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Fabrication of Automatic Car Washing System with multiple features using IOT.

Akram Hossain[1]
Department of Mechatronics and Industrial Engineering,
Chittagong University of Engineering and Technology (CUET)
Chittagong, Bangladesh

Hrittik Mural[2], Adri Dash[3]
Lecturer
Department of Industrial and Production Engineering,
Bangladesh Army University of Science and Technology (BAUST)
Saidpur 5311, Bangladesh
hrittik@baust.edu.bd

Md. Firoz Kabir[5]
Assistant Professor
Department of Industrial and Production Engineering
Bangladesh Army University of Science and Technology. (BAUST)

Md. Foysal Rahman[4]
Department of Industrial and Production Engineering,
Bangladesh Army University of Science and Technology (BAUST)
faisalr090@gmail.com

Abstract

Automated car washing system is one of the most important applications for automobile engineering. Most of the time due to lack of time people cannot manage to wash their car properly. More than that chemical washer is also important for a car. And for that reason, we have proposed such a system that will automate car washing system with the help of IoT. The system will connect with a IoT module by which it will send HTTP request to the server. After that from the server it fetches the system variable into an android application. From that application user can control the overall car washing system. The main purpose of this system is to reduce human hand usage for car washing system. By this system a user can wash multiple cars at a time. So, the main novelty of work of this car washing system is to reduce human presence in car washing process. We shall see the output on android application as a data output. It will save both money and time.

Keywords
Microcontroller, Sensors, IoT Module, User Interface, Programmable Logic Controller.

1. Introduction
The Web of Things (IoT) presents a promising avenue for enhancing various aspects of daily life and business operations by improving connectivity and data exchange. A notable example of this potential is the wristwatch, which

monitors vital physiological functions while maintaining continuous connectivity to cloud-based systems. The intercommunication between embedded systems can significantly enhance efficiency, facilitate the development of innovative production processes, and provide deeper insights into consumer markets, particularly in sectors focused on end-user engagement. Beyond the mere transfer of data between computers, which simplifies access to information, IoT offers substantial potential for advancements in areas such as healthcare, education, safety, and other critical components of everyday life. This concept is often referred to as "Smart Businesses," or "Industries 4.0."

A survey conducted by 2ndWatch involving 500 IT and digital marketing professionals yielded insights that reflect both the current state and future potential of IoT. Notably, 29% of respondents viewed IoT as a tool for better understanding consumer behavior, while improving supply chain networks emerged as the second most cited benefit. For instance, data collected from bees as they enter and exit hives, facilitated by tiny sensors at hive entrances, provides valuable information for beekeepers and primary producers. The ability to remotely collect data extends beyond the corporate world and smartphone users; it is accessible to anyone.

An illustrative example of IoT application is in the automotive industry, specifically in car washing systems. IoT-enabled intelligent car washing systems are poised to significantly reduce the time and labor involved in the process. The proposed system divides the car washing procedure into distinct phases, such as cleaning, watering, and drying, and integrates them into an automated sequence. This not only ensures that vehicles are thoroughly cleaned but also helps restore them to their original condition, allowing drivers to operate them with ease.

The pervasive nature of technology in modern life underscores the need for innovation across all industries, including car washes. For car wash operators who have yet to adopt operational improvements, there is a risk of falling behind in a rapidly evolving market. Integrating innovative practices is essential to maintaining a competitive edge. In the car wash industry, early preparation is particularly crucial due to the significant financial and operational impacts of hardware failures or downtime.

