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Movable Automatic Car Wash Truck

Farshad Amirjani[1*], Seyed Ali Akbar Mousavi[2], Shahin Amirjani[3], and Mahmood Karimi[4]

[1]*Robat Karim University, Iran*
[2]*Azad University of Norabad, Iran*
[3]*University of Sharjah, UEA*
[4]*Azad University of Teheran, Iran*
[1]famirjani@gmail.com, [2]invention500@gmail.com, [3] Sales@northbayservices.com, [4]trading@northbayservices.com

Abstract— In this project, we intend to design and build a movable/mobile car wash mounted on a truck and inside a container. Upon exiting the container, parked cars can be washed on the spot, anywhere and anytime. There will no longer be a need for drivers to waste their precious time in ordinary car washes Because, most office workers are on the job 8 hours a day and do not have sufficient free time to drive to a traditional or automatic car wash. Moreover, it is difficult and challenging to wash the car in unfavorable weather. This is a completely novel project.

Keywords*: Ability to be folded and placed in a container, Car wash businesses, Two distinct models (with & without brush).*

1. INTRODUCTION

Unlike normal fixed car washes where the driver has to spend a substantial amount of time taking his/her vehicle to the car wash for it to be washed/cleaned, in this project, it is our objective and intention to build a mobile/movable car wash where we will be present in workplaces, businesses and companies as well as on the street to wash parked cars. This mobile car wash has the ability and is capable to conduct both vertical & horizontal washing of parked vehicles.

In stationary car washes, the vehicle is driven to a fixed location for the car wash operation to be performed. Often, the driver's time is wasted and in really hot or very cold weather, they don't even bother with going to the car wash. In this project, we intend to construct a mobile/movable mechanized car wash. This is a completely novel project, and no such project or device exists in Google Scholar, the Internet or anywhere else. This mobile mechanized car wash can be moved to various workplaces, companies, institutions and car shows or even in the street and wash parked cars (even in bad weather). This mobile car wash has the ability to wash parked cars both vertically and horizontally.

For instance, in a study conducted by the Simply Hired Institute, the lowest mobile car wash revenue in the Louisiana area was about US$39,000 annually (350 million tomans), and the highest income belonged to a mobile car wash in Washington DC with US$79,000 per year (750 million tomans) [1].

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* Corresponding Author: famirjani@gmail.com

2. THEORITICAL REVIEW

Types of Car Wash:

1) High-Pressure Water Manual Car Wash.
   In the high-pressure water car wash method, a large location is required for its establishment. Moreover, equipment such as high-pressure waterjet, car wash pump, air pump, nonabrasive cloth, construction of wastewater drainage, etc., are needed to set up a high-pressure water car wash. This is a very costly and expensive endeavor. In addition to the cost of equipment related to the commissioning of a high-pressure water car wash, energy consumption expenses can also be exorbitant.
2) Permanent Mechanized Car Wash.
   Via mechanized devices, automatic car washes perform operations without human intervention. The modern way to wash your vehicle is through an automatic car wash. But automatic car wash equipment is very costly. Additionally, the maintenance expenses of automatic car washes can be substantial. In older automatic car washes, water and electricity consumptions are very high, and as stated, if you opt for advanced up-to-date automatic car was devices, you have to pay quite a hefty price.
3) Home Car Wash.
   A home car wash is the oldest method for washing vehicles, however, it is not recommended due to the excessive water usage/wastage. There is some equipment available on the market for home car wash, which utilizes high-pressure water and supposedly reduces water consumption. But there is only one advertisement for the sale of such equipment. There are other home car washes that are very popular in the market called home waterjets. Home waterjet car washes are like high-pressure water car washes and have the disadvantages of all other high-pressure water car washes.
4) Small Mobile Car Wash.
   A mobile car wash is installed in the back of a van and can be used to wash certain areas as well as vehicles manually. By producing strong water pressure, mobile car washes can eliminate contaminants. A mobile car wash is portable due to its small size. A powerful pump motor creates water pressure; hence water exits the nozzle at high pressure. For this reason, it can be used anywhere.

