

Automated Car Wash Systems

1. Introduction to automated car wash systems

With the average person's busy schedule, finding time to hand wash a car isn't easy. Hand washing wastes more water on average and getting a thorough clean can be difficult, it's also very time intensive. Automated car wash systems are more water efficient, clean more effectively, and take far less time than hand washing.

1.1. History

The first car wash started in 1914 in Detroit, America. It was a tunnel with different stations that the car would be pushed through where workers would hand wash each car. In 1946 Thomas Simpson introduced semiautomatic car washes, with overhead sprinklers and an air blower to dry the vehicle. Only 5 years later the first fully automated system was developed which included machine powered soaping, scrubbing, rinsing, and drying. Today, car washes are fully automated using PLC technology. Motors, gantries, pumps, and sensors to fully automate the process.



Figure 1: Automated Laundry - 1914 Detroit

1.2. Needs and Usefulness

Automatic car washes have several important benefits over hand washing. Hand washing is water inefficient, careful control over the amount used is difficult when washing by hand. Automated car washes use solenoid valves and pumps to carefully control the amount of detergent and water used for each wash. The runoff is recycled through in-floor drains, reducing the amount of fresh water being consumed. A heavy emphasis is placed on water usage in the development of car wash systems.



Figure 2: Modern Car Wash - Softcare Pro

Automatic car washes can clean more thoroughly than hand washing. Brushes are driven by brushless DC motors, the depth and speed of these brushes are controlled by a PLC to thoroughly clean caked on dirt. Combined with the careful control of soap and water the system can thoroughly clean a car in minutes as opposed to hand washing which can take upwards of half an hour. Car washes also use specialised detergent that increase the resilience of the paint on the car.

A major benefit of the automatic system is that it takes no human input or effort to operate. This is especially useful for people who are unable to clean their car without assistance, people with disabilities or the elderly may struggle or be unable to clean their car. Automatic car wash systems enable anyone regardless of ability or experience to perform key maintenance on their car. It is also important for large vehicles that cannot be cleaned well by hand.

2. Operating Principle

2.1. Overview

Automated car washes have four main stages.

1. First the car is parked in the bay or loaded onto the conveyor, some car wash systems use lifts or pressure cylinders to raise the car and allow cleaning of the undercarriage.
2. Next, solenoid valves and pumps are programmed to open at specific intervals dispensing detergent and water. This allows careful control cleaning agents used.
3. Brushes are operated on gantries or arms and driven by induction motors to brush and clean the car. Water is also applied to clean off dirt as it's brushed and remove detergent.
4. After the wash cycle is complete the car is dried with high powered air to remove moisture. The car is then ready for the customer.

These four stages ensure the car is cleaned thoroughly, and careful control means a more efficient clean. This is why PLC technology is essential to car wash systems.

2.2. Roll Over Systems

Roll over systems have a moving gantry that can move back and forth across the car on a linear rail. The car is kept stationary, making this the most compact configuration. The gantry has several jets that disperse detergent and water. Brushes are equipped that can determine the amount of force applied to the car based on the load on the motor, and accurately clean the car without damaging it. This configuration is widely adapted for large trucks and semi-trailers, as well as commercial vehicles. Since a long conveyor is unnecessary this configuration is compact and easily deployed at petrol stations or car parks. Its much easier to recycle water through this system as there is less chance for water to splash where it can't be drained. All equipment is mounted to the gantry, allowing all equipment to access every part of the vehicle.



Figure 3: Rollover System - Softcare Pro Classic Race

2.3. Conveyor Systems

Conveyor based systems have a long conveyor that the car is loaded onto with cleaning equipment positioned on either side along the conveyor. As the car is pulled through the bay jets of water and detergent, as well as various brushes, clean the car. These systems use IR sensors to determine the position of the car. This is important for making sure the system does not damage the vehicle, and so that the system only uses water when it needs to. These systems allow for much more customisation, brushed designed just to clean the tyres and rims, or floor mounted jets. More advanced car washes have cleaning equipment that follow the car on rails to reduce cleaning time. These systems use the most amount of space due to the lengthy conveyor, however they are also the fastest system that is widely used.

