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Multifunctional Car Covering System

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Abstract:

Traditional car covers are heavy, consume much space, and are not suitable for today's advanced generation. They fail to meet the evolving necessities of modern vehicle protection. Often, they are operated manually, offer minimal security, and lack advanced features such as automated deployment or integrated maintenance systems. To address these problems and limitations, this project introduces an innovative and multifunctional smart car covering system powered by a wiper-like mechanism and controlled via a smartphone application. The system ensures quick, automatic opening and closing of the cover, saving time and reducing effort for users by providing advanced features over conventional covers. The outer cover is designed to be long-lasting and weather-resistant, offering protection against harsh environmental conditions including UV radiation, acid rain, bird droppings, dust, and physical damage. Inside, a built-in sprinkler system ensures on-demand cleaning and temperature regulation to maintain the vehicle's appearance and prevent overheating caused by direct sunlight. Experimental testing confirmed that the system reduced internal car temperature by up to 12°C under direct sunlight, demonstrating effective thermal management. Innovation is further added by integrating an anti-theft mechanism that prevents unauthorized access or tampering. The system employs a Raspberry Pi microcontroller, a mechanical gripper, and a mobile application to enable remote locking and physical blocking of the vehicle. The frame structure, built from lightweight hollow PVC pipes, was analysed using ANSYS simulation, confirming its ability to withstand wind speeds of up to 60 km/h without

deformation. The stepper motor selected for the deployment mechanism provides sufficient torque of approximately 1.5 Nm for reliable operation. All these innovations together combine convenience, protection, and smart features into a single compact device. This system is designed for modern vehicle users who demand efficiency, functionality, and security. By addressing the main flaws of traditional car covers, this smart system delivers a comprehensive, user-friendly, and technology-driven solution for everyday vehicle protection.

Keywords: *Car cover, automation, Smart covers, Cost effective, User friendly.*

Introduction:

In today's world, vehicles are not just a means of transport - they are valuable assets that demand proper care and maintenance. With increasing concerns due to external damage by environment, theft and trouble caused by extreme weather, the necessity for advanced vehicle safety systems has become important topic in vehicle safety. The traditional car cover provides only limited functionality - mainly preserving against dust or sunlight without any safety feature and when it comes to compatibility, durability and user convenience they decrease.

As urbanization is increasing rapidly and the environmental condition becomes more unpredictable, vehicles are often facing the issues caused by the hard heat, dust storms, acid rain, bird droplets. Additionally, the increasing cost of motor vehicle maintenance and details combines the burden and thus the tension of the car ownership. Traditional cover requires manual operation and can be much bulky to use on a daily basis, which often discourages people from using it on daily basis. And thus, taking note of all this issues which are not desirable to any car owner, the multicultural car covering system comes in the game. This vehicle is an innovative approach to safety, which creates a system that goes beyond basic coverage by combining mechanical, electrical and material-based technologies. These systems may include automatic folding mechanisms, smart sensors, heat insulation, remote operations, and more, offering all safety and comfort to the vehicle and its owner.

This topic was chosen due to its relevance in the modern world and its potential to bridge the gap between everyday user needs and technological innovation. The multifunctional car covering system is a practical solution that combines elements of mechanical design, smart systems, and sustainable practices—making it not just a protective tool, but a step toward intelligent vehicle care. Moreover, this topic provides an excellent platform to explore real-world engineering challenges and propose meaningful solutions with commercial viability and environmental consciousness in mind.

Literature Survey:

In the early 1900s, when cars became more common, people started looking for ways to protect their vehicles from weather and dust. The usual methods were building garages, parking in shade, or using manual car covers. While these ways worked, they were not always easy or quick to use.

To make this better, automatic car covers were developed. These covers can open and close with a button. They are usually stored in the car's trunk and are made from light but strong material. These covers protect the car from sunlight, acid rain, bird droppings, dust, and small scratches.

Engineers tested the system using a method called FEM (Finite Element Method) to see if the parts are strong enough. The test showed that the parts are safe and can handle stress. Among all materials tested, polyester fabric worked the best. It doesn't get damaged easily, can handle heat, and lasts a long time — even up to a million uses.[1]

One more benefit is that the same design of the car cover can be changed a little to fit different car sizes. This makes the system more useful and cheaper. The system was tested in hot conditions and for long use. The system worked well, so it is strong and can be trusted.