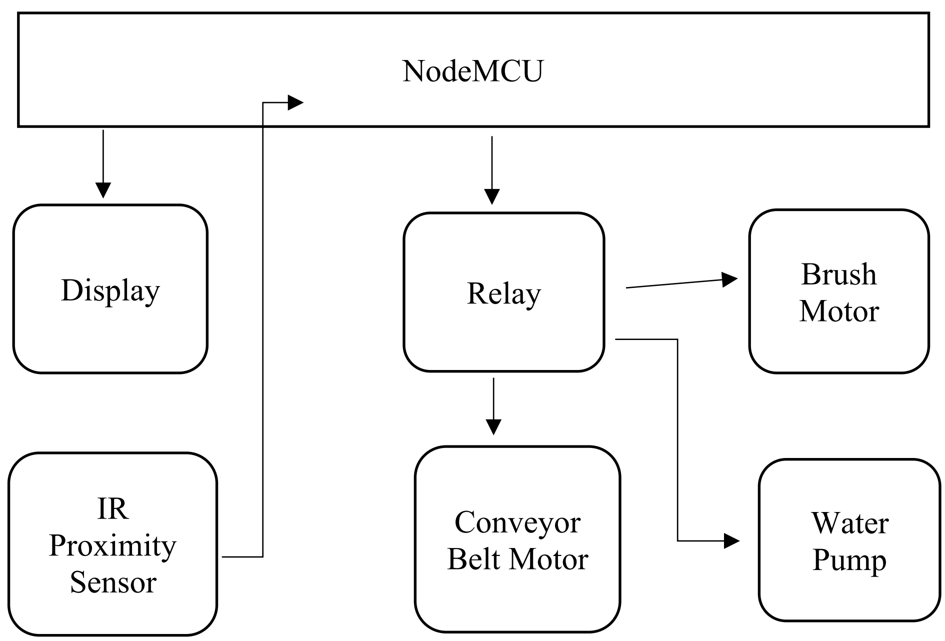

Figure 1. Block Diagram of the systrem

This challenge is further compounded in colder climates, where freezing temperatures can lead to operational shutdowns, frozen equipment, and costly repairs. IoT and robotic automation can mitigate these risks by providing real-time alerts on temperature fluctuations, thereby preventing damage before it occurs and ensuring continuous operation regardless of weather conditions. Additionally, these systems offer business owners and managers comprehensive visibility into all aspects of their operations at any time and from any location. The adoption of new technologies has revolutionized the car wash industry, enabling proprietors to monitor equipment status and tailor operations to their specific needs through mobile devices. This proactive approach helps prevent malfunctions, saving businesses both time and money.

1.1 Objectives
To monitoring car washing process over IoT
To executing car washing steps over IoT
To checking dust presence after cleaning.
To moving the car to its previous position after car wash through conveyer belt.

2. Literature Review
2.1 Introduction
The Internet of Things (IoT) has significantly influenced the automobile servicing industry, particularly in the car washing sector. Each year, numerous innovative car washing techniques are developed in response to evolving customer needs. Consequently, extensive research has been conducted to enhance the efficiency and effectiveness of car washing processes. This literature review aims to explore these developments and compare them with our current work, focusing on the applications of IoT in car washing systems.(*2023-Wiley-ScrivenerBookChapter-ApplicationofInternetofThingsIoTintheAutomotiveIndustry*, n.d.)

2.2 Historical Review and IoT
The evolution of the car washing industry dates back to 1940 when the first "automated" vehicle wash system was introduced in Hollywood, California. This system, while considered automated, utilized a winch system to move vehicles through the washing tunnel, where they were manually cleaned, rinsed, and dried by workers. The introduction of Thomas Simpson's semi-automatic car washing system in 1946 marked a significant advancement. This system featured a conveyor belt for moving cars through the wash, an overhead sprinkler for rinsing, and a 50-horsepower air blower for drying, showcasing Simpson's pioneering efforts in applying new technology to car washing.

In the early 1950s, the Anderson brothers in Seattle, Washington, launched the first hands-free automated car wash, where all cleaning processes were performed by machines, including pulling vehicles through the tunnel, soaping, scrubbing, rinsing, and drying. The 1950s and 1960s saw further innovations such as water recycling systems, soft cloth friction cleaning, and wraparound brushes, leading to the widespread establishment of car washes. Although these early systems differ from modern car washes, they represented a significant leap from the entirely manual methods of the 1910s.

Today, car washes continue to evolve, incorporating advanced features to cater to diverse customer preferences and financial needs. Modern car washes are becoming more environmentally friendly through the development of gentler detergents, equipment that consumes less water and energy, and water recycling systems that allow up to 95% of used water to be reused in subsequent washes. Given the high demand for car washes, it is likely that the car wash industry will continue to undergo significant transformations over the next fifty years.(*ISNCC 2018 : The 2018 International Symposium on Networks, Computers and Communications : 19-21 June, 2018, Rome, Italy* 2018)

2.3 The Internet of Things (IoT)
The term "Internet of Things" (IoT) refers to the network of interconnected devices and the technology that enables communication between these devices and the cloud, as well as among the devices themselves. The proliferation of low-cost computer processors and increased telecommunications bandwidth has led to billions of devices being connected to the internet. This connectivity allows everyday items such as toothbrushes, vacuum cleaners, cars, and appliances to gather data and respond intelligently to human inputs.The IoT connects everyday objects to the internet, enabling them to collect and exchange data. Since the 1990s, computer engineers have been integrating sensors and computers into various commonplace items. However, early efforts were hindered by the large and cumbersome nature of early chips. Initially, low-power microchips known as RFID tags were used for tracking expensive equipment. Over time, these chips have become smaller, faster, and more efficient, thanks to advancements in computing technology. The cost of embedding computing power into small devices has also decreased significantly, making it feasible to add connectivity features to everyday objects.

