motors will be controlled by the L298N Motor Driver which takes commands from microcontroller.
* Receiver and Transmitter: 2.4 GHz Flysky receiver and transmitter.
* Battery: 16.8V 16800mAh Lithium-ion to increase the maximum battery life of the robot.

**Advantages:**

* Small sized cleaner robot with a maximum length of up to 500mm and breadth of 350mm.
* Controllable using 2.4Ghz Controller and with range more than 500 meters (average height of a High rise building) and can be extended using antennas.
* The robot is made using simple and low priced components like Arduino microcontroller, N20 motors, bldc motors, and lithium ion battery. The costs can extend up to 32000 rupees (385 dollars).
* The robot will be powered by a 16.8v battery which increases the work output of the robot also while enhancing battery life.

**MODELLING:**

**Robot Chassis:**

The chassis of a glass cleaning robot is the main body of the robot that houses all of its components, including the motor, battery, control system, and cleaning mechanisms. The chassis is typically made of plexi glass(acrylic Sheet), to protect the internal components and provide a sturdy platform for the robot to move around. It has a rectangular shape with four rounded corners. The chassis is divided into two sections by a central ridge. The front section of the chassis houses the motor and battery, while the rear section houses the control system and cleaning mechanisms.

The chassis also has a number of openings for ventilation, sensors, and other components. The openings are strategically placed to ensure that the robot can operate efficiently and safely.

* The chassis has a relatively low profile, which allows the robot to easily access and clean hard-to-reach areas.
* The chassis is well-balanced, which helps to prevent the robot from tipping over.
* The chassis has a smooth surface, which makes it easy to clean and maintain.
* The chassis has a number of mounting points for attaching various components, such as the cleaning head, sensors, and navigation system.

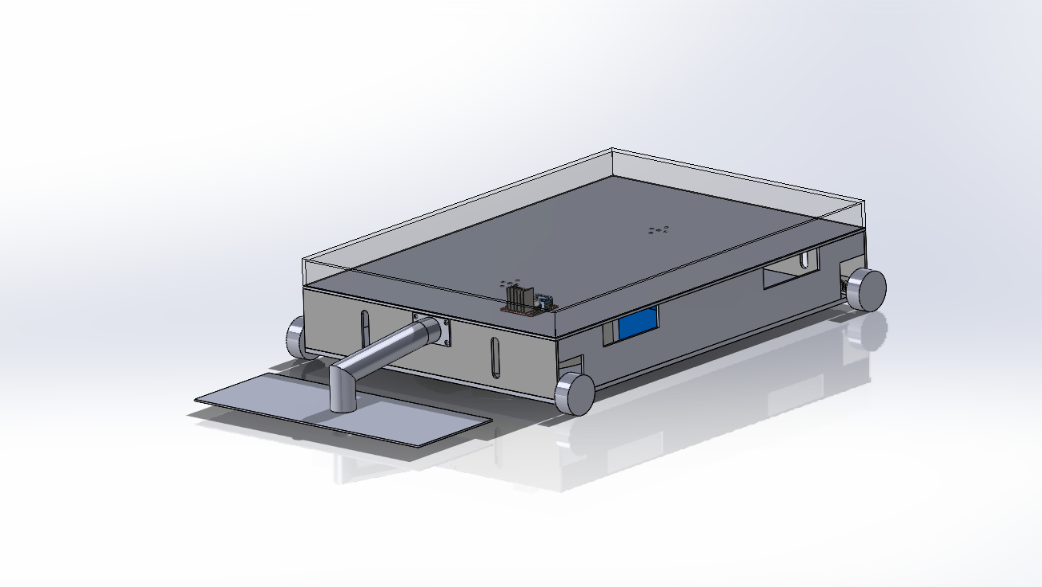


Fig: 3D Model of the chassis of the robot

**Dimensions:**

1. Length: 500 mm
2. Breadth: 350mm
3. Height: 70 mm
4. Thickness: 20 mm

**SOFTWARES INCORAPATED**

**Arduino IDE:**

The Arduino IDE stands as a pivotal tool in the realm of embedded systems, offering a streamlined environment for programming Arduino microcontrollers. With a user-friendly interface, it facilitates code creation, compilation, and uploading onto Arduino boards seamlessly. Designed for compatibility with Windows, macOS, and Linux, it ensures accessibility across diverse operating systems. Its programming language, a simplified version of C and C++, incorporates beginner-friendly structures like setup() and loop(), making it approachable for those new to coding.