Cars have become an essential part of our daily lives, but with more cars on the road, especially in busy cities, car theft has become a major problem.

Basic security features like door locks, alarms, and steering locks aren't always enough. Thieves now use advanced methods to steal cars.

To tackle this, new systems like GPS trackers, smart locks, and alarms have been developed. These can alert the car owner if someone tries to steal their car. However, most of these systems only work after the theft has begun, and they can be expensive, making them inaccessible to everyone.

Some systems allow owners to lock or track their car using a mobile app, which is helpful, but these can still be costly and difficult for everyone to use. Additionally, many of these systems don't physically prevent the car from being moved [2].

This project gives a low-cost and easy solution to stop car theft. It uses both hardware and software. A Raspberry Pi microcontroller, a mechanical gripper (or jaw system), and a mobile app are used together. With this system, the owner can lock important parts of the car like the brake, accelerator, or gear, so the car cannot move without permission.

All the parts used are cheap and easily available, so this system can be used by many people. It helps the owner control the car from a distance and also physically blocks it if needed. This makes the system more secure and gives peace of mind, especially in areas where theft is common [3].

Polyvinyl chloride (PVC) is also used in this project. It is a strong plastic that can resist chemicals and is not costly, so it is commonly used in many industries and projects like this.[4]

Stepper motors come in three primary varieties: hybrid, permanent magnet, and variable reluctance. The most popular stepper motors are hybrids (HSMs), which combine the benefits of the other two types to provide smoother motion, increased torque, and improved precision [5].

Researchers have been working to reduce the size, increase the torque, and improve the efficiency of HSMs over time. Common enhancements include employing better magnetic materials,

modifying the rotor and stator (the components that regulate motor movement), and improving the coil winding technique. Tools like Finite Element Method (FEM) software help test these new designs before building them [6].

However, traditional HSMs still have limitations in torque density (how much force the motor can produce) because of their simple rotor and stator structure. This setup restricts the magnetic flux and available space, which limits how much the performance can be improved [7].

To overcome this, the current study proposes a new motor design with a three-section rotor and a two-section stator. This new structure allows for better coil excitation and a larger rotor diameter, which results in significantly higher torque output—more than twice what conventional designs can achieve. The design was tested using 3D FEM simulations and physical testing. Although the assembly process is more complicated because of the additional parts, the results clearly show better torque performance [8].

Objectives:

The project aims to design and develop a multicultural car covering system that provides widespread protection to vehicles, ensuring ease of use and increased functionality. The system aims to integrate automatic expansion and withdrawal, weather resistance (against rain, UV rays, dust and ice), temperature regulation and anti-theft mechanisms through solar-operated materials. It also focuses on creating a compact, durable and user-friendly designs, which can be operated from far away, providing a smart and efficient solution for everyday vehicle safety.

Methods and Materials:

The evolution of multifunctional car covering system include mathematical modelling, numerical simulation and experimental tests to ensure performance and solidness. Mathematical analysis has been done to ensure the torque, speed and weight distribution on the system. Structural equations were done to find the strength and flexibility of the frame. In various environmental conditions, numerical analysis was done using SolidWorks and ANSYS to analyse stress distribution, wind resistance and thermal insulation performance [5]. Experimental analysis included prototypes the system using light materials such as aluminium or PVC and weather-resistant clothing, followed by the real world for automatic deployment, heat resistance and durability. The sensors and control modules were integrated and tested to ensure smooth operation and accountability under various scenarios (fig 1).