Today, IoT devices are ubiquitous in homes, businesses, and workplaces, forming a vast industry. These connected devices can automatically transmit data to and from the internet, facilitating real-time data collection and analysis.(Zhong et al. 2017)

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2.4 Previous Studies

Extensive research has been conducted on IoT technologies in the car washing industry. This section will review these studies and assess them in relation to the current work, with a focus on the advancements and applications of IoT in car washing systems.(Brous et al. 2020)

2.5 Study of the Patterns of Automatic Car Washing in the Era of the Internet of Things

The Web of Things (IoT) is revolutionizing traditional business approaches. The integration of the Web of Things and Web of Vehicles is ushering in an era of autonomous vehicles. Interestingly, over half of the global vehicle market comprises the aftermarket sector, which includes activities such as repair, washing, general vehicle care, insurance, and auto financing. Vehicle washing, being the most frequently utilized service, presents significant opportunities for online businesses. This paper introduces an IoT-based automatic vehicle washing model and explores its development from three perspectives: the deficiencies of current vehicle washing systems, customer attention towards vehicle washes, and technological advancements in IoT. This model proposes the development of a Vehicle Wash Cloud via IoT, integrating operators, vehicle washers, and leading automated vehicle washer manufacturers, thereby restructuring the automatic vehicle washing model. This research highlights the positive aspects of this approach, focusing on customer needs. Drivers can take their vehicles to the nearest automated wash, enjoy the automated cleaning service, and assess the quality of service provided. The automated vehicle washing model represents a novel business approach in the auto aftermarket, requiring not only support from the service sector post-manufacturing but also guidance from government and market capital.

2.6 Design Of A Password Protected Automatic Car Washing System

Keeping the exterior of a car clean often involves regular washing, typically performed manually at service centers or garages. This process requires considerable time and resources. To address this issue, automating the vehicle washing process is essential. While automated car washing systems are widely used in developed countries, they remain less common in developing nations like Bangladesh or India due to high costs and complexity. This paper presents a microcontroller-based password-protected automatic car washing system that is cost-effective, easy to use, and secure. The entire process, from foaming to brushing, washing, and drying, is automated. Users can access the system by entering their personal identification number (PIN) on a keypad, enhancing both convenience and security.(Al Banna et al. 2020)

2.7 Process of RO's Waste Water Reuse & Water Management in Society by Using IoT Automation

An increasing number of water purifier users face the issue of reverse osmosis (RO) systems wasting a significant amount of water to produce a smaller quantity of drinking water, with 75% of water being discarded. This waste can be repurposed for other uses instead of being wasted. India alone is responsible for the loss of over 2430 million liters of water daily. This paper proposes a method for reusing RO wastewater and managing water resources through IoT automation. The IoT and sensors are employed to develop a system that collects RO wastewater from individual homes into a single tank. This water can then be used for washing vehicles and irrigating public spaces. The design incorporates an ESP32 as a central component, alongside various sensors such as soil moisture sensors, water level indicators, and Digital Temperature and Humidity sensors (DTH11). Using Blynk software, the researchers have developed a user interface (UI) to monitor the system's live status. This design not only conserves clean water but also aligns with the Atmanirbhar Bharat initiative, aiming to establish a community dedicated to natural resource conservation.(Wimalawansa & Www 2008)

2.8Managing IoT-Defined Networks-Based Smart Healthcare Systems Traffic with Software

The Internet of Things (IoT) is an ambitious project aiming to connect billions of additional devices to the internet, generating an immense volume of traffic. A Wireless Body Area Network (WBAN) collects data from body sensors, either implanted or worn, and this data must be sent to a server on an edge node or in the cloud for further processing. The widespread adoption of IoT has enabled WBANs to offer users of smart healthcare applications a more contextual environment. Software-Defined Networks (SDN) is a relatively recent networking architecture offering centralized control and programmability. These characteristics open new possibilities for WBAN and IoT applications. This paper designs a personal digital assistant (PDA) as an SDN switch and simulates SDN functionality with Mininet, demonstrating its applicability in WBANs with minimal network complexity and overhead while efficiently managing connected devices and their interactions.(Wu et al. 2017)