3. RESEARCH METHODS

Figure 1. Design SolidWorks

The research method that applied was a research and development approach. This mobile car wash consists of the following parts, components, and materials:

1) Truck

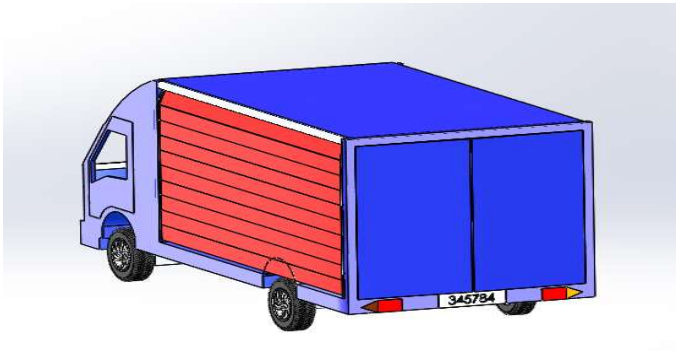

Figure 2. Truck and Container

The truck is a device wherein the crane is placed on the floor of the truck and the crane is connected to the car wash. To prevent the container from tilting or falling during operation, 4 jacks shall be utilized (connected under the container chassis).

2) Container

The inside of the container consists of a lid, a crane, pumps, a clean water storage tank, a dirty wastewater storage tank and a washing liquid storage tank. The container has 2 doors that slide under the roof of the container and then the car wash and the crane can exit the container. Water Pump: A centrifugal pump is utilized to transfer water from the storage tank to the car wash. Washing Liquid (Detergent) Pump: A small centrifugal pump is used to transfer water, the washing liquid detergent, and the foam. Dirty Wastewater Pump: In order to collect dirty water from the street, another pump is used toward transporting the dirty wastewater to a storage tank.

3) Crane

The telescopic crane is connected to the folding car wash. It moves via rotating, fore-and-aft, etc., enabling the car wash to perform. Moreover, the crane has a hydraulic jack system. The hoses as well as the power and data cables are connected to the car wash through small pulleys. When the telescope is retracted, the cables and hoses are stored in a hose storage tank. In addition, the crane telescope has an oil collector to prevent oil spillage.

4) Compact-Size Folding Car Wash

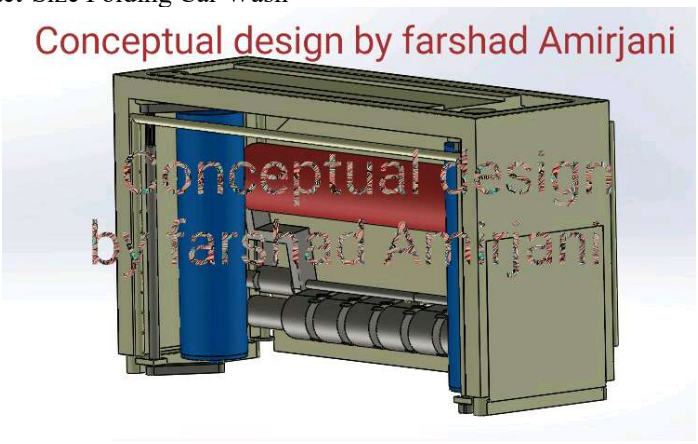

Figure 3. Car wash

The car wash is designed and will be constructed in such a manner where it can be folded inside a container. Most car wash materials will be made of anti-corrosion plastic and stainless-steel alloys.

Car Wash Mechanism

The car wash is opened from its compact folding state to a normal state. Initially, foaming commences, and in the next stage, the washing is performed, and then drying ensues in the third stage. Thereafter, and ultimately, the device is converted back to its compressed folding state and brought back to the container by a crane. The mechanical components of the car wash are controlled by brush-less motors, servo motors, circuits, and via sensors.

Car Wash Components

Vertical and horizontal brush, angle & direction adjustment parts, foam & wash components, dryer. In brush-less mode, washing is done only by spraying foam and via water pressure. Angle Adjustment Component: This mechanism is utilized to control the angle of the car wash relative to the road and the vehicle. Dryer: Composed of a large number of centrifugal air pumps.

5) Plc and Arm Electronic Systems

For maximum accuracy in the car wash, electronic systems including Plc & Arm circuits, artificial intelligence and detection sensors shall be utilized.
Fault/Error Detection: In order to detect faults/errors in the mechanical and electronic systems, more auxiliary circuits will be used, which are connected to electronic fuses, and also control hydraulic control valves, thereby preventing mistakes and damages.
In order to display the foaming and washing operations of vehicles, cameras are attached to the car wash. The cameras are connected via artificial intelligence and circuits and relay their video data to the monitor in the driver's cabin, enabling the car wash operator to observe the entire operation.

6) Control System

A control system will be designed & displayed in the driver's cabin. It will be controlled by the car wash operator.

