



AUTOMATED OVERHEAD TANK CLEANING SYSTEM WITH BLUETOOTH MODULE

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ABSTRACT

The purpose of this paper is to design and develop an Electro-mechanical system for cleaning households' overhead water tanks using a Bluetooth module. The system includes a simple mechanism with centrifugal force. The principal involved in this mechanism is the left-hand Fleming rule, where simple electric energy is converted into rotational energy. It includes a rack and pinion gear mechanism and a reciprocating four-bar linkage mechanism. The rack and pinion arrangements are used to move the cleaning part up and down for cleaning the cylindrical tank. The rack and pinion mechanism is used to move the total setup of four-bar linkages upward and downward by operating the switch control unit. The four-bar mechanism is attached to the motor shaft which is used to clean the water tank by using a brush arrangement. To the ends of the four-bar linkage, the PVC brushes are attached to it. Four-bar linkage is made in such a way that it can be adjusted according to the inside diameter of the water tank. When the motor is started the linkage rotates and with the help of brushes, cleans the wall of the water tank. Thus, a cleaning operation is performed. Society is trending toward automation day by day; cleaning the tank manually is undesirable as it requires lots of time and effort. So, to solve this problem, this household water tank cleaning system is developed that is more efficient, safer, less time-consuming, and of course no extra-human effort. The aim of this paper is to clean a domestic cylindrical water tank with the help of a mechatronics system. The mechatronics system consists of a grooved gear rod attached to two arms with brushes at the ends. The two arms are connected to the gear rod by a nut. By rotating the gear rod, the up and down motion of the two arms is achieved. The gear rod is rotated with the help of a D.C gear motor. The main grooved shaft is powered by an A.C motor. The motor and the shaft are connected by a rubber belt. The clockwise rotation of the main shaft will make the arms move and vice versa. The whole operation is controlled by a circuit consisting of relay switches, buttons, and a Bluetooth module. The number of times for the operation to repeat can be fed into the circuit.

It doesn't affect the environment and human health in any way. Here a rod having grooves is placed in which brushes are attached through two arms. For rotation of the arms, we connect a DC gear motor and an AC motor to the main rod. The system also consists of a microcontroller and relays for controlling purposes.

Keyword - Water Tank Cleaning, Cylindrical water.Tank, Four-bar linkage, Motor shaft, Rack and pinion, PVC brush

1. INTRODUCTION

In recent studies, it has been set up that no robotization-grounded machine is used in the cleaning of the overhead tank. This is because of the irregular shape and colorful heights of the tank locales. The former check tried to make a machine by robotization process for cleaning tank. An alternate result has been planned to break this problem. In India, the operation of sintex tanks by the people is roughly 71%. After studies made the information that has faced a lot of difficulties like nonstop work in dirty places, irregular payment, and other colorful reasons. nonstop work and irregular payment may also be the major reason for this attempt. To conclude that drawing the overhead tank using a robotization process can be useful to break all these problems. In this case, the machine has the capability to clean the tank fluently and snappily. Designing of our machine is grounded on the check report conducted.

Methods of Water Tank Cleaning:

Homemade scrubbing in which all bottoms of the tank are dropped to remove dirt, sediments, fungus, and stains, but this system is more tedious and time-consuming. The water tank can also be gutted by using chemicals to remove the dirt and sediments. The chemicals used may affect mortal health. Pressurized water can be scattered on the walls of the tank which will remove the dirt from the tank face. These styles are time-consuming and bear further trouble for cleaning. To find such an approach, there's a need of studying the approaches and algorithms that had formerly been used for automated overhead water tank drawing systems. This motivates us for the literature review. The association of this paper is as follows. In Section 2, a methodical donation of the literature review is done, which involves a list of the affiliated approaches along with a

summary of the affiliated work that's more applicable to the developed approach. Section 2 concludes with our findings from the literature review and the provocation behind linked problems. Section 3 focuses on the expression of the linked problems. Section 4 is devoted to the proposed approach. Section 5 emphasizes the experimental results. Section 6 addresses the conclusions along with the unborn work.

