Development of an Automatic Board Cleaning system using Microcontroller

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Development of an Automatic Board Cleaning system using Microcontroller

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ABSTRACT

Now-a-days white boards are widely used in almost every educational institute. About 70-80% educational institute around the world uses white board as the writing medium in their class room. They are large in size, for that reason it is very time consuming process to erase the writings from the board with duster. Using duster also reduce the visual quality of the board. If a class continue about one hour then about 8-10% time become waste because of cleaning the board using duster. Considering this "The board wiper", an automatic system can solve these problems. The board wiper will shorten the time and also the effort. It takes around 8 sec to clear the board without destroying the quality. The wiper has horizontal movements and it wipes the board twice at a short time. The wiper consists of electric motor, supports, a wiper bar and a microcontroller to give that an automation figure. It is possible to control the wiper by a remote control system and this allows the controller to wipe the board from a reasonable distance. And it has an advantage to remove the wiper if it's necessary to clean and the whole wiper system can be established at a very low cost. So, "The Automatic board wiper" is a spectacular replacement of "duster" and it can be suggested to use this to reduce the effort of the board user as well as to introduce the classroom with an automation system.

Keywords: Board wiper, Automation, control system, Automatic duster.

1. Introduction

When we said teaching and learning process we will focus on teacher and student, who are person that delivering and receiving information and knowledge. How do they deliver their knowledge to student? Nowadays, there are many methods which are used by teachers to deliver their knowledge such as computer, note given by teacher and at last but not the least whiteboard or blackboard as medium to deliver the information to student. The invention of blackboards was a revolutionary change in the history of mankind which led to the development of the society. One of the problems we are experiencing in our classroom is erasing the blackboard. Chalk dust scatter causing extreme nuisance especially for people who have asthma. Also, chalk dust causes skin irritation and serious health problems. [1] Blackboards require lot of time to get rubbed which increase the demand of whiteboards. The first whiteboards were very expensive and was made of enameled steel but seeing the growing demand in the market cheaper whiteboards made of steel with polyester or acrylic coating of white color on it were launched. Innovations in the field of whiteboards were done since a long time. Different types of whiteboards like laminated chipboard, high pressure laminated boards and porcelain boards were launched in the market for cheaper alternatives. [2] Modifications were also done in cleaning and rubbing methods of whiteboards. Remote control motorized cleaners were innovated to reduce the human efforts required for cleaning. This type of cleaner is operated by motors and is controlled by switch or remote.

2. Background

In the very past cave man used the wall of the cave as the writing medium. There they used the board to capture various memories or the story of their own culture and daily activities. As the time goes on and a civilized society was being formed the scenario begun to change. In the middle age people began to use a big slice of the wood piece as the board, and coal as the pen medium. [3] But it was not so comfortable and it became nasty. Then the black board had been introduced. It's nothing but a black canvas where a chalk is used as the pen medium. Chalk is a composite of calcium carbonate and it looks like a stick. It was comfortable but it creates dust during wiping the board using the duster. A duster is device which is used to wipe the writings from the board. Though the black board has not lost its popularity as in present time and it's being used widely across the world. But a white board is the modified version of the black board. Here a marker pen is used as pen medium and as duster a piece of cloth or a foam duster. As the white board has the advantage of not creating the dust as it only make the duster dirty and it is very much comfortable using marker pen as it comes in different colors. Across the world now white board is the best writing medium during teaching. Now almost everything is automated. And the automation system has the capacity to reduce the human effort and to make any arrangement easier. And those became possible for micro-controlling system. The Arduino microcontroller is an open-source hardware controller which is designed to ease any mechanism by using electronic commands.

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3.0 System Components

The whole system is based upon two individual parts. One is the wiping system which ensure to erase writings and other is the controlling part which control the wiping system. The wiping system consists of the necessary arrangement which enable the wiper slide over the board and the controlling system consists of micro-controller which control the motor, rpm, and the time of rotation.

The controlling unit contain the following elements:

3.1 Arduino UNO:

The Arduino Uno is a microcontroller board based on the ATmega328 .It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller. One of its most important features is its ease of programmability. [4]

Fig. 1: Arduino UNO Microcontroller

3.1 Motor Driver: (L293D IC)

The L293D is a monolithic integrated, high voltage, high current, 4-channel driver. Using the chip it is possible to use DC motors and power supplies of up to 36 Volts and maximum current of 600mA per channel.
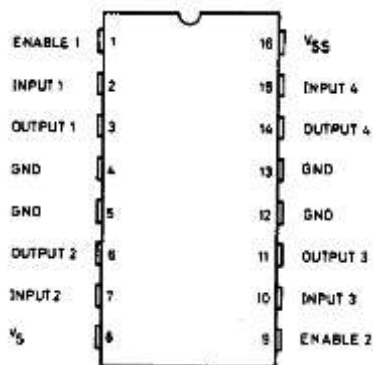

Fig. 2: Motor driver

The other components for control system are enumerated below.