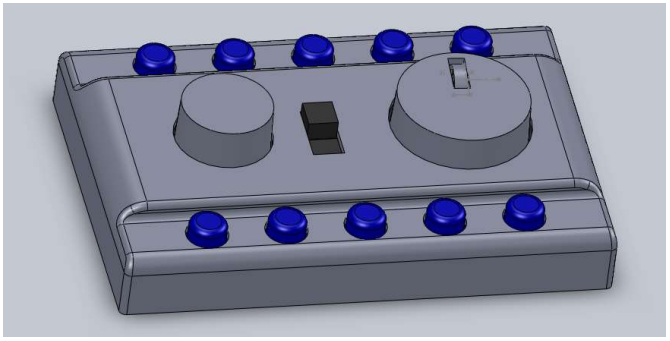

Figure 4. Control

The control is used to guide/direct the car wash to the front of the vehicle. This control has 4 channels and has a number of buttons:

1) First channel for height control.
2) Second channel to rotate the car wash.
3) Third channel for telescope.
4) Fourth channel to control the rotation of the crane.
5) Two of the buttons are for opening and closing the car wash in a specific direction from inside the container.
6) A button to lock in the car wash on the vehicle.
7) A button to start the car wash after locking in on the vehicle.
8) Two buttons to dry water droplets on vehicles.

9) Other buttons are utilized to open container doors, car wash doors and other parts.

Control Process:

First, by pressing a button, we open the container door, and with the help of control channels, we guide the car wash to the front of the vehicle, and by pressing a button, we open the car wash door, and by pressing another button, we expand the car wash from its compressed and compacted mode, and press the lock button in order to lock the car wash mechanism on the vehicle and activate the limited artificial intelligence (with the help of sensors), and then the system is in the right position and ready for operation. By pressing the car wash start button, the washing process commences (aided by sensors and programmed circuits). Pursuant to the washing operation, by pressing a button, the drying operation begins.

7) Dirty Wastewater Collection System (From Street)
For collection of dirty wastewater, a system has been designed where an operator holding a water suction mechanism, the dirty water on the street is rolled up and transferred to the dirty waste water storage tank via a hose and a pump. This task is performed to prevent slippage of vehicles on the road/street.

Car Wash Truck Mechanism

First, the car wash truck is placed in the designated/desired location and the container doors are opened and the car wash comes out of the container with the assistance of a crane and is placed either in front or behind the vehicle.

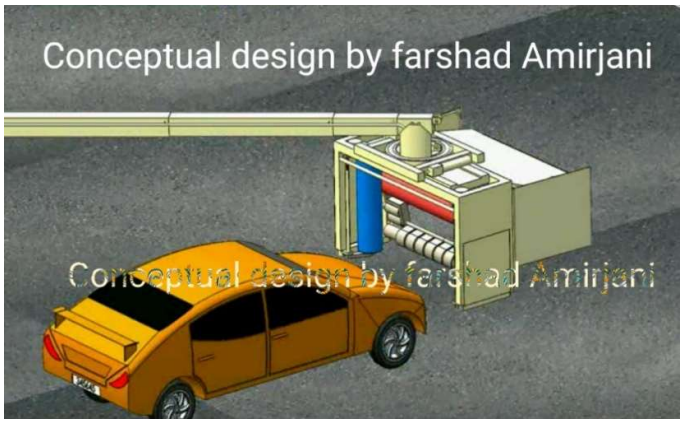

Figure 5. Folding Car Wash Opening

Next, the car wash is unfolded from its compressed folding mode to normal. Initially, foaming commences, and in the next stage, the washing is performed, and then drying ensues in the third stage.

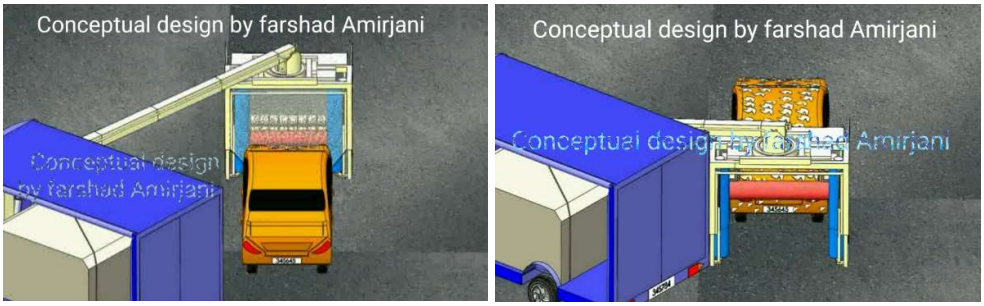

Figure 6. Start and End Foaming

Finally, the device is converted back to its compressed/compact folding state and brought back to the container via a crane.