2.9 DeepHealth: A Self-Attention Based Method for Instant Intelligent Predictive Maintenance in Industrial Internet of Things

The rapid development of artificial intelligence and the Internet of Things (IIoT) has significantly increased the focus on intelligent predictive maintenance (IPdM). Effective prediction of impending failures and mitigation of unexpected downtime are crucial for maintaining production capacity while meeting the immediate maintenance needs of modern workplaces. This paper introduces DeepHealth, a self-attention-based perception and prediction system for instant IPdM. The system consists of two submodels (DH-1 and DH-2), each used independently for health assessment and prediction. By improving the architecture, the proposed models predict health issues by anticipating future signal patterns, thereby facilitating instant IPdM. The enhanced attention mechanism captures global dependencies from vibration signals, leveraging long- and short-term sequence prediction of sensor signals to support real-time maintenance decisions. This study conducts a destructive experiment on IoT-enabled rotating machinery and generates a realistic dataset for model evaluations. The results demonstrate that the proposed solution achieves high accuracy in predicting instant IPdM using datasets from automated washing equipment and Case Western Reserve University.(Zhang et al. 2021)

2.7 Conclusion

An IoT-based car washing system can revolutionize the automobile industry by automating the entire process. This system not only washes cars but also integrates car tuning processes, offering a fully automated solution for vehicle maintenance.

3. Methods

3.1 **IoT Data Transmission Process**

Devices within the Internet of Things (IoT) ecosystem possess the capability to communicate through a multitude of protocols and methods. The specific communication method employed by these devices is influenced by their function, location, the systems they interact with, and the nature of the data they transmit. No single protocol can be universally considered the optimal choice, as the selection of a protocol is contingent upon the specific requirements of the application. A protocol serves as the "language" that enables IoT devices to exchange information. Consequently, the appropriate protocol selection must always consider the application's specific needs. Many IoT devices require aftermarket software or hardware to enable internet connectivity, as they were not originally designed with this capability. However, IoT functionality is increasingly being integrated directly into new products, leading to significant cost reductions and enhanced utility.

Despite the diverse challenges IoT devices address, they typically share a core set of components. These include:
A sensor to detect physical events, such as motion or a water leak.
Actuators that enable physical actions, such as activating a light or closing a valve.
Microprocessors that process the logic necessary for IoT functionality, linking the sensors and actuators.
Communication capabilities, such as wireless radios or wired connections like Ethernet, are essential for the device to be considered a connected device.

3.2 **Hardware Component**

1. NodeMCU.
2. 8 channel Relay.
3. 60 W SMPS Power Supply.
4. DC gear motor.
5. Water pump.
6. Cooler unit.
7. IR module.
8. LCD Display.
9. 12C module.
10. Vero Board.
11. Conveyor Belt.
12. Jumper wires and bread board.

4. Working Principle

Power Supply:

A 12V DC input powers the system, and relays and buck converters distribute the power to different parts.

Car Detection:

At every step, the car's position is determined by the IR proximity modules. Every module is in charge of a particular function, such as turning on the brush or starting pumps.

Control by NodeMCU:

- Based on the signals from the IR modules, the NodeMCU sends commands to the relay module.
- The relay module then switches the connected devices (e.g., pumps, fans) on or off as required.

Sequential Operation:

- As the car moves along the conveyor belt, each stage is activated in sequence:
  - Stage 1: Pumps spray water or soap.
  - Stage 2: Brushes clean the car.
  - Stage 3: Pumps rinse the car.
  - Stage 4: Drying fan activates.

Display:

- The LCD shows the current status (e.g., "Washing," "Drying," "Ready").