The IDE features a built-in library manager for easy integration of additional functionalities, while the Board Manager simplifies the process of selecting and configuring Arduino boards. The Serial Monitor aids in debugging by enabling communication between the Arduino board and the computer. Furthermore, the IDE supports a vast array of Arduino boards and provides a rich repository of examples for users to explore. As an open-source platform, it encourages community contributions and extensibility, allowing users to customize their development environment. With a commitment to user-friendly design, the Arduino IDE remains a vital resource, fostering innovation and collaboration within the expansive Arduino community.

Beyond its foundational features, the Arduino IDE empowers users with a dynamic and extensible environment. Its open-source nature invites developers to contribute and adapt the IDE to specific project requirements. The inclusion of a library manager facilitates the incorporation of pre-built code modules, streamlining the development process. The Board Manager not only simplifies the selection of Arduino boards but also ensures seamless integration of necessary drivers. This compatibility extends to a diverse range of Arduino boards and clones, providing flexibility for various hardware projects. The Serial Monitor, a key debugging tool, establishes a communication bridge between the Arduino board and the computer, aiding in real-time data analysis and troubleshooting. For both novices and seasoned developers, the IDE's rich collection of built-in examples serves as an invaluable resource. These examples cover a spectrum of functionalities, enabling users to grasp different aspects of programming and hardware interaction.

1. Installation:

- You can download the Arduino IDE from the official Arduino website (https://www.arduino.cc/en/Main/Software).

- It's available for Windows, macOS, and Linux, making it versatile for various operating systems.

2. User Interface:

- The Arduino IDE has a simple and user-friendly interface.

- It consists of a text editor for writing code, a toolbar for common functions, and a message area that displays compilation and upload status.

3. Programming Language:

- Arduino programming uses a simplified version of C and C++ languages. The code structure includes setup() and loop() functions, making it accessible for beginners.

4. Libraries:

- The IDE includes a library manager, allowing users to easily add and manage libraries that provide additional functionalities.

5. Board Manager:

- The Board Manager in the Arduino IDE allows users to select the type of Arduino board they are using and install the necessary drivers.

6.Serial Monitor:

- The Serial Monitor is a tool within the IDE that helps in debugging by allowing communication between the Arduino board and the computer via serial communication.

7. Upload and Compile:

- Once the code is written, users can compile and upload it to the Arduino board directly from the IDE through a USB connection.

8. Examples:

- The IDE comes with a variety of built-in examples that users can explore to understand different functionalities and components.

9. Open Source:

- Arduino IDE is open source, allowing users to contribute to its development and customize it according to their needs.

10. Extensibility:

- The IDE can be extended with plugins and additional tools, providing flexibility for users with specific requirements.

11. Community Support:

- The Arduino community is active and supportive, making it easy for users to find help, tutorials, and resources online.

12. Compatibility:

- Arduino IDE supports a wide range of Arduino boards and clones, making it a versatile choice for various hardware projects.

**SolidWorks 2023:**

SolidWorks 2023 is a powerful computer-aided design (CAD) software package that allows engineers and designers to create, design, and simulate 3D models of products, parts, and assemblies. It is a popular choice for a wide range of industries, including automotive, aerospace, electronics, and manufacturing.

SolidWorks 2023 includes a number of new features and enhancements, including:

* Enhanced productivity: New tools and workflows to help you design and engineer faster.
* Improved performance: Significant performance improvements to help you work with large and complex models.
* Enhanced collaboration: New tools to help you collaborate with colleagues and stakeholders.

Key features of SolidWorks 2023 include:

* Part modelling: Create 3D models of parts using a variety of features, including extrudes, revolves, blends, and sweeps.
* Assembly modelling: Create 3D models of assemblies by combining parts together.
* Drawing creation: Create 2D drawings of parts and assemblies.
* Simulation: Simulate the behaviour of parts and assemblies using finite element analysis (FEA) and computational fluid dynamics (CFD).
* Data management: Manage your CAD data using PDM (Product Data Management) software.

