AUTOMATIC WINDOW CLEANING ROBOT USING DIGITAL IMAGE PROCESSING

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Abstract—The rapid growth of advanced robots has given researchers unprecedented opportunities to explore and discover new fields of research where robots can be used to assist humans in their daily life. There are many applications that use robots and automation in different aspects of life such as industry, medical, domestic machines and etc. In this paper, the work has been devoted for the use of robotics and robots in cleaning process. The window cleaning robot is one of the robots that have applications in industrial as well as in domestic domain. This robot can be used in homes, offices and large buildings. The main target is to design a robot that can clean glass windows efficiently and rapidly even in dangerous and hazardous places. The robot will be controlled using the Microcontroller and Digital Image Processing. The motion will generated by three servo motors.
Index Terms—Robotics, Microcontrollers, DC Motors and Drivers.

I. INTRODUCTION

Robots have been created to assist or replace humans in various dangerous and difficult tasks. Robots have been used in construction, manufacturing, security and etc. This is because they are able to adapt to different environments and situations. They have conquered nearly all environments that we had put them through. Many kind of cleaning mechanisms are invented to ease the human daily chores such as vacuum cleaners, window cleaners which are to clean glass windows. Nowadays, with the large increase in development of tall and smart buildings in urban areas, the window cleaning robots have become a necessity. In older days humans were mostly appointed for cleaning the window glass panels which was difficult, less precise and time consuming, where the man was solely responsible for cleaning regardless of what he uses facing tiredness and dangers of falling down until a machine called "forklift" was invented to lift him to high building or the places which man can't reach. This machine lifts the man to the upper places and reduces the time consumed in the cleaning process. But still there were some drawbacks like process costs, danger to human life and less precision. Because of all these factors there was a necessity to develop a machine which can independently and autonomously carry out the cleaning of the glasses of the sky scrapers or the high altitude buildings with high precision and in less time. In this paper we tried to explain the development and fabrication of a machine which can be used for glass cleaning purpose. We

are going to use the de motors for the mechanical movement of the robotic arm. The motion of the motors will be controlled using a microcontroller and for measuring the degree of dust on the glass surface we will be using digital image processing.

II. SYSTEM DESIGNE AND DESCRIPTION

The automatic window cleaning robot consists of hardware and software design. The hardware part deals with the mechanical and construction design, electrical and electronic circuitry. The software parts deals with the programming of the Microcontroller to control the motion of the process. Figure 1 shows the block diagram of the designed system.
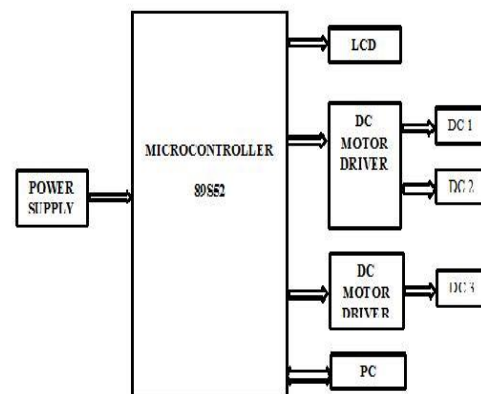

Fig.1: Block Diagram of System

1. Hardware Part:
A. DC Motors:
The DC Motors used here are permanent magnet type. All the three motors are of same ratings. The ratings are as follows-
Power 12V DC
- Torque 6 kN
- Current 0.3 mA
- Speed 60 RPM.

B. Microcontroller.
The controller used here is Atmel 89S52. It is a 40 pin IC dual in line package. The features of the IC are as follows:
- 4.0V to 5.5V Operating Range
- 256 x 8-bit Internal RAM
- Fully Static Operation: 0 Hz to 33 MHz

- Full Duplex UART Serial Channel
- Three 16-bit Timer/Counters
- Eight Interrupt Sources

C. Communication Link

A communication link is required for interfacing the microcontroller with the computer. The link used here is RS 232, which is a driver IC to convert the μC TTL logic (0-5) to the RS 232 logic (+/-9v) which is required to communicate with the computers.

D. DC Motor Driver

The driver IC used here is L293D, which is a 16 pin ic. It is capable of driving 2 dc motors at a time. In order to protect the dc motor from a back EMF generated by the dc motor while changing the direction of rotation, the dc motor driver have an internal protection suit.

E. Limit Switches

The limit switch is a mechanical device that uses physical contact to detect the presence of an object (target). When the target comes in contact with the actuator, the actuator is rotated from its normal position to the operating position. This mechanical operation activates contacts within the switch body.

F. Rack and pinion

A rack is a toothed bar or rod that can be thought of as a sector gear with an infinitely large radius of curvature. Torque can be converted to linear force by meshing a rack with a pinion: the pinion turns; the rack moves in a straight line. Software part consists of the microcontroller programming and Matlab programming for digital image processing. The microcontroller programming is done in assembly language with the help of software "Keil Micro Vision 4". For the programming of image processing the code is written in Math works Matlab Version R2009a.

III. WORKING

The system needs a manual startup which can be done by simply pressing a push button meant for the purpose. When the main switch is on, the microcontroller will send commands to the DC motor 1 & 2 to the topmost position which is detected by limit switch 1. As soon as the limit switch 1 goes high, the microcontroller will send a signal to stop the DC motor 1 & 2 and also to start the DC motor 3. Now the DC motor 3 starts and moves in horizontal direction. Limit switches 3 & 4 are used to detect the presence of the wiping brush. Initially the wiping brush is at right most position and starts moving toward left with the activation command as explained above. Now as the wiping brush reaches the leftmost position the limit switch 4 detects its presence and sends a command to the microcontroller. With this command the microcontroller reverses the direction of the DC motor 3 and the motor starts moving in opposite direction i.e. towards right. When wiping brush reaches the rightmost position again, limit switch 3 gets activated and send a signal to the microcontroller. Now the microcontroller

sends a command to stop the DC motor 3. After this the camera which is mounted in front of the glass captures images of the glass and compares them with reference images. If the current image matches with the reference image the microcontroller sends a command to start the dc motors 1 & 2 and make them move to next down position. If the current image does not matches with the reference one, the microcontroller will send command to dc motor 3 to start it moving towards left, and the cycle repeats. Above cycle repeats till the glass is cleaned completely.

IV. CONCLUSION

The automatic window cleaning robot has been successfully designed and fabricated. The components used in this project are simple and cheap. The software programming is simple and can be modified and implemented easily. In general the system works satisfactorily well as anticipated in the design process. The time required for complete cleaning depends on the speeds of the motors and the degree of the dirt on the glass surface. The system can be further developed to have more features.

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