3.2 10K Ohm resistor (Brown, Black, Orange, Gold)
3.3 50V 10uF Capacitor.
3.4 4 piece 6V DC motor.
3.5 A switch (push)
3.6 Breadboard.
3.7 Jumper.
3.8 9V DC power supply.

The elements that are used for building the wiping section consists of stainless steel, aluminum pipe, wood, pulleys ,foam, cord and cloth.

4.0 Methodology:

For rotating a motor both clockwise and anti-clockwise a motor driver is used along with the Arduino. The L293D chip is also what's known as a type of H-Bridge. The H-Bridge is typically an electrical circuit that enables a voltage to be applied across a load in either direction to an output. [5] This means it is possible to reverse the direction of current and thus reverse the direction of the motor. It works by having 4 elements in the circuit commonly known as corners: high side left, high side right, low side right, and low side left. By using combinations of these it is possible to start, stop and reverse the current. Here the care about in all of this is the 2 input pins per motor that do this logic and these, more importantly it can be controlled from the Arduino board. The voltage regulation allows for 2 power sources – 1 direct source, up to 36V for the motors and the other, 5V, to control the IC which can be supplied from the Arduino power supply. Capacitors is used in this circuit to smooth out the power load to the motors as much as possible to help avoid any spikes and stabilize the current.

It starts with the 16 pins on the L293D chip and has 2 sides, 1 for each motor. Pin 1 Starts and stops the motor whether it is on or off comes from the Arduino digital PWM pin 9. Pin 2 is the Logic pin for the motor goes to Arduino digital pin 4. Pin 3 is for one of the motor terminals can be either +/-. Pin 4 and 5 are grounded. Pin 6 is for other motor terminal. Pin 7 is the Logic pin for the motor (input is either high or low) goes to Arduino digital PWM pin 3. Pin 8 is for Power supply for the motor. Pin 9 Enables and disables the 2nd motor on or off (high or low). Pin 9 is the Logic pin for the 2nd motor (input is either high or low).pin 11 is for one of the 2nd motor terminals can be either +/-. Pin 12 and 13 are grounded. Pin 14 is for the 2nd motor's other terminal. Pin 15 logic pin for the 2nd motor (input is either high or low). Pin 16 Connected to +5V, in this case the power from motor supply. Next it switch on Arduino digital pin 2 and the GND pin from Arduino connected to the GND rail on the project board. The capacitor is used in between the power supply – making sure that the negative and positive terminals are correctly aligned. [6]

5.0 Design, Modeling & Construction

5.1 Design

Table 1: Functions of switch and Motor Rotation:

Switch	Motor 1	Motor 2	Motor 3	Motor4
1st push	Clockwise	Anticlock wise	Clockwise	Anticlock wise
2nd push	Anticlock wise	clockwise	Anticlock wise	clockwise
3rd push	Clockwise	Anticlock wise	Clockwise	Anticlock wise
4th push	Anticlock wise	clockwise	Anticlock wise	clockwise

A single motor driver can run highest two DC motor, so two motor driver is needed for running four DC motor. The motor arrangement follows the same but for four motors the +ve and −ve terminals are arranged for executing the targeted motion. Fig. 3 shows that the wiper can move up and down with the motor clockwise and anticlockwise rotation.

Fig. 3: Complete design of an Automatic board cleaner

5.1.1   Main Structure:

When a motor rotates it can create torque. This torque can be converted to linier motion. It is the basic principle of this machine. Here the wiper bar can slide over the board. Two stainless steel pipe is setup at the both side of the board. The wiper bar attached to the s-s pipe in a way that the bar can easily slide. Using cord and pulley arrangement the bar connected to the motors. When the motor rotates the pulleys attached to the motor also rotates. Then the pulley spin up the cords on it and the wiping bar moves vertically. There are four motors to drive the wiper bar. Two at the upper side and other two at the bottom side at four corners. Every complete move (from upper side to bottom side or lower side to upper side) of the wiper bar wipe the board

completely. The control box controls all the motors in such manner that the motors spin in the same direction.