Benefits of using SolidWorks 2023 include:

* Improved product quality: Create high-quality products that meet your design and engineering requirements.
* Reduced development time: Design and engineer products faster and more efficiently.
* Reduced costs: Save money by reducing the need for physical prototypes.
* Improved communication: Communicate your design intent effectively with colleagues and stakeholders.

Overall, SolidWorks 2023 is a powerful and versatile CAD software package that can help you create innovative and high-quality products. It is a valuable tool for engineers and designers in a wide range of industries.

**Creality Slicer Cura:**

Creality Slicer is a software tool developed by Creality, a leading manufacturer of 3D printers, to prepare 3D models for printing. It's specifically tailored for use with Creality's range of 3D printers, such as the Ender series and CR-10 series. Creality Slicer is based on the popular open-source slicing software Cura, but it's customized and optimized for use with Creality printers, providing users with a seamless and user-friendly experience.

Here are some key features and functionalities of Creality Slicer:

User Interface (UI): Creality Slicer features a user-friendly interface designed to simplify the 3D printing process for beginners while offering advanced options for experienced users. The UI is intuitive and easy to navigate, making it accessible to users of all skill levels.

Slicing Engine: Like other slicing software, Creality Slicer uses a slicing engine to generate the toolpaths and instructions necessary for the 3D printer to create the physical object layer by layer. It supports various slicing settings such as layer height, infill density, print speed, and support structures to customize the printing process according to the user's preferences and requirements.

Printer Compatibility: Creality Slicer is optimized for use with Creality's lineup of 3D printers, ensuring seamless compatibility and integration. Users can select their specific Creality printer model from a predefined list within the software, which automatically configures the slicing settings for optimal print quality and performance.

Predefined Profiles: Creality Slicer comes with predefined printing profiles tailored for different filament types (e.g., PLA, ABS, PETG) and print resolutions. These profiles serve as starting points for users, allowing them to quickly select the appropriate settings for their printing project without needing to configure each parameter manually.

Customizable Settings: While Creality Slicer offers predefined profiles for convenience, users also have the flexibility to customize slicing settings according to their specific needs. Advanced users can fine-tune parameters such as retraction settings, print temperatures, and print speeds to achieve optimal print quality and performance.

Visual Preview: Creality Slicer provides a visual preview of the sliced model, allowing users to inspect the toolpaths, layer heights, and support structures before initiating the print. This preview helps users identify potential issues and make adjustments to optimize the printing process.

Multi-Platform Support: Creality Slicer is compatible with multiple operating systems, including Windows, macOS, and Linux, ensuring accessibility to users regardless of their preferred platform.

**TECHNOLOGY STACK**

**Arduino UNO Microcontroller:**

The Arduino Uno board features a microcontroller unit (MCU) at its core, typically an ATmega328P from Atmel (now owned by Microchip Technology). This MCU operates at 16 MHz and has 32 KB of flash memory for storing the user's program, 2 KB of SRAM for variable storage, and 1 KB of EEPROM for data that needs to be retained even when power is removed. Additionally, the board includes 14 digital input/output pins, of which 6 can be used as PWM outputs, and 6 analog input pins. There are also power pins, including 5V, 3.3V, and ground, to power external components. The board is typically powered via USB or an external power supply.

Programming Environment:

The Arduino Uno is programmed using the Arduino Integrated Development Environment (IDE), which provides a user-friendly interface for writing, compiling, and uploading code to the board. The programming language used is a simplified version of C++ with a set of Arduino-specific libraries that abstract away low-level details, making it easier for beginners to get started with embedded programming. Advanced users still have the flexibility to access lower-level features of the microcontroller when needed.

Expansion and Compatibility:

One of the key features of the Arduino Uno is its expandability. The board is compatible with a wide range of shields—plug-in boards that extend its functionality. These shields can add capabilities such as wireless communication (Wi-Fi, Bluetooth, etc.), motor control, GPS, LCD displays, and more. Additionally, the Arduino Uno can communicate with other devices via various protocols such as I2C, SPI, UART, and USB, further expanding its compatibility with external components.

Community and Ecosystem:

The Arduino platform has a vast and active community of users, ranging from beginners to experienced professionals. This community contributes to an extensive library of code examples, tutorials, and projects that users can leverage for their own creations. Forums and online communities provide support and troubleshooting assistance, making it easier for users to overcome challenges and learn from others' experiences.