Necessity of Cleaning Water Tank:

Every day we use the tank water for brushing and bathing, drawing, mopping, washing clothes, and other ménage chores. With the passage of time, sediments scale, and algae get deposited on the walls, ceiling, and bottom of the water tank. This deposit contaminates the water and makes it unfit for use. With time algae and bacteria grow and breed in this water infecting it and could make us fall sick ultimately. Hence water tank cleaning is veritably important.

2. LITERATURE REVIEW

Manual scrubbing in which the wall and floor of the water tank are scrubbed to remove dirt, sediments, fungus, and stains, but this method is more tedious and time-consuming. The water tank can also be cleaned by using chemicals to remove the dirt and sediments. The chemicals used may affect human health. Pressurized water can be sprayed on the walls of the water tank which will remove the dirt from the water tank surface. These methods are time-consuming and require more effort for cleaning.

Alternate Method:

All methods of cleaning water tanks as discussed above are time-consuming and require more human effort. So alternate method is required for cleaning purposes, which will overcome the drawbacks of all other methods. Therefore, we are developing water tank cleaning equipment that requires less time and human effort for cleaning. To avoid all such disadvantages, this motorized water tank cleaning has been designed in such a way that it can be used to stand the vehicle very smoothly without any impact force. The operation is made simple that even any person can handle, by just pressing the button.

In semi-automation, a combination of manual effort and mechanical power is required whereas in full automation human participation is very negligible.

Need For Automation:

Automation can be achieved through computers, hydraulics, pneumatics, robotics, etc., of these sources, motorized form an attractive medium for low-cost automation. Automation plays an important role in automobiles. The automobile vehicle is being atomized for the following reasons.

- To achieve high safety
- To reduce manpower
- To reduce the workload
- To reduce the vehicle accident
- To reduce the fatigue of workers
- To high responsibility
- Less Maintenance cost

3. COMPONENTS AND DESCRIPTION

The major parts that are effectively employed in the design and the fabrication of the automatic water tank cleaning machine are described below:

- Frame
- DC motor
- Battery
- Bearing
- Rack and pinion Arrangement
- Spur Gear Arrangement
- Four bar linkage with brush Arrangement.
- Bluetooth Module HC05
- Relay Control Board
- Arduino Uno

FRAME:

This is made of mild steel material. The whole parts are mounted on this frame structure with a suitable arrangement. Boring of bearing sizes and open bores are done in one sitting to align the bearings properly while assembling. Provisions are made to cover the bearings with grease.

DC MOTOR:

An electric motor is a machine that converts electrical energy to mechanical energy. Its action is based on the principle that when a current-carrying conductor is placed in a magnetic field, it experiences a magnetic force whose direction is given by Fleming's left-hand rule.

When a motor is in operation, it develops torque. This torque can produce mechanical rotation. DC motors are also like generators classified into shunt-wound or series wound or compound wound motors.

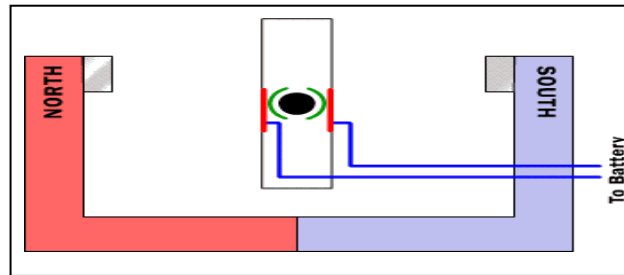


Figure 3.1: Mechanism of DC motor

In this figure, the armature winding has been left out so that it is easier to see the commutator in action. The key thing to notice is that as the armature passes through the horizontal position, the poles of the electromagnet flip. Because of the flip, the North Pole of the electromagnet is always above the axle so it can repel the field magnet's North Pole and attract the field magnet's South Pole.