Fig. 4: Main structure design

5.1.2   Wiper Bar:

It is made of aluminum pipe and has two drill at both side that enables it to slide following the stainless steel pipe slider. Aluminum pipe is preferred due to its light weight and agility. Cloth and a piece of foam is used as wiping material. The cloth which used here is very soft and the foam makes sure that the cloth can easily sweep over the board.
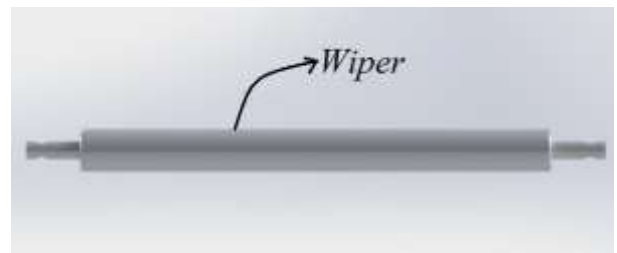

Fig. 5: Designed wiper roller

5.1.3   Control Box:

The control box consists of an Arduino and a circuit board with necessary elements. The control box is situated at the outer side of the main structure. It is connected through wire to the motors. An external power source is also connected to the control box to supply the power.

5.2 Modeling:

The circuit diagram is shown below at Fig. 6. Here Atmega-328 is used instead of Arduino UNO. Four motors are connected through two motor drivers. A switch is used as input. When switch becomes ON current flows to the motor driver through drivers. Here current is passed according to the program loaded in the microcontroller. Then motor starts respective of the microcontroller program.
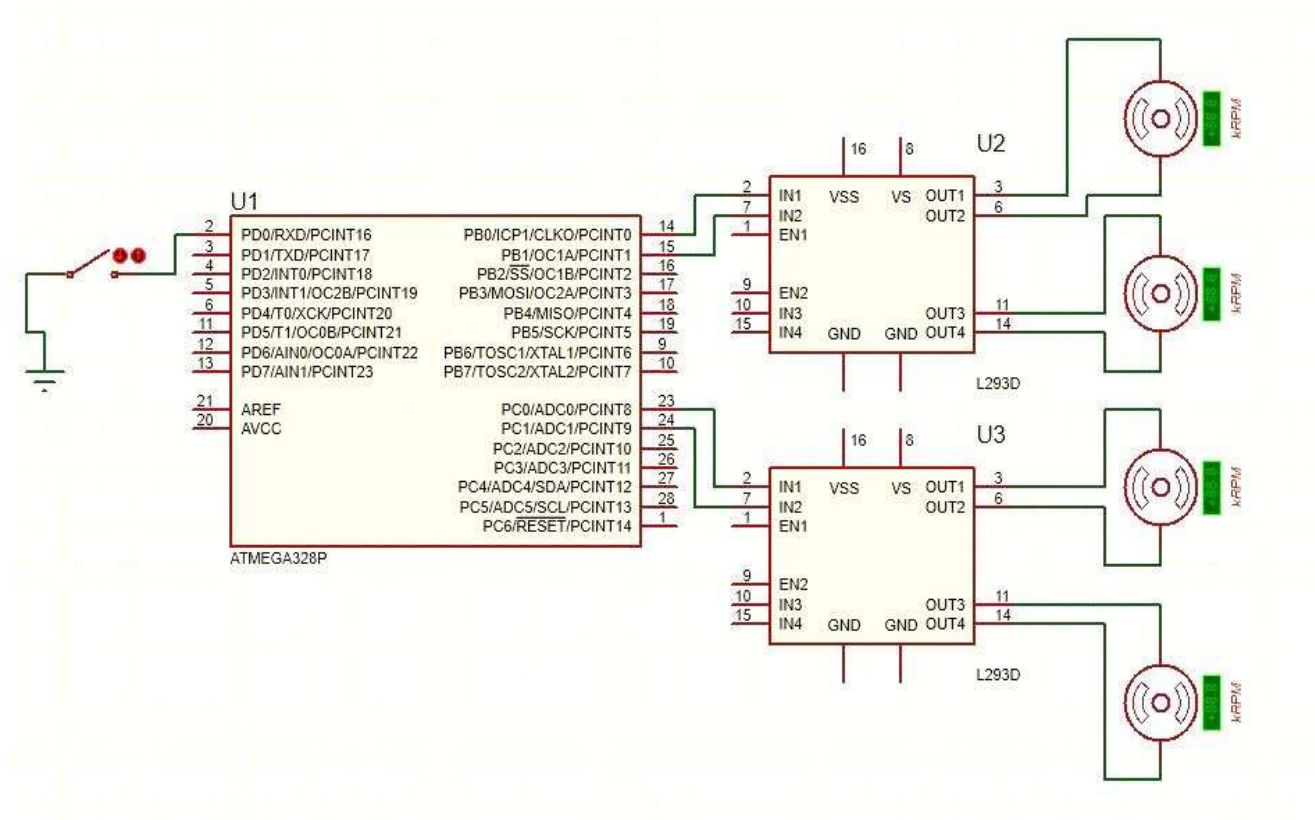
Fig. 6: Circuit diagram of the whole system for the board cleaner