Applications:

The versatility of the Arduino Uno makes it suitable for a wide range of applications. It is commonly used for prototyping and developing projects in areas such as home automation, robotics, Internet of Things (IoT) devices, data logging, interactive art installations, and educational tools. Its ease of use and affordability make it particularly popular in educational settings, where it is used to teach electronics, programming, and engineering concepts.

In Smart Glass Cleaning Robot, the Arduino uno acts the brain of the robot and controls the bldc motors and l298n motor driver and it also receives input signal from the receiver module and based on the signal from receiver the Arduino uno sends signal to the l298N driver which controls the four 200 RPM n20 motor.

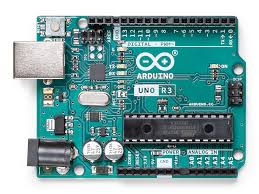


Fig: Arduino Mega Microcontroller

**1450KV BLDC Motor:**

A 1450kV (kilovolt) brushless DC (BLDC) motor refers to an electric motor commonly used in radio-controlled (RC) vehicles, particularly in electric-powered model aircraft, cars, boats, and other similar applications. The "kV" rating indicates the motor's velocity constant, representing the RPM (revolutions per minute) that the motor will turn per volt applied to it when there's no load.

Here are some key features and characteristics of a 1450kV BLDC motor:

1. Type:

* Brushless DC Motor (BLDC): Unlike brushed DC motors, BLDC motors use electronic commutation instead of brushes to control the direction of current flow in the motor windings.

2. kV Rating:

* 1450kV: The kV rating indicates the motor’s speed constant. In this case, the motor will theoretically rotate at 1450 RPM for every volt applied to it under no load conditions.

3. Application:

* RC Vehicles: 1450kV BLDC motors are commonly used in high-performance RC vehicles, such as cars, airplanes, helicopters, and boats.

4. Power and Torque:

* Power Output: The power output of the motor is determined by the voltage applied and the current drawn. Higher voltage generally results in higher power output.
* Torque: The torque produced by the motor is influenced by the design and construction of the motor, as well as the current flowing through it.

5. ESC (Electronic Speed Controller):

* BLDC motors are typically paired with an ESC, which is responsible for controlling the speed and direction of the motor by varying the timing and intensity of the electrical signals it sends to the motor.

6. Efficiency:

* BLDC motors are known for their high efficiency and reliability. They offer a good power-to-weight ratio and are capable of providing a significant amount of power for their size.

7. Sensor less Operation:

* Many BLDC motors operate without sensors, meaning they don’t require external sensors to determine the rotor’s position. Sensor less control is often used in RC applications for simplicity.

8. Cooling:

* Some high-performance BLDC motors feature built-in cooling mechanisms, such as fins or cooling fans, to dissipate heat generated during operation.

9. Customization:

* Many BLDC motors are available with various winding configurations, allowing users to choose motors that suit their specific performance requirements and voltage preferences.

10. Maintenance:

* BLDC motors are generally considered low maintenance because they lack brushes, which can wear out over time in brushed motors. This contributes to their longer lifespan.

11. Control Systems:

* BLDC motors are commonly used with advanced control systems, such as pulse-width modulation (PWM), to precisely control the speed and direction of the motor.

12. Voltage Range:

* The motor is designed to operate within a specific voltage range, and it’s crucial to stay within these limits to ensure proper performance and prevent damage.

When using a 1450kV BLDC motor with 3 blade propeller in Smart Glass Cleaning Robot, it generates a thrust upto 3000grams (1500 grams per motor) which enough to make the 2kg robot stick to the vertical surfaces like walls and glasses. The 1450 KV bldc motor speed is fixed and programmed to Arduino uno to make the bldc motor work at given fixed speed.



Fig: Brushless DC Motor

**80A ESC(Electronic Speed Controller):**

An 80A ESC (Electronic Speed Controller) is a device used in electrically powered RC (Radio Control) vehicles, particularly in model airplanes, helicopters, cars, boats, and drones. Let's break down the key aspects and functions of an 80A ESC:

Current Rating (80A): The "80A" designation refers to the maximum continuous current (in amperes) that the ESC can safely handle. This current rating indicates the maximum load the ESC can sustain without overheating or malfunctioning. It's crucial to choose an ESC with a current rating that matches or exceeds the current demands of the motor and the application to ensure safe and efficient operation.