If you ever take apart an electric motor you will find that it contains the same pieces described above: two small permanent magnets, a commutator, two brushes, and an electromagnet made by winding wire around a piece of metal. Almost always, however, the rotor will have three poles rather than two poles as shown in this article. There are two good reasons for a motor to have three poles:

- It causes the motor to have better dynamics. In a two-pole motor, if the electromagnet is at the balance point, perfectly horizontal between the two poles of the field magnet when the motor starts; you can imagine the armature getting "stuck" there. That never happens in a three-pole motor.
- Each time the commutator hits the point where it flips the field in a two-pole motor, the commutator shorts out the battery (directly connects the positive and negative terminals) for a moment. These shorting wastes energy and drains the battery needlessly. A three-pole motor solves this problem as a water tank.
- It is possible to have any number of poles, depending on the size of the motor and the specific application.

BATTERY:

In isolated systems away from the grid, batteries are used for the storage of excess solar energy converted into electrical energy. The only exceptions are isolated sunshine loads such as irrigation pumps or drinking water supplies for storage. In fact, for small units with an output of less than one kilowatt.

Batteries seem to be the only technically and economically available storage means. Since both the photo-voltaic system and batteries are high in capital costs. It is necessary that the overall system be optimized with respect to available energy and local demand pattern. To be economically attractive the storage of solar electricity requires a battery with a particular combination of properties:

1. Low cost
2. Long life
3. High reliability
4. High overall efficiency
5. Low discharge
6. Minimum maintenance
 - (a) Ampere hour efficiency
 - (b) Watt-hour efficiency

We use lead-acid batteries for storing the electrical energy from the solar panel for lighting the street and so the lead-acid cells are explained below.

LEAD-ACID WET CELL:

Where high values of load current are necessary, the lead-acid cell is the type most used. The electrolyte is a dilute solution of sulfuric acid (H_2SO_4). In the application of battery power to start the engine in an automobile, for example, the load current to the starter motor is typically 200 to 400A. One cell has a nominal output of 2.1V, but lead-acid cells are often used in a series combination of three for a 6-V battery and six for a 12-V battery.

The lead-acid cell type is a secondary cell or storage cell, which can be recharged. The charge and discharge cycle can be repeated many times to restore the output voltage if the cell is in good physical condition. However, heat with excessive charge and discharge currents shorten the useful life to about 3 to 5 years for an automobile battery. Of the different types of secondary cells, the lead-acid type has the highest output voltage, which allows fewer cells for a specified battery voltage.

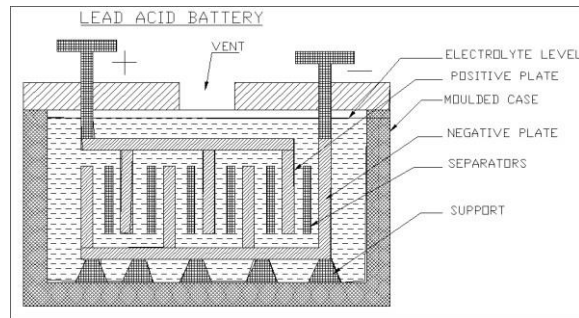


Figure 3.2: Lead-acid wet Cell

BEARING:

The bearings are pressed smoothly to fit into the shafts because if hammered the bearing may develop cracks. The bearing is made up of steel material and the bearing cap is mild steel.

Construction and Types of Ball Bearings:

A ball bearing usually consists of four parts: an inner ring, an outer ring, the balls, and the cage or separator. To increase the contact area and permit larger loads to be carried, the balls run in curvilinear grooves in the rings. The radius of the groove is slightly larger than the radius of the ball, and a very slight amount of radial play must be provided. The bearing is thus permitted to adjust itself to small amounts of angular misalignment between the assembled shaft and mounting. The separator keeps the balls evenly spaced and prevents them from touching each other on the sides where their relative velocities are the greatest. Ball bearings are made in a wide variety of types and sizes. Single-row radial bearings are made in four series, extra light, light, medium, and heavy, for each bore. 100 Series 200 Series 300 Series Axial Thrust Angular Contact Self-Aligning Bearing. The heavy series of bearings are designated by 400. Most, but not all, manufacturers use a numbering