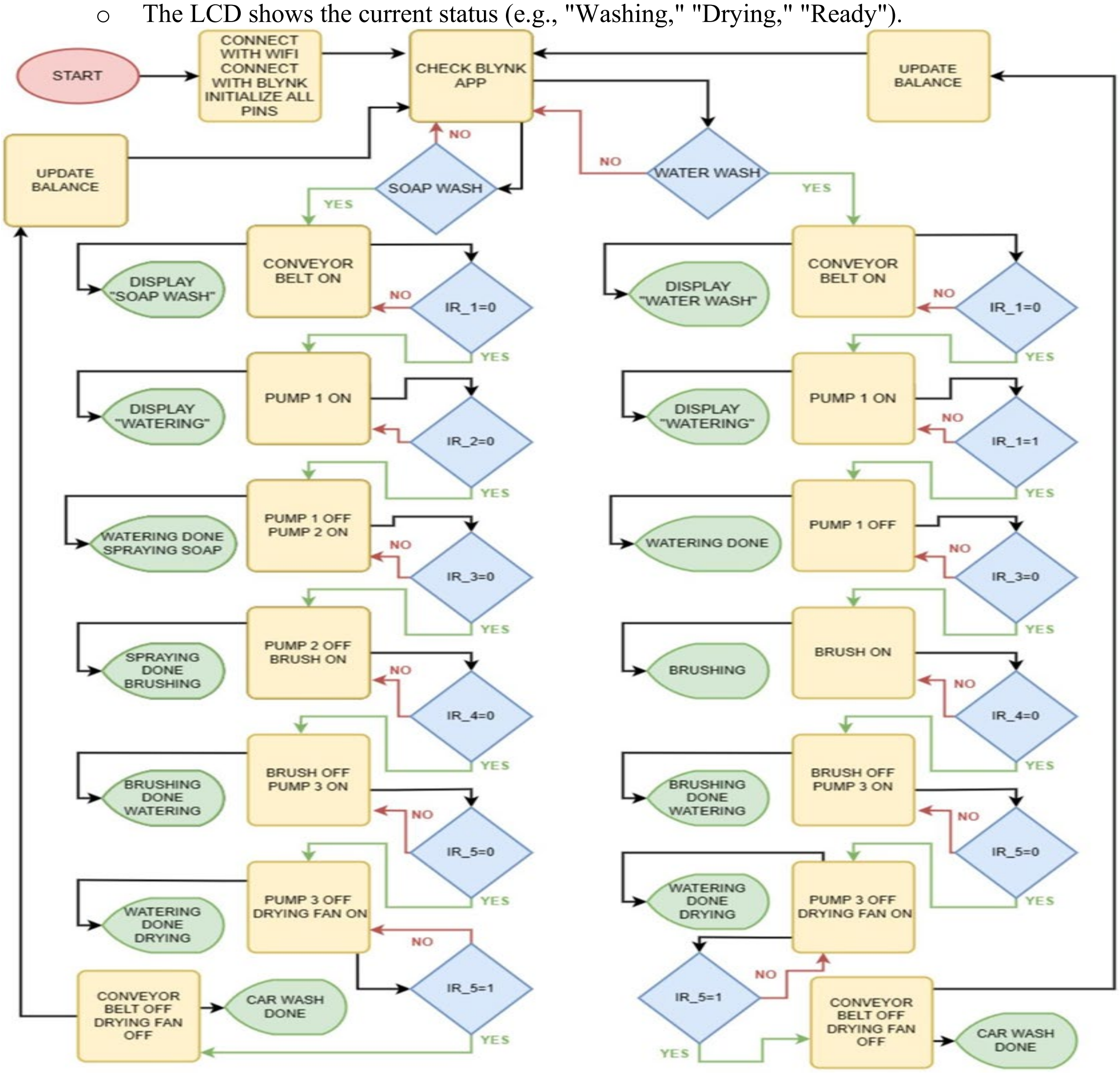

Figure 2. Overall Flow Chart of the system

This flowchart in Figure, outlines the operational procedure of an automated car washing system that uses IoT and integrates with the Blynk app. Here's a breakdown of the steps:

1. **Initialization**:
    - The system starts by connecting to Wi-Fi and initializing all pins, preparing for communication with the Blynk app.
2. **User Interaction**:
    - The system checks the Blynk app to decide between two options: "Soap Wash" or "Water Wash."
3. **Soap Wash Sequence**:
    - If "Soap Wash" is selected:

- The system activates the conveyor belt.
- Indicates that watering is in progress.
- Activates Pump 1 for watering.
- Once watering is finished, Pump 2 is activated to spray soap.
- The system then switches to brushing, activating Pump 3 to control the brushes.
- After brushing, it moves to the drying stage.
- Finally, the conveyor belt is turned off, and the car wash process is marked as complete.

Water Wash Sequence:
If "Water Wash" is chosen:
Similar to the soap wash, the conveyor belt is activated.
Watering and soap spray steps occur, followed by brushing.
The drying process then takes place.
The conveyor belt is turned off, completing the process.

Sensor Checks:
Throughout the process, infrared sensors (IR) monitor different stages, ensuring that each step is completed before moving on to the next.

Balance Update:
At various points, the system updates the user's balance based on the chosen washing option, ensuring real-time financial tracking.

Here the flowchart visually represents the sequence of operations in the automated car washing system, emphasizing the IoT integration and user interface through the Blynk app.