Voltage Range: An 80A ESC typically supports a wide range of input voltages, commonly ranging from 2S (7.4 volts) to 6S (22.2 volts) LiPo (Lithium Polymer) batteries. This flexibility allows users to power their RC vehicles with various battery configurations while maintaining optimal performance and efficiency.

PWM (Pulse Width Modulation) Signal Input: The ESC receives control signals from the RC transmitter via a receiver. These signals, usually in the form of PWM pulses, determine the desired speed and direction of the motor. The ESC interprets these signals and adjusts the power supplied to the motor accordingly.

Motor Control: The primary function of the ESC is to regulate the speed and direction of the electric motor connected to it. By adjusting the timing and duration of the pulses sent to the motor, the ESC controls the motor's rotational speed and direction. Additionally, some ESCs offer features such as brake functionality and programmable settings for throttle response and motor timing.

Protection Features: High-quality ESCs often include various protection features to safeguard the motor and ESC from damage. These may include over-current protection, over-temperature protection, low-voltage protection (to prevent over-discharging the battery), and signal loss protection (automatically reducing motor power if the signal from the transmitter is lost).

BEC (Battery Eliminator Circuit): Many ESCs incorporate a BEC to provide power to the receiver and other onboard electronics (such as servos) using the main battery pack. The BEC typically steps down the voltage from the main battery pack to a lower voltage (such as 5 volts) suitable for powering the receiver and servos.

The 80A ESC used in the Smart Glass Cleaning Robot is capable handling currents upto 80A continuous discharge and 100A burst discharge, the 1450KV bldc motor used here uses 45A current at maximum speed and also uses upto 60A current burst speed (overload). The ESC is powered from 8400mah 16.8v lithium ion battery with discharge rating of 10C so that esc can power the motor with the current needed for its operation. We use 2 ESC here to control two different motors because one esc is not enough for two motors because the esc has chances of burning due to overload or motors running without any sync. The esc are controller through Arduino UNO which sends signal to the ESC, the in our project the motor is made to rotate at fixed speed so the code is defined accordingly.



Fig: 80A Electronic Speed Controller

**200 RPM N20 Motor:**

The 200 RPM N20 motor is a type of small DC motor known for its compact size, high torque, and relatively low speed of rotation, typically around 200 revolutions per minute (RPM). Here's a breakdown of its key features and applications:

Features:

Compact Size: The N20 designation typically refers to the size of the motor, with a cylindrical body measuring around 20mm in diameter. This compact size makes it suitable for applications where space is limited.

DC Motor: The N20 motor operates using direct current (DC) and is powered by a DC voltage source. It typically has two terminals for connecting to the power supply, providing a simple interface for control.

High Torque: Despite its small size, the N20 motor is capable of delivering relatively high torque, making it suitable for applications requiring the motor to exert a significant amount of force, such as driving small robots, mechanisms, or miniature vehicles.

Low Speed: The nominal speed of the N20 motor is around 200 RPM, although this can vary depending on the specific model and operating conditions. This low speed makes it suitable for applications where precise control and slower rotation speeds are required.

Efficiency: N20 motors are known for their efficiency, converting electrical energy into mechanical energy with minimal losses. This efficiency contributes to their suitability for battery-powered applications where energy consumption is a concern.

Applications:

Robotics: The high torque and compact size of the N20 motor make it popular for use in small robotic applications, such as robotic arms, grippers, and mobile robots. Its ability to deliver sufficient torque at low speeds enables precise control of robot movements.

Mechanical Systems: The N20 motor finds use in various mechanical systems and mechanisms, including gearboxes, actuators, and linear motion systems. Its high torque output makes it suitable for driving gears, pulleys, and other mechanical components.

Automotive Models: Hobbyists often use N20 motors in miniature automotive models, such as remote-controlled cars, trucks, and planes. The motor's compact size and efficient performance make it ideal for powering these small-scale vehicles.

Automation: In automation applications, the N20 motor can be used to drive conveyor belts, feeder mechanisms, and other automated systems where precise control of motion is required.