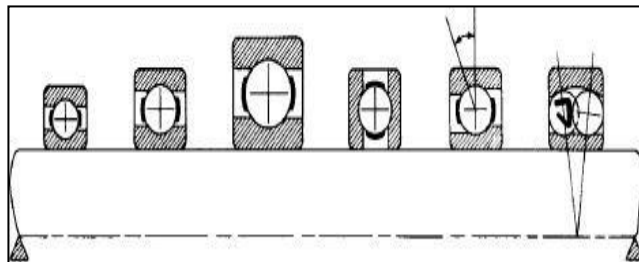
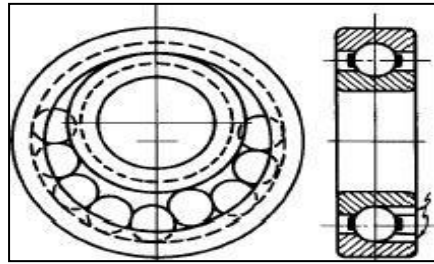


Figure 3.3: Construction of Bearing

The system so devised that if the last two digits are multiplied by 5, the result will be the bore in millimeters. The digit in the third place from the right indicates the series number. Thus, bearing 307 signifies a medium-series bearing of 35-mm bore. For additional digits, which may be present in the catalog number of a bearing, refer to the manufacturer's details.



Some makers list deep groove bearings and bearings with two rows of balls. For bearing designations of Quality Bearings & Components (QBC), see special pages devoted to this purpose. The radial bearing can carry a considerable amount of axial thrust.

RACK AND PINION MECHANISM:

The block is the important part of the unit as it houses the rack and pinion. This block converts linear motion into rotary motion.

A rack and pinion gear system is used to transmit rotary motion into diameter and the line of action is tangent to the pinion.

Pinion:

This is a gear wheel that is provided to get mesh with a rack to convert the linear motion into rotary motion. They are made up of Cast iron.

Rack:

Rack teeth are cut horizontally about the required length. This is made up of Cast iron.

SPUR GEAR:

The spur gears, which are designed to transmit motion and power between parallel shafts, are the most economical gears in the power transmission industry.

INTERNAL SPUR GEAR:

The internal gears are spur gears turned "inside out." In other words, the teeth are cut into the inside diameter while the outside diameter is kept smooth. This design allows for the driving pinion to rotate internally to the gear, which, in turn, allows for clean operation. Intended for light-duty applications, these gears are available only in brass. When choosing a mating spur gear, always remember that the difference in the number of teeth between the internal gear and pinion should not be less than 15 or 12.

EXTERNAL SPUR GEAR:

Perhaps the most often used and simplest gear system, external spur gears are cylindrical gears with straight teeth parallel to the axis. They are used to transmit rotary motion between parallel shafts and the shafts rotate in opposite directions. They tend to be noisy at high speed as the two gear surfaces come into contact at once. Internal spur gears: The internal spur gear works similarly to the external spur gears except that the pinion is inside the spur gear. They are used to transmit rotary motion between parallel shafts, but the shafts rotate in the same direction with this arrangement.

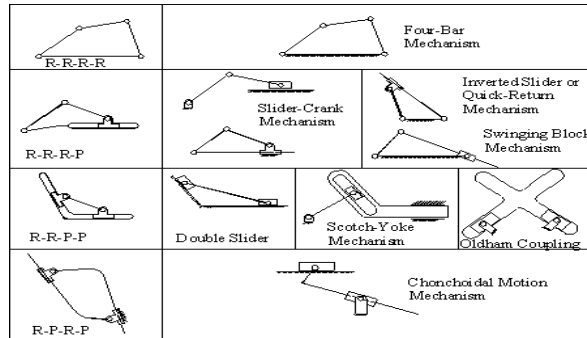


Figure 3.4: Spur gear

The spur gears, which are designed to transmit motion and power between parallel shafts, are the most economical gears in the power transmission industry. Spur gears or straight-cut gears are the simplest types of gear. They consist of a cylinder or disk with teeth projecting radially. Though the teeth are not straight-sided (but usually of special form to achieve a constant drive ratio, mainly involute but less commonly cycloidal), the edge of each tooth is straight and aligned parallel to the axis of rotation. These gears mesh correctly only if fitted to parallel shafts.