Figure 6 illustrates the control system circuit diagram drawn by Proteus. The system is constructed according to this diagram. The corresponding pin numbers are exactly connected to the motors through motor drivers. The logical expression for the system is shown below as a flow diagram at Fig. 7.
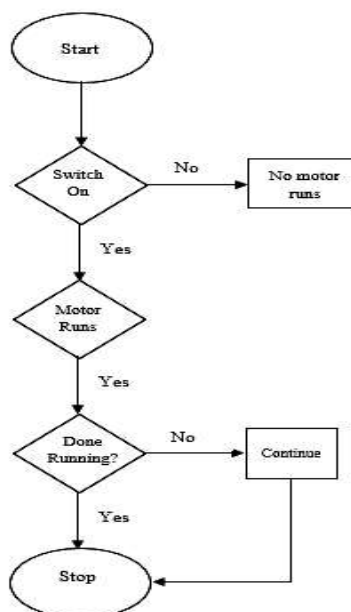
**Fig. 7:** Flow diagram of control system

5.3 Construction

After completing the virtual design main design has been executed. Material is same as it determined. The main structure dimension is also same. But some attachment is added for better performance. The main constructed model is shown in figure below.

Fig. 8: Constructed board cleaner

Fig. 8 represents the full constructed view of the Automatic Board Cleaner integrated within the white board. Here two stainless steel piers are supporting the wiper which is made of aluminum pipe surrounded with a foam and a cover. For wiping purpose the foam is attached with a cloth. The cloth has a zipper arrangement that helps the foam to attach with the aluminum bar as a round shape. It is possible to remove the bar and wash the cloth after a certain time.
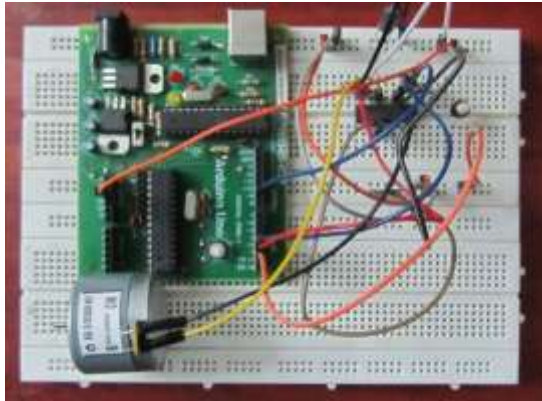
Fig. 9: Fabricated control circuit

Fig. 9 shows the connection of the designed circuit. For checking purpose only a motor is connected within the embedded system. Bread boards are used to connect all electronic components.

6.0 Time analysis

6.1 Using manual Duster:
For this project the prototype board was 4 feet wide and 2.5 feet longer. Using manual duster for complete cleaning the time requires averagely 25 sec.

6.2 Using Automatic Wiper:
Several data was taken to determine the time requires for completing the wiping process. Table-2 shows the time for five observations.

Table 2: Time requires for complete wiping.

Observation No.	Motor 1	Motor 2	Motor 3	Motor 4	Position Of wiper	Time (Sec)
01	Clockwise	Anticlockwise	Clockwise	Anticlockwise	Upward	8.3
02	Anticlockwise	clockwise	Anticlockwise	clockwise	Downward	9
03	Clockwise	Anticlockwise	Clockwise	Anticlockwise	Upward	7.8
04	Anticlockwise	clockwise	Anticlockwise	clockwise	Downward	8.9
05	Clockwise	Anticlockwise	Clockwise	Anticlockwise	Upward	6.2

7.0 Discussion and Conclusion

It is observed that the time requires for complete cleaning the board using this machine is average 8.04 sec. On the other hand while using the manual process the time is about 25 sec which is nearly about three times of the machine time. Though there have some lagging in to start the motor, but averagely it is optimum. The machine is reducing both time and human effort. It also maintaining the visual quality of the board. This construction consists of Arduino microcontroller. But it is possible to fabricate the circuit using Atmega-328p, Atmega-128p and other chip. For that reason it is very easy to crest the controlling circuit which enable us to create the machine easily. On the other hand to construct the main structure very simple tool work is need, and the materials use in this not very costly and available in market. So, it is not complicated to construct this machine and it will help to introduce an automation system. The system can be further developed by integrating a Bluetooth remote for controlling the switch. Infrared sensors can be used to convert this system to a smart white board.

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