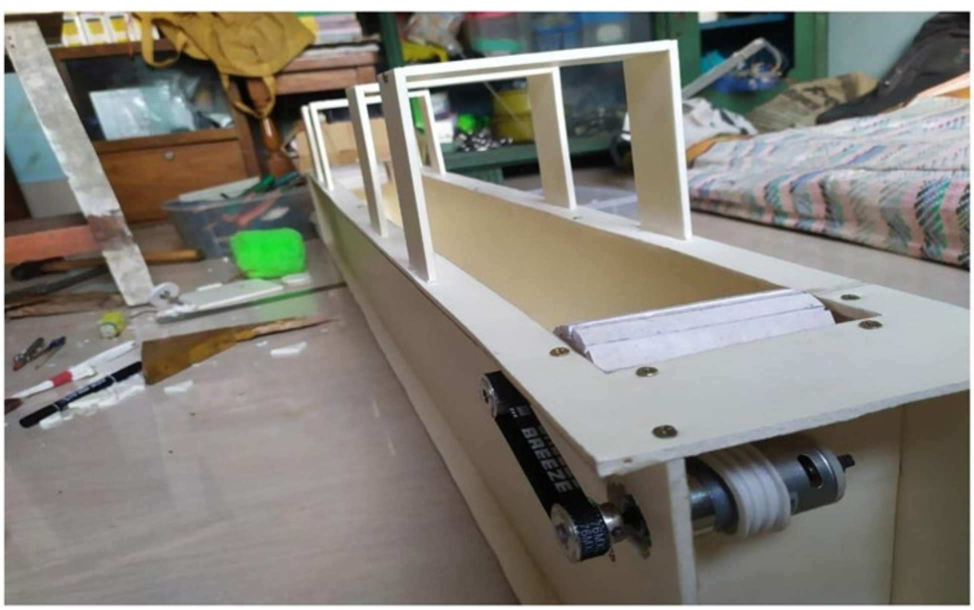

Figure 3. System Interface

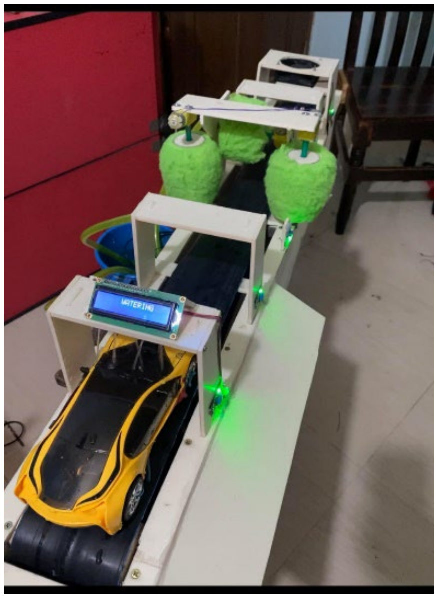

Figure 4. Side view of the system

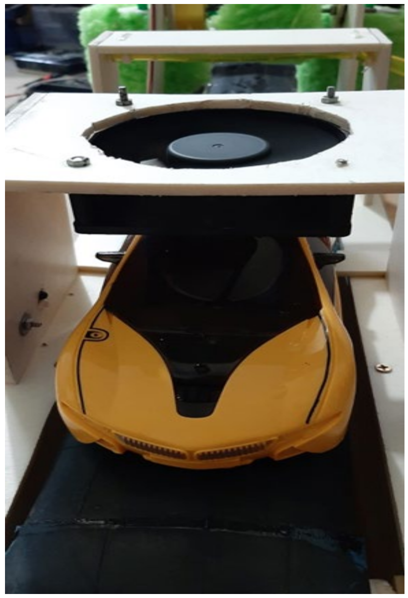

Figure 5. Top view of the system

Figure 6. Side view of the system

Connections

- **NodeMCU to IR Modules**:
    - Each IR module's output is connected to an input pin on the NodeMCU to send car detection signals.
- **NodeMCU to Relay Module**:
    - The NodeMCU sends control signals to the relay module's inputs (IN1-IN8).
- **Relay Module to Devices**:

- Each relay is connected to a specific electrical device (e.g., Pump 1, Brush) for switching.

