Autonomous Water Tank Cleaning Robot for Indian Household

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ABSTRACT: It is common in Indian household to store water in tanks which may be groundwater, rainwater or from any other source. The water stored in it may have fine particles which will settle at the bottom as well as the sides of the tank and form stains and precipitate when left undisturbed for a while. It needs to be cleaned periodically. If not cleaned periodically, it may form salt deposits in pipes and block the water path. Currently, a manual cleaning process is seen in abundance. In the manual cleaning process, a man has to get inside and clean the tank. The problems in this cleaning process include an improper light for vision, lack of provisions to get in and out of the tank and risk of damaging the tank in case it is made of plastic or lightweight material. The proposed project idea will convert that cumbersome manual labour work to an effortless task. There are many robots available for cleaning various industrial tanks. Those robots can't be used for cleaning domestic water tanks since they are application specific. Location of the water tank varies with its purpose, a rainwater storage tank is usually installed underground and groundwater storage tank is installed at the roof-top to use the gravitational pressure. The proposed robot will clean the water tank without much effort. However, a human part is needed to take the robot to the location of the tank and to place the robot inside the tank. Once placed in the tank, the robot cleans the tank autonomously and the user can take out the robot after the completion of the process.

KEYWORDS: Autonomous, water tank, high-pressure water, robot.

I.INTRODUCTION

Our proposed robot will have an Arduino controller, high-pressure water pump, suction pump, ultrasonic sensors and battery inside the robotic body and robotic arm on the top of its body. To clean the desired water tank, a person has to manually place the robot inside the tank. Then the operation is completely autonomous and after completion of the cleaning operation, the robot can be taken out. Before placing the robot inside the tank, the water present inside the tank will be completely drained using an outlet. The robot uses ultrasonic sensors for calculating the distance from its location to the sides of the wall. Based on the output from an ultrasonic sensor, the robot will move accordingly to reach the centre of the tank. The high-pressure water pump will be present inside the robot. The water will be supplied to the pump from outside of the tank. This water will be used for cleaning the tank. There will be a robotic arm present on the top of the tank. The pump output is terminated as a small nozzle at the robotic arm.

The robot first moves in the forward direction and the arm will move in up and down as well right and left direction to pump out high-pressure water to the walls of the tank. In case of heavy scaling inside the tank, chemical agents can be mixed with the cleaning water. When the robot completes the entire cleaning process in the forward direction, it again reaches its default tank centre position. Now, it moves in the reverse direction and performs the same operation. The entire body of the robot will be water sealed and all components will be present in the waterproof body. Only, the robotic arm will be exposed outside. Now, as the walls of the water tank are cleaned. The robot moves around the entire tank and cleans the floor of the tank using rotating scrubber present at the bottom of the tank. There will be dirty water and sludge remaining at the bottom of the tank. It will be sucked out using the suction pump present inside the robot.

II.LITERATURE SURVEY

There is an existing Remotely Operated Vehicle (ROV) for water tank cleaning [2]. This ROV was designed in Solidworks platform and uses Raspberry Pi controller. It is an underwater robot that can work effectively up to the depth of 1m. The disadvantage of this robot is there is a need for a human operator to control the robot. There is also a research work on a rugged robot for oil tank sludge cleaning [1]. This robot may be suitable for other industrial tank cleaning but not for domestic tank cleaning because of its size, cost and mechanism. Moreover, its rugged explosive proof body may also damage the plastic water tanks. There is also a machine for water tank cleaning [3]. This machine is fitted on the opening of the water tank and with the help of rack and pinion, a brush will move up and down inside a water tank and clean it. The working and construction of this machine is quite simple. But, it is heavy and not suitable for tanks of different dimensions.

III.COMPONENTS

Arduino Mega is used as the controller in this robot. It has 54 digital IO pins. Out of which 16 can be used as PWM output and it also has 16 analog input pins. The analog input pins accept signals from various sensors and digital IO pins are used to send control output from Arduino. The 12 V, 7.2 Ah Lead acid battery is used to power all the components present in the robot. Four 12 V high torque gear motors are used for the motion of the robot. The high torque is required since the estimated total weight of the robot is between 12Kg to 16Kg. The Arduino output is just 5V, so the relay is needed to supply 12 V to the motors. The chassis (Fig.1) is made of lightweight metal, aluminium. Aluminium is also preferred because of its less corrosive nature.

Fig. 1 - Chassis

Fig 2 - Robotic Arm

The robotic arm (Fig.2) is made up of acrylic glass. Ultrasonic sensor modules (HC-SR-04) will be mounted on the front and back side of the chassis. The 12V high-pressure diaphragm type water pump will be used to pump the cleaning water from outside.
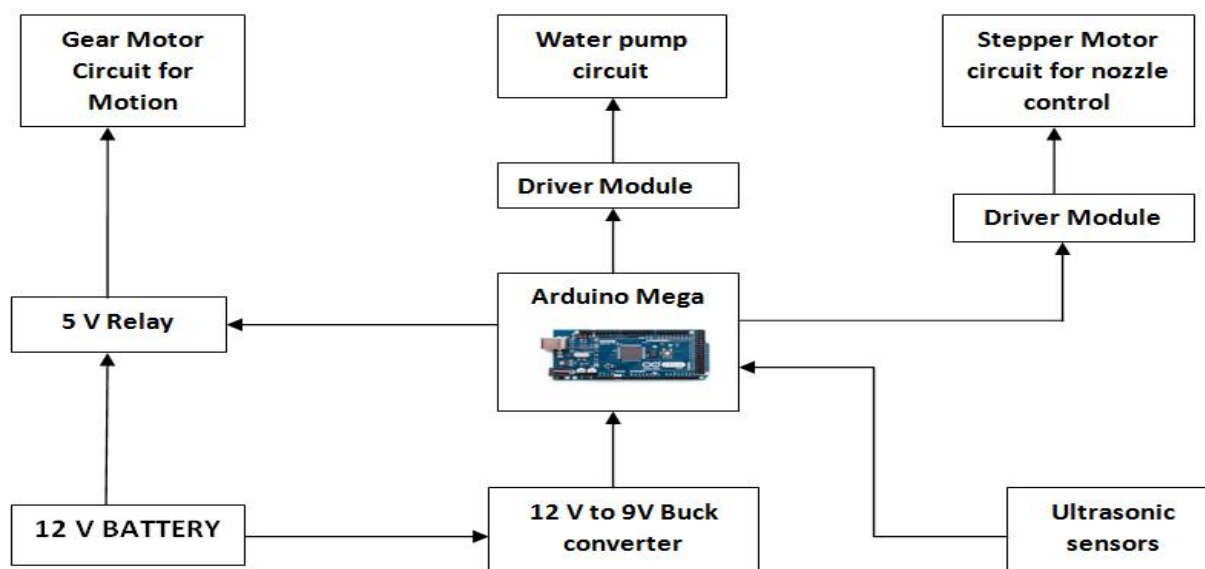
IV.BLOCK DIAGRAM

The three main sub circuits present in the main design is motion control circuit, water pumping circuit and robotic arm control or nozzle control circuit. The Arduino input supply can be between 7V to 12V. But due to excessive heat produced when operated for a long time, the 12V is reduced to 9V with the help of buck converter and fed to the Arduino board.

V.CONCLUSION

After a detailed study, it is concluded that there is hardly a complete autonomous robot suitable for cleaning domestic water tanks. This work could be the solution to that problem. Our future work would be to develop a robot to clean both domestic as well as industrial tanks.

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