FOUR BAR LINKAGES WITH BRUSH ARRANGEMENT:

A four-link mechanism with four revolute joints is commonly called a four-bar mechanism. The configuration of a quadrilateral linkage may be classified into three types: convex, concave, and crossing. In the convex and concave cases, no two links cross over each other. In the crossing linkage, two links cross over each other.

**Figure 3.5: Four bar mechanism with brush**

In the convex case, all four internal angles are less than 180 degrees, and in the concave configuration, one internal angle is greater than 180 degrees. There exists a simple geometrical relationship between the lengths of the two diagonals of the quadrilateral. For convex and crossing linkages, the length of one diagonal increases if and only if the other decreases. On the other hand, for non-convex non-crossing linkages, the opposite is the case; one diagonal increases if and only if the other also increases. A plane linkage consists of four links pinned tail to head in a closed loop with lower or closed joints. It is a plane mechanism consisting of four links that form rotating kinematic pairs. The four-bar linkage is arranged in such a way that it adjusts the inner diameter of the tank.

BRUSH:

**Figure 3.6: Brush**

The brushes are made up of Poly Vinyl Chloride (PVC) polymer. Brushes attached to the ends of the four-bar linkage revolve due to the rotation of the motor shaft to clean the inner surface of the tank.

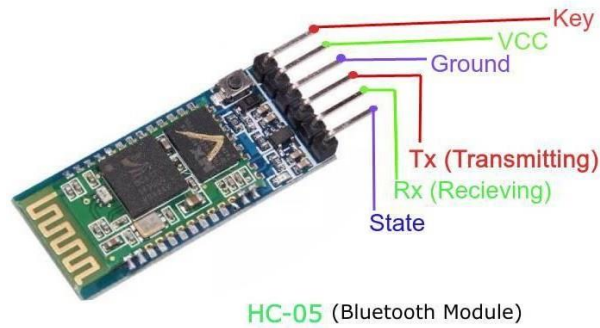
SHAFT:



Figure 3.7: Shaft

A shaft made up of mild steel of diameter 15mm is used to transmit rotary motion from the motor to the four-bar linkage. Holes provided on the shaft, adjust the four-bar linkage according to the diameter of the tank.

4. BLUETOOTH MODULE HC05

**Figure 3.8: Bluetooth HC05**

HC-05 has red LED which indicates connection status, whether the Bluetooth is connected or not. Before connecting to HC-05 module this red LED blinks continuously in a periodic manner. When it gets connected to any other Bluetooth device, its blinking slows down to two seconds.

This module works on 3.3 V. We can connect 5V supply voltage as well since the module has on board 5 to 3.3 V regulators. As HC-05 Bluetooth module has 3.3 V level for RX/TX and microcontroller can detect 3.3 V level, so, no need to shift transmit level of HC-05 module. But we need to shift the transmit voltage level from microcontroller to RX of HC-05 module.