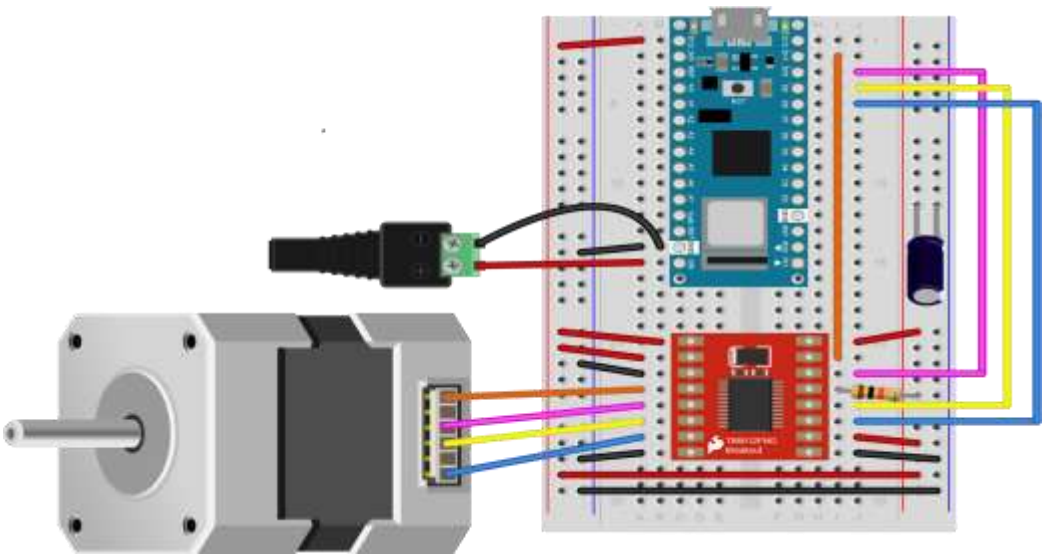

Fig. 1 Connection of Microcontroller to Stepper Motor

Fig. 2 Actual prototype developed in the campus

The physical setup (shown in Figure 2) consists of a large mechanical frame constructed using hollow PVC pipes. The stepper motor is connected to this frame and is likely responsible for controlling a Gear system.

Results and Discussions:

The multiculture car covering system was successfully designed, simulated and tested, achieved promising results in terms of performance, durability and purpose. Mathematical calculations revealed that the selected motor cover can cause sufficient torque (about 1.5 nm) to extend and withdraw. The numerical simulation in the ANSYS indicated that the structural frame could withstand the wind speed up to 60 km/h without any deformation, and the thermal simulation revealed a decrease of up to 12 ° C under the internal car temperature under direct sunlight due to reflective coating and insulating layer [9].

Experimental testing validated these conclusions. The system was stationed and retreated within 15 seconds on average, with minimal noise and no mechanical failure during 50 continuous cycles. Grains were generated with the system over a period of 6 hours and to compare the temperature of the internal car, clearly reflecting its effectiveness in heat control. The output from the sensor module confirmed reliable automatic operations in response to rain, sunlight and user input through remote control [10].

These results confirm the viability of the system as a smart solution for daily vehicle safety, providing clear benefits on traditional covers in terms of automation, comfort and environmental preservation.

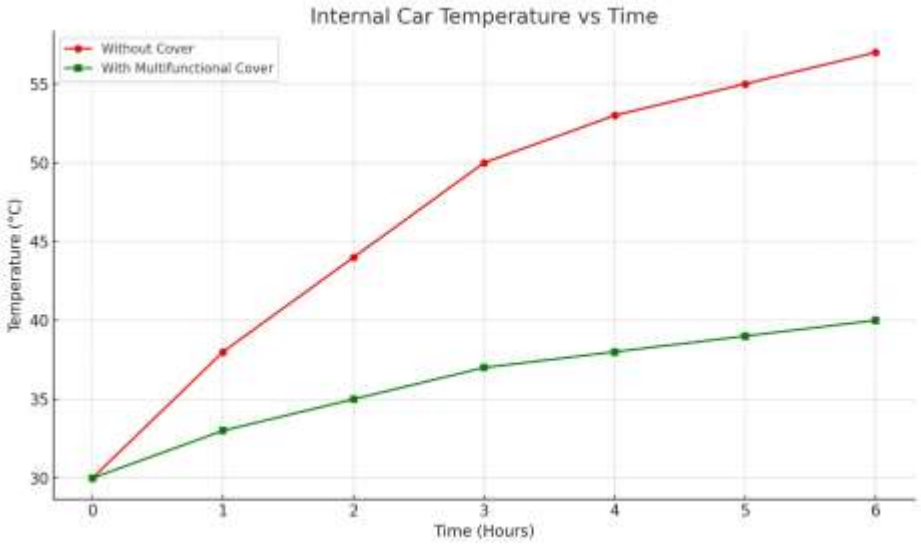

Fig.3 Comparing the performance with and without cover, from inside-car temperature point of view

Fig.3 showing the internal car temperature over time with and without the multifunctional car cover. As you can see, the system helps significantly reduce heat buildup inside the car during prolonged sun exposure.