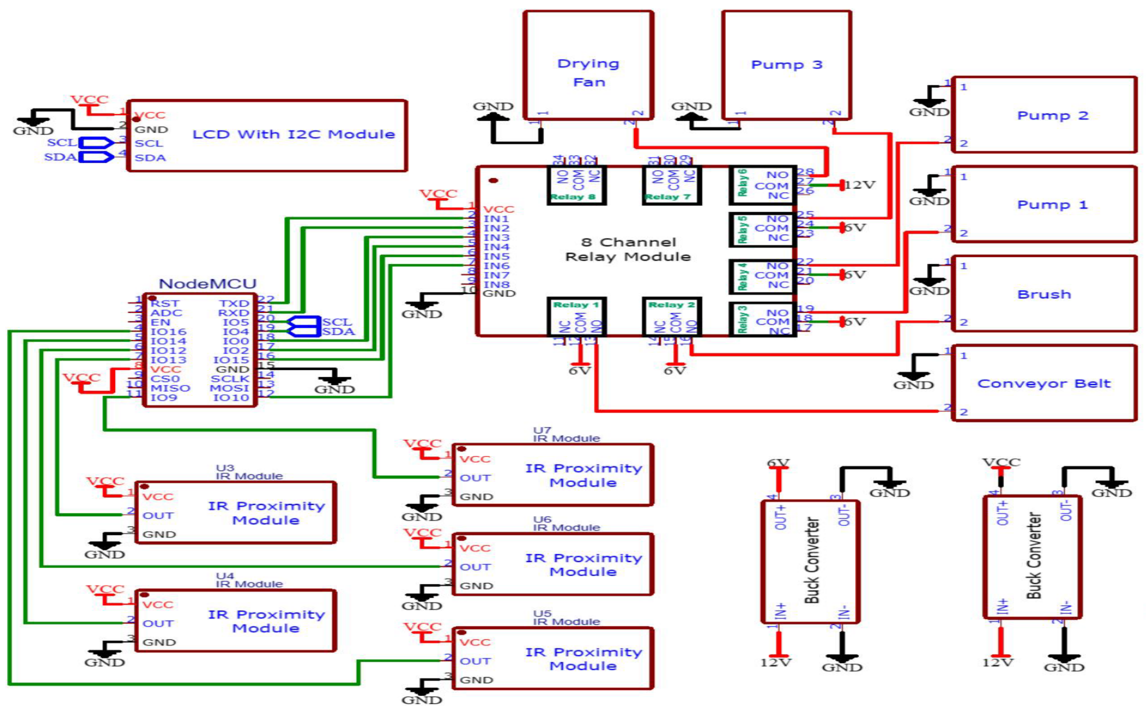

Figure 7. Circuit Diagram

5. Results and Discussion

By integrating with IoT technology, the manufactured automatic car wash system showed notable improvements in efficiency and functionality. Key steps in the car wash process, such as scrubbing, applying detergent, and spraying water, were all effectively automated by the system and managed remotely through a smartphone app. This invention demonstrated the possibility of doing away with manual intervention while maintaining uniform cleaning results for various car models.

When compared to manual methods, the system's operational efficiency resulted in a significant decrease in the amount of time needed for a full wash cycle. The synchronized operation of the conveyor system, pumps, and brushes was credited with streamlining the entire process and achieving this improvement. Furthermore, the precise detergent application and the improved water spray mechanism greatly decreased resource waste, which led to a discernible drop in the amount of water used for each wash.

The system's user-centric Internet of Things interface was another noteworthy result. Users could choose particular cleaning modes according to their needs thanks to the smartphone application's user-friendly platform for managing and personalizing the washing process. Positive test results for this feature demonstrated the system's potential for widespread user adoption in a variety of contexts.
The study also provided information about how well the system functions in practical settings. Even though the system worked well, there were certain issues that were noted, like keeping the water pumps' pressure constant and making sure the mechanical parts were durable. By addressing these issues, the system's dependability and longevity could be further increased.

Overall, the findings showed how well IoT integration works to automate vehicle wash procedures, opening the door for more resource-conscious, user-friendly, and effective solutions in the automotive service sector. Future advancements can concentrate on adding sophisticated sensors for real-time surveillance and improving the system's architecture to increase its durability and scalability.