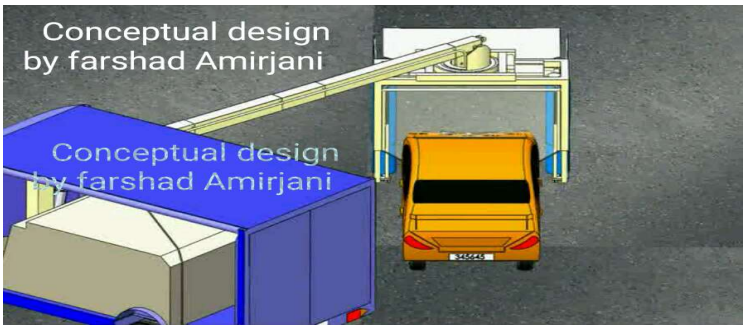

Figure 7. Washing a Car

The dirty wastewater on the street floor will be collected by an operator holding a water suction mechanism and transferred to a wastewater storage tank and ultimately the container lid is closed. This car wash system has the ability to wash multiple cars.

General Artificial Intelligence

With the assistance of multiple sensors, general artificial intelligence senses and can process and successfully complete tasks like humans. In this mobile mechanized car wash project, general artificial intelligence is programmed (via programming sensors and mathematical equations) and loaded on microcontrollers or microprocessors. During the car wash operation, with the aid of sensors, the system is cognizant of the car wash's status. Hence, with the help of drivers and motors, the car wash process is performed successfully. An article containing the programming of this project will be presented in the coming years.

Proximity Sensors

Figure 8. Proximity Sensors

Proximity sensors shall be deployed to detect the distance and align the car wash with the vehicle. Some of these sensors are described hereinafter:

1) Ultrasonic or Electromagnetic Sensors

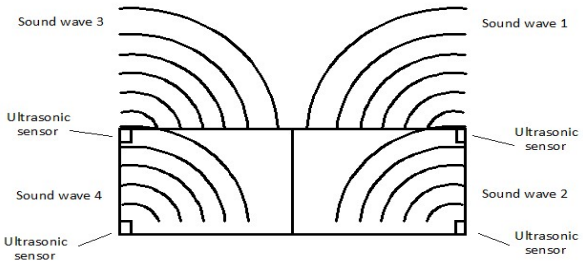

Figure 9. Where to Install Sensors

In order to control the start/stop of car wash operation and process, these sensors are used. 10 sensors shall be installed to control the car wash process. The control mechanism shall be via by a controller, the electronic components of the motor driver and the mechanical parts of the electric valve.

In order to preclude the interference of sensors, they will be programmed to be activated in a scheduled manner. (3)

2) Smart Laser Scanner Sensor:

In order to scan the vehicle, this sensor will be used to determine the surface points of the vehicle body and to have and perform superior control over the washing brushes. This sensor is located in front of the car wash. (4)

3) Load Cell Strain Gauge Sensor:

This sensor will be used in order to apply brush pressure on the vehicle's body. It is located on the arm of the brushes. This sensor changes its position when the brushes hit the body of the vehicle and the ohm value (the resistance) of the sensor is transmitted to the microcontroller. (5)

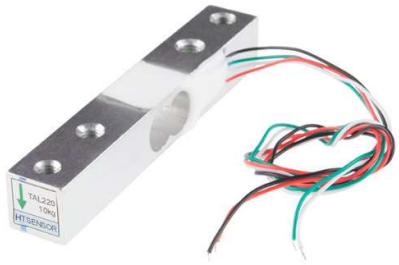

Figure 10. Load Cell Strain Gauge Sensor

Equations

Balance:

4 jacks will be used to maintain balance in this craned automatic mobile car wash. It is necessary that the end result of all car wash forces of the truck be zero. Due to having wheels, there is no need to prove the forces, but the anchor on the two wheels should be zero (requires proof).