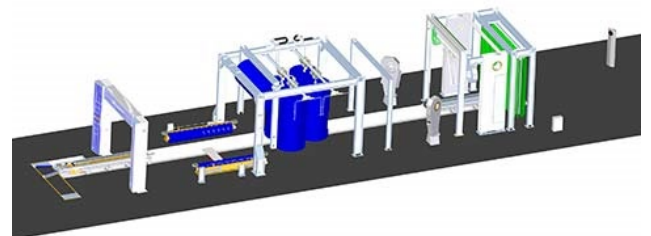


Figure 4: Conveyor car wash system – SoftLine2 Vario

2.4. Touchless Systems

Touchless systems make no contact with the vehicle with physical scrubbers. Instead, they use carefully controlled high pressure jets to pressure wash dirt of the vehicle. These systems can use gantries, conveyors, or both to clean a vehicle with little risk of damage. Where contact-based systems can potentially damage sideview mirrors and chip paint, there is lower risk of this in touchless systems. Due to the lack of scrubbing, these systems are typically less effective at cleaning than conventional systems. These systems aren't widely adopted, much development is needed before these systems can match previous cleaning systems.



Figure 5: Touchless car wash system

3. Companies and Market Survey

The largest market for automatic car wash systems is in North America, with an estimated market size of \$15.21 billion (USD) in 2022, accounting for 51% the global market size of 31.06 billion (USD) [1]. Car washes are popular in North America with many people needing a car to commute. The main suppliers for car wash hardware consist of: Sonny's, WashTec, Belanger, and Tommy's Car Wash. Smaller markets exist in Europe at 23% and Asia Pacific at 20% [1]. Australia's market size was approximated at \$642 million (USD) in 2022 and is estimated to reach \$930 million (USD) by 2030 [2]. Major manufacturers and suppliers include PDQ Manufacturing, MHCW AVW Equipment, WashTec, Motor City Wash Works.

4. Challenges and Improvements

4.1. Ecological Impact

A major concern with car wash systems is the ecological impact of the detergents used. Without proper wastewater management, and detergents often seeped into the ground or local water systems. Detergents such as these would be incredibly damaging to local flora and fauna.

Developments in biodegradable detergents are reducing the potential impact on the environment. Effective wastewater management and recycling is being used to reduce the water and detergent used.

4.2. Water Shortages

Water shortages and limitations are one of the major challenges in the development of car washes. Many countries are experiencing the impact of climate change, and with it there are significant issues with water supply. In Australia there are significant water restrictions around bushfire season, as well as throughout summer. Water efficiency is an important consideration when designing and deploying a car wash in an area.

4.3. Maintenance

Maintaining and repairing car wash systems is essential for ensuring safe and effective operation. Since many car washes are deployed remotely in service stations or car parks, its important to have an effective way to monitor systems. With the use of PLC systems, a car wash can be monitored from offsite. The Internet of Things will allow even more detailed monitoring, using smart devices and monitoring equipment to collect telemetry data for day-to-day operation. With this data and information on operation of the components, accurate maintenance schedules can be made. Component failure can be predicted and effectively dealt with, decreasing downtime.

5. The Future of the System

5.1. AI Computer Vision

With the implementation of AI becoming more and more advanced, its potential applications have become increasingly apparent. With the use of AI cameras can be used to visually identify dirtier parts of a vehicle. If a vehicle is particularly dirty in specific areas, the system can focus attention there. If a car is not particularly dirty the system could save water and run the scrubbers slower. This has the benefit of making sure the car is completely clean whilst using the smallest amount of resources possible.

5.2. Eco Friendly Development

Development in ecofriendly and biodegradable detergents, water recycling, and renewable energy, technology exists to make car wash systems more efficient than ever. Using compact solar panels remote car wash deployments can even further offset their impact on the environment by generating their own power. Battery technology will have to be implemented carefully to make sure uptime and safety is considered.

5.3. Tunnel Car Wash Systems

Tunnel car wash systems are tunnels fitted with contactless jets to clean the car as it passes through. The car is driven slowly through the tunnel by the customer removing the need for gantries or conveyors. These system takes a lot of space, but with development these systems will become more effective and more compact. These systems are much faster than their competitors, as the customer doesn't have to leave or turn off their car. The car can roll through much faster as there are no scrubbing steps.

6. References

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Additional Materials

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