Consumer Electronics: Due to its small size and efficiency, the N20 motor is also found in various consumer electronic devices, including cameras, printers, and small appliances, where it provides motion control for moving parts or mechanisms.

The 200 RPM N20 motor is used here because of its very compact size contributing to lightweight nature while also retaining sufficient amount of torque and speed necessary for the Smart Glass Cleaning Robot. These four motors are controlled by L298N Motor Driver which takes commands from the Arduino uno microcontroller based on the input signal from receiver. They are controlled by two speed modes in which the cleaning mode makes the robot movements slower while the roam around mode makes the robot faster.



Fig: Johnson Motor

**L298N Motor Driver:**

The L298N motor driver is a popular integrated circuit (IC) commonly used to control and drive DC motors, stepper motors, and other inductive loads in various electronic projects. It serves as an interface between a microcontroller or other control system and the motors, providing the necessary circuitry to control motor speed and direction. Here's a breakdown of its key features and functionalities:

H-Bridge Configuration: The L298N motor driver typically incorporates two H-bridge circuits. An H-bridge is an electronic circuit that allows a voltage to be applied across a load (such as a motor) in either direction, enabling bidirectional control of the motor's rotation. Each H-bridge consists of four transistors arranged in a configuration that can reverse the polarity of the voltage applied to the motor terminals, thus controlling its direction.

Dual Motor Control: With its two H-bridge circuits, the L298N driver can control two motors independently, allowing for simultaneous control of speed and direction for each motor. This capability makes it ideal for applications such as robotics, where multiple motors need to be controlled.

High Current Handling: The L298N is capable of handling relatively high currents, typically up to 2A per channel (or 4A peak), depending on the specific model and operating conditions. This makes it suitable for driving a wide range of motors, including small DC motors and stepper motors used in various projects.

Built-in Diodes: The L298N includes built-in diodes (often referred to as "freewheeling" or "flyback" diodes) across each H-bridge to protect the driver and other components from voltage spikes that occur when the motor is turned off. These diodes allow the energy stored in the motor's inductive load to dissipate safely, preventing damage to the driver and ensuring reliable operation.

Control Inputs: The L298N driver typically accepts four control inputs per motor: two inputs for controlling motor direction (one for forward and one for reverse) and two inputs for controlling motor speed (using pulse-width modulation, or PWM). By varying the PWM signal, the motor's speed can be adjusted proportionally.

Versatility: While commonly used for controlling DC motors, the L298N can also be used to drive stepper motors by controlling the current flow through each motor coil. This versatility makes it suitable for a wide range of applications, including robotics, automation, and hobbyist projects.

Ease of Use: The L298N is relatively easy to use and can be interfaced with a microcontroller or other control system using simple digital signals. It typically requires minimal external components, such as capacitors for decoupling and protection diodes for the motors.

The L298N motor driver in Smart Glass Cleaning robot is used to control the four 200 RPM N20 motors which are used for the movements of the robot. The receiver send control signals to Arduino UNO and then microcontroller controls the motor driver accordingly.

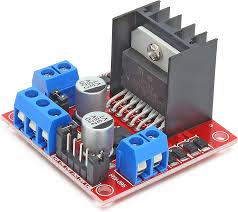


Fig: L298N Motor Driver

**Flysky Transmitter and Reciver:**

The Flysky FS-i6 transmitter and IA6B receiver are components of a radio control (RC) system commonly used in remote-controlled vehicles, such as RC airplanes, helicopters, cars, and boats. Let's explore each component:

**1. Flysky FS-i6 Transmitter:**

The Flysky FS-i6 transmitter is a feature-rich, 6-channel radio transmitter designed for controlling RC models. Here are its key features:

6 Channels: The FS-i6 transmitter provides control over six channels, allowing users to operate various functions of their RC model, such as throttle, elevator, aileron, rudder, and auxiliary channels for additional features like retractable landing gear or camera gimbal control.

2.4GHz Frequency: It operates on the 2.4GHz frequency band, which offers reliable control with minimal interference. The spread spectrum technology used in 2.4GHz radios helps to avoid frequency conflicts, allowing multiple RC enthusiasts to operate their models simultaneously without cross-talk.