For this objective, it is requisite:

$$R=\sum fx = 0 \qquad M = \sum M = 0 \tag{1}$$

$$M3>M1+M2 \tag{2}$$

$$M3 \rightarrow M3=m3g \times d \rightarrow 2500\times10\times2.6=65000\ N.m \tag{3}$$

$$\sum M1 \rightarrow M1=m1g \times d \times \sin\alpha \rightarrow 500\times10\times3.25\times\sin 42.51=10980.4\ N.m \tag{4}$$

$$\sum M\,2 \rightarrow M2=m2g \times d \sin\beta \rightarrow 300\times10\times6.18\times\sin 67.17=17087.5\ N.m \tag{5}$$

$$65000\ N.M > 10980.4\ N.M + 17087.5\ N.m \tag{6}$$

shapes shall be drawn/devised as a free body diagram

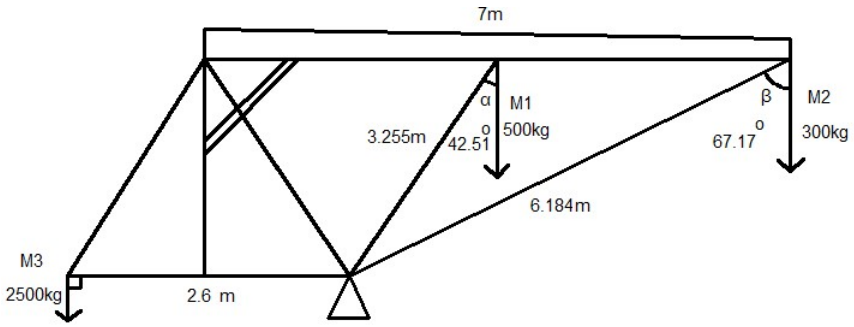

Figure 11. Free Body Diagram

Consistent with the equation solution, the crane telescope can be pulled out up to 7 meters and the balance can be maintained.

4. RESULTS AND DISCUSSION

Due to the length of the crane telescope, this car wash can service 5 meters' length of consecutive parked vehicles (both horizontally & vertically). The angle adjustment component can be used to optimally control the car wash operation in steep slope conditions.

Table 1. Dimensions of Truck, Car Wash & Container

	Height	**Width**	**Length**
Truck	270cm	260cm	630cm
Car Wash	155cm	80cm	240cm
Container	270cm	260cm	448cm

Source: Proceeds Data (2022)

A mobile car wash deploys electronic equipment and distance-detection sensors to prevent the car wash equipment from colliding with vehicles. The entire car wash process is fully automatic and does not require human intervention. However, this mobile car wash is not equipped or capable of washing large vehicles such as buses.

The mobile car wash has been designed according to road standards and is road-worthy (able to be driven in the streets) in line with the established dimensions (Table 1). It is able to wash most vehicles with the maximum height of 150 cm, width of 190 cm & length of 5 meters. If an investor is successfully attracted, a mobile car wash production company can be established in the next year or two. For collection of dirty wastewater and foam, if not drained via the drainage canal, a system has been designed where an operator holding a water suction mechanism, the dirty water on the street is collect and transferred to a storage tank. This is done to preclude slippage of vehicles on streets.

The car wash truck (height: 270 cm) should not enter any indoor/roofed parking with a clearance of less than 3 meters. A guard is placed under the crane to prevent grease from the crane telescope to leak out and spill on the vehicles. In the future, enhanced/advanced designs will enable us to wash wider & larger cars.

Comparison of mechanized mobile car wash with other car washes:

1) In unfavorable or cold weather, manual, home or small mobile car wash is impractical, but a mobile mechanized car wash can perform this operation under any situation.
2) In special circumstances, customers need to quickly take their vehicle to a covered location in bad weather (after washing the car so that it does not get dirty). Consequently, home, manual, small mobile and automatic mechanized car washes

are not suitable for this purpose. However, movable mechanized car washes are the perfect solution for this purpose (for instance: car shows).

3) When the customer/driver does not have sufficient time and the weather is cold or unsuitable, the mechanized mobile car wash can do the job (not possible with other car washes).

5. CONCLUSIONS

This project will have a positive impact on society as well as the economy. Vehicle owners will not be wasting their time driving to a traditional car wash. While they are being productive at work and in their businesses and companies, their parked cars will be washed and made immaculately clean. This project is also ideal during cold weather. According to our feasibility study, there is a market and substantial customer base for mobile/movable automatic car washes in Iran. Car washes throughout the city will be affected because of the competition. Businesses, companies, etc., will be positively impacted by this mobile car wash service. Car washes throughout the city will be affected because of the competition. Businesses, companies, etc., will be positively impacted by this mobile car wash service. Movable automatic car washes usually have excellent returns/profits; therefore, this mobile car wash project is likely to have substantial earnings and revenues. One of the reasons for economy slowdowns is the lack of sufficient time for employees and institutions. This mechanized movable automatic car wash has the ability to induce economic prosperity.

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