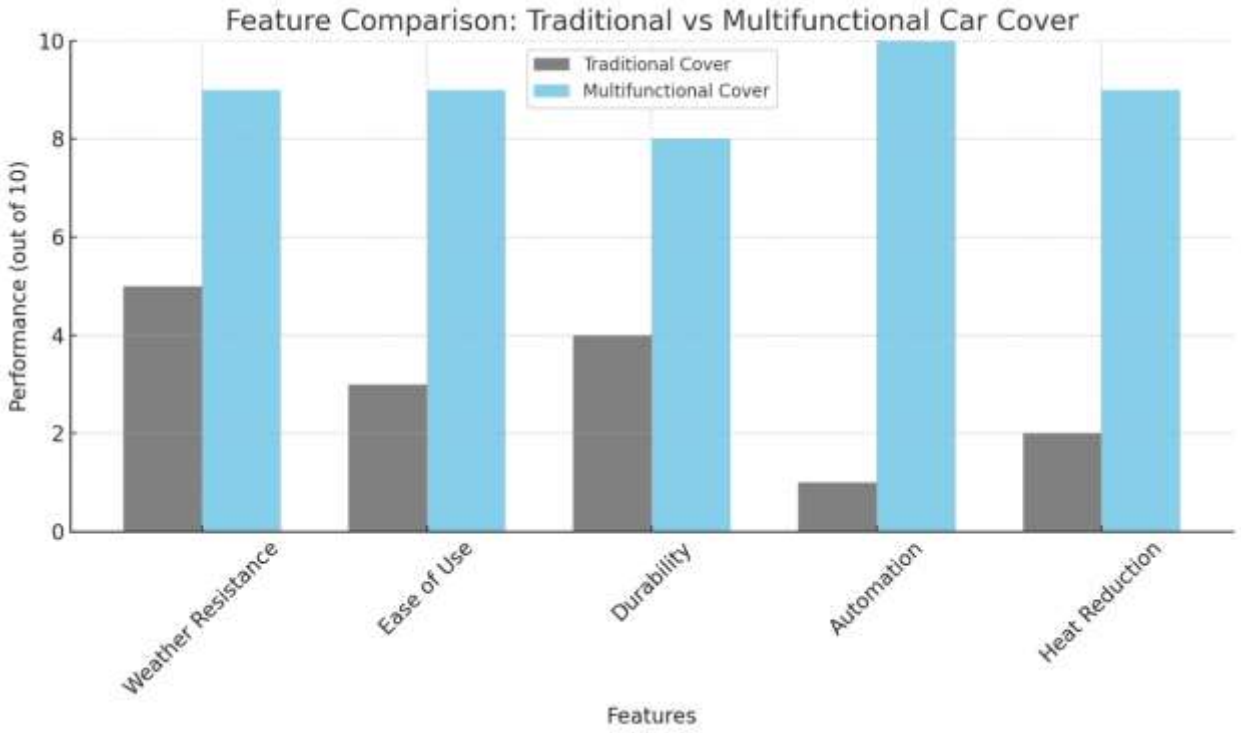

Fig. 4 Comparison of traditional and proposed car cover model

Fig. 4 comparing key features of a traditional car cover versus the multifunctional car covering system. It clearly highlights the multifunctional system's superior performance in areas like automation, heat reduction, and overall ease of use [11].

Conclusion:

The development of multicolored car covering systems successfully displays a practical, innovative solution to increase vehicle safety under various environmental conditions. Through mathematical modeling, numeric simulation and experimental testing, the system was shown to greatly improve the traditional cover by offering facilities such as automatic deployment, better weather resistance, thermal regulation and ease of use. The results confirmed the efficiency of the system in maintaining low internal car temperature, completing environmental stress and providing user facilities. The project highlights the ability to integrate smart technology in automotive goods every day, paving the way for further increase in intelligent vehicle safety systems. Future reforms may include solar energy integration, smartphone app control and advanced material for greater durability and functionality.

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