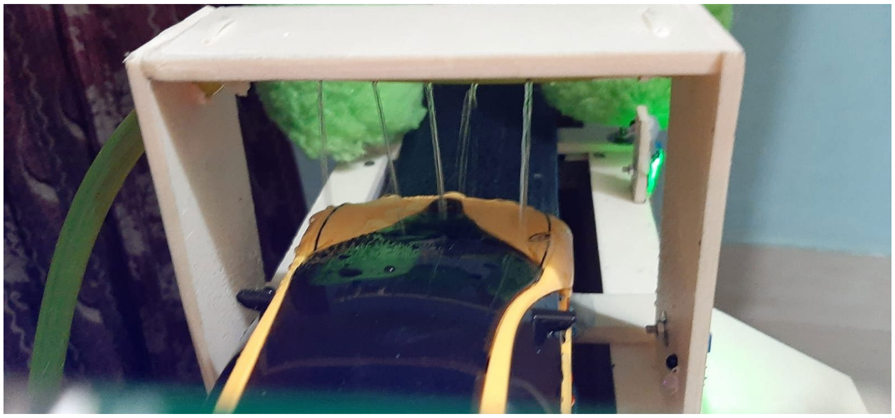

Figure 8. Washing of the Car by using IOT

5.1 Proposed Improvements

a) In future, we can replace the motor input with solar energy that it can be efficient, low-cost operation.
b) AI (Artificial Intelligent) can be used as grinding operation controller.
c) Coolant system can be built to prevent overheating.

6. Conclusion

To increase the efficiency of conventional car washing systems, this study developed and designed an automatic system. It primarily cleans, soaps, and dries the car completely on its own. A password is required to access the system. Therefore, it is simple to stop any unwanted misuse. Due to the system's complete automation, no unusual work is needed, saving a significant amount of time and money. In order to store vehicle data in its database, this system will have a data log. This will make the washing procedure more precise by managing distinct profiles for various automobile kinds. Water can be saved by washing cars with a water recycling system. Additional actions can be taken to put this system into place.

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Biographies

Akram Hossain holds a degree in Mechatronics and Industrial Engineering from Chittagong University of Engineering and Technology (CUET). With a strong foundation in engineering principles and practical problem-solving, Akram has developed significant expertise in mechanical systems and industrial processes.

Hrittik Mural has made notable contributions to industrial and system engineering through various projects and research. His work includes analyzing casting defects in gas burners using the Taguchi method, and he is preparing a review paper on advancements in wearable sensor technologies. He successfully integrated Six Sigma with Total Quality Management (TQM) to improve quality and reduce waste in the beverage industry, and utilized Multi-Criteria Decision-Making (MCDM) techniques to address supply chain disruptions in the steel and rolling industries in Bangladesh. His undergraduate thesis focused on real-time Bangla sign language detection using Long Short-Term Memory (LSTM) networks, achieving 96% accuracy.Mural has also designed and fabricated several innovative systems, including a pulley-based horizontal belt grinding machine, a contactless air conveyor, a smart door lock using RFID technology, and an automatic car washing system with IoT integration. He holds a certification as a Supply Chain Analyst from ISCEA. Mural graduated with a BSc in Mechatronics and Industrial Engineering from Chittagong University of Engineering and Technology (CUET). He currently serves as a Lecturer in Industrial Production Engineering at BAUST.

Adri Dash, a Bangladeshi Industrial and Production Engineer, is a lecturer at the Bangladesh Army University of Science and Technology (BAUST) in Saidpur. He holds a Bachelor of Science in Industrial & Production Engineering from Rajshahi University of Engineering & Technology (RUET) and has expertise in supply chain management, quality control, lean manufacturing, sustainability, and automation. Adri has held teaching and research positions at the National Institute of Textile Engineering and Research (NITER) and the Bangladesh Industrial Technical Assistance Centre (BITAC). His research focuses on innovative applications in supply chain management and sustainable manufacturing, with notable publications on multi-objective job-shop scheduling and supply chain resilience in Bangladeshi industries. His project portfolio includes designing safety and automation devices like automatic hand sanitizers and gas leakage detectors. Adri has been an active member of professional and academic societies, earning awards like Student of the Year and multiple scholarships

Foysal Rahman is an undergraduate student in the department of industrial and production engineering at Bangladesh Army University of Science and Technology, Saidpur. He has an interest in research and development. Also, he is a senior executive member of the IEOM Society student chapter and secretary admin of the IPE Club at BAUST.
Email: faisalr090@gmail.com

Md. Firoz Kabir is an Assistant Professor and Head of the Department of Industrial and Production Engineering (IPE) at BAUST, Saidpur. He holds a BSc and MSc in IPE from RUET and is pursuing a Ph.D. in the same field. With academic experience since 2017, he has served in teaching and administrative roles, including Program Coordinator and Department Head. His research focuses on optimization, manufacturing processes, natural fiber-reinforced composites, and solid waste management, with notable publications in respected journals. He is a professional member of IEOM Society International and contributes to the Center for Engineering, Research, and Revision Services (CERRS Ltd.), enhancing academic and industrial applications in his field.