5. RELAY CONTROL BOARD

**Figure 3.9: Relay 5V**

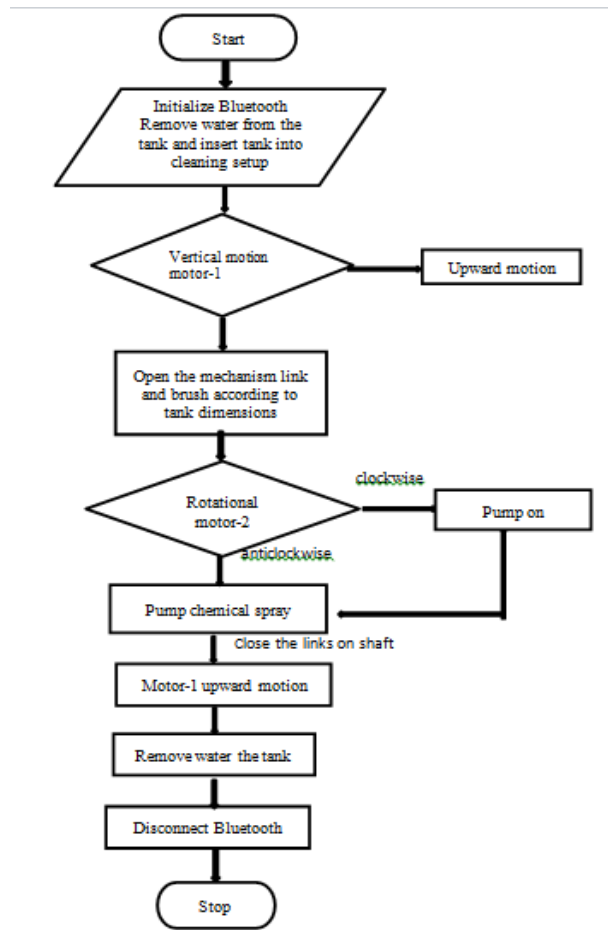
Relay boards are computer boards with an array of relays and switches. They have input and output terminals and are designed to control the voltage supply. Relay boards provide independently programmable, real-time control for each of several onboard relay channels. Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal. Relays were first used in long-distance telegraph circuits as signal repeaters: they refresh the signal coming in from one circuit by transmitting it on another circuit.

ARDUINO UNO:



Figure 4.0: Relay 5V

6. FLOW CHART



2D DRAWING:

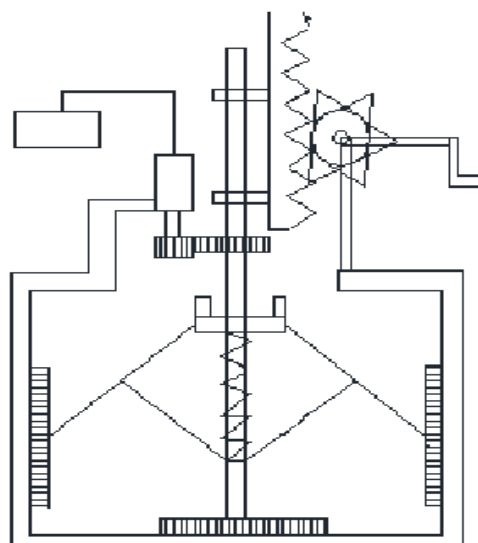


Figure 4.1: Mechanism Drawing

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board has 14 digital I/O

pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website.

7. CONCLUSION

In this work, the automatic water tank cleaning become efficiently evolved to clean the water tanks with the usage of rotating brushes. This approach is more powerful and more secure than the traditional techniques of cleaning which takes much less time and human effort. Water splashes anywhere alongside the dividers within the tank and the rotating brushes clean the external separators. The water tank cleaner becomes used to clean the water tanks through the usage of rotating brushes. This technique becomes extra powerful and secure than the traditional methods. This technique is successful to clean water tanks with much less time and human effort. The superior version for tank cleaning systems is cleaning the tanks for that reason making the operation user-friendly. The running prototype is promising each in terms of supplying cleanliness and avoiding excess manpower. The destiny scope of the mission is to increase it with an auto-feeding mechanism through which the manpower involved in feeding receives removed. With the assist of the auto-feed mechanism, it is simple to clean the tanks without extra manpower. The mission may be even extended to boom the cleanliness of the tank through Insulating the body and different components with the use of stainless steel. The water tank cleaner was used to clean the water tanks by using rotating brushes. This method was more effective and safe than the conventional methods. This method is capable to clean water tanks within less time and human efforts Advanced model for tank cleaning system is cleaning the tanks thus making the operation user friendly. The working prototype is promising both in terms of imparting cleanliness and avoiding excess manpower.

8. FUTURE SCOPE

This system is user friendly and time saving also the cost is less hence it can be used in the future water tank cleaning purpose. In future the advance system may also be invited like the vacuum cleaner type system that can clean the tank without removing the water from the tank. The system could be more compact and light weighted and more user-friendly and efficient by improvement in the design and using some other advance equipment

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