LCD Display: The transmitter features an LCD display that provides real-time feedback on battery voltage, signal strength, trim settings, and other important information. This display enhances user experience by providing essential feedback during operation.

Programmable Functions: The FS-i6 transmitter offers programmable functions, allowing users to customize settings such as servo reversing, exponential rates, dual rates, and endpoints to suit their preferences and the requirements of their specific RC model.

Model Memory: It typically supports model memory, enabling users to save and recall settings for multiple RC models. This feature simplifies the process of switching between different models without the need to reconfigure settings each time.

Compatibility: The FS-i6 transmitter is compatible with a wide range of Flysky receivers, including the IA6B receiver, which we'll discuss next, as well as other Flysky receivers, making it a versatile option for various RC applications.

**2. Flysky IA6B Receiver:**

The Flysky IA6B receiver is a 6-channel receiver designed to work with the Flysky FS-i6 transmitter. Here are its key features:

6 Channels: Like the transmitter, the IA6B receiver supports six channels, allowing it to receive signals for throttle, elevator, aileron, rudder, and two auxiliary channels from the transmitter.

Compact Size: The IA6B receiver is compact and lightweight, making it suitable for use in a wide range of RC models without adding significant weight or bulk.

i-BUS Protocol: It supports the Flysky i-BUS protocol, which enables digital serial communication between the receiver and the transmitter, reducing wiring complexity and allowing for faster and more precise control signals.

Dual Antennas: The IA6B receiver typically features dual antennas, enhancing signal reception and reducing the likelihood of signal loss or interference, particularly in environments with obstacles or electromagnetic interference.

Telemetry Capabilities: Some versions of the IA6B receiver offer telemetry capabilities, allowing users to monitor real-time data such as receiver voltage, signal strength, and other telemetry sensors when used with compatible transmitters.

Compatibility: The IA6B receiver is designed specifically for use with the Flysky FS-i6 transmitter and is not compatible with other transmitter brands. However, the FS-i6 transmitter can also be used with other Flysky receivers, providing flexibility in system configuration.

The Flysky transmitter and receiver are synced together and used to send control signals to Arduino uno microcontroller which the controls the l298n motor driver based on the signals from receiver.



Fig: Drone Controller Set

**16.8 Volt Rechargeable Lithium Ion Battery:**

A 16.8-volt rechargeable lithium-ion battery with a capacity of 16800 mAh (milliampere-hours) is a power storage solution commonly used in various electronic devices and applications. Here's an overview of the key features and characteristics of such a battery:

Voltage (16.8V):

The voltage specification indicates the nominal voltage of the battery. In this case, the battery has a nominal voltage of 14.8 volts and goes upto 16.8volts on full charge. However, it's important to note that the actual voltage can vary depending on the state of charge and load conditions. Lithium-ion batteries typically have a voltage range, and the nominal voltage represents the average voltage during discharge.

Capacity (16800mAh):

Capacity refers to the amount of charge the battery can store and is measured in milliampere-hours (mAh). A higher capacity indicates that the battery can provide power for a longer duration before requiring recharging. In this case, the battery has a capacity of 16800mAh, which means it can theoretically supply a current of 16800 milliamperes (or 16.8 amperes) for one hour before being fully discharged.

C Rating (10C):

The C rating of a battery indicates its maximum discharge rate relative to its capacity. A higher C rating implies that the battery can deliver more current safely. In this context, the battery has a C rating of 10C. To calculate the maximum discharge current, multiply the C rating by the capacity of the battery in ampere-hours (Ah). Therefore, for this battery:

Maximum Discharge Current = C Rating × Capacity

= 10C × 16.8Ah

= 168 amperes

This implies that the battery can discharge at a maximum rate of 168 amperes without being damaged. However, it's crucial to operate the battery within its specified limits to prevent overheating, performance degradation, or safety hazards.

The 16.8V 16800mAh lithium battery with 10C rating is a combination of two 16.8volt 8400 mah battery with 10c rating which is the used the power the two separate ESC(used to control bldc motor) because independent esc requires independent power source so that they operate properly, the other components gets the power from the parallel connection of the two batteries so that they don’t disturb battery capacity of one single battery.



Fig: 16.8 V Rechargeable lithium Ion Battery

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