ICMIEE-PI-140384

Development of a Control System and Modelling of an Automatic Window

Md.Armin Islam [1], Ishtiaq reza Emon[2], Md. Zahid Hasan[3]*

[1,3] Department of Mechanical Engineering
Khulna University of Engineering & Technology, Khulna-9203, BANGLADESH

[2] Department of Computer Science & Engineering
Khulna University of Engineering & Technology, Khulna-9203, BANGLADESH

ABSTRACT

Now a day's human comfort has become most significant conscience of engineers .The project is one step further about human comfort. The goal of this project is to close the window automatically as well as the zebra curtain too. The control system is prepared by using two motors, two sensors (one is water sensor and another is ambient light sensor), a microcontroller and some other necessary objects needed for circuit implementation. The ambient light sensor will be connected with the microcontroller which will sense the ambient light intensity. The sensor will send the result to microcontroller (which is a customized with program) and microcontroller will give necessary output to motor for controlling zebra curtain. Another is the water sensor which will work like the ambient sensor. Water sensor is set on the window and will sense the water drop on the window. Then it will send the result to microcontroller and after that the window will turn automatically off. The whole system is designed to get an autonomous control of window and zebra curtain whether the people is at home or not. The system will act according to weather condition.

Keywords: Automatic Window, Sensors, Microcontroller, Curtain controller, Control system.

1. Introduction

The project is aimed to be a widely used product to help enhancing human comfort by working with great accuracy. Many times we forget to close our window when raining and also forget to close down the curtain. Besides sometimes it feels bother to walk and close these. This system brings the solution. It automatically closes the window when it starts raining outside as well as it shuts down the curtain sensing a minimum light intensity of 300 lux outside. For example in a busy office where all the employees are too busy with their work, if an employee working at a distance from window suddenly faces rain or high sunlight outside then what will he do? He might not be intended to go to near window to close it because it may cause of interruption in his concentration of work. If this system was implemented there it could automatically close the window or curtain as necessary without having interruption during his work. The automation of window can be overdone using either sensors or a Bluetooth controlled remote device. The window will be designed to be sensitive to rain only. Its components will be so designed so that it can be easily manufactured and would be affordable to the common man. A typical house window is made of an aluminum frame. The glass used is double paned. Each frame has two window doors, both of which are sliding. A rain sensor is a device which is actuated by rainfall. For the purpose of our project we considered the use of the capacitive sensor. Capacitive sensors are preferred over resistive sensors as they are less prone to false detection of rainfall. If the resistive sensor gets contaminated by a carbon containing particle, the resistance changes and the system is triggered, whereas this is not the case with the capacitive sensors. And in case of light sensor Monolithic Silicon IC based light to voltage sensor was used. The device provides a linear voltage output that is proportional to light and covers a wide range of speed and fast response to ambient light.

2. Background

The background of this project consists with Atmel ATmega328p, Light sensor TS 12SM-LF, water sensor WS10 series, Motor Driver L293D, Motor DC (12V, Model: HN-GH12-1634T - 30:1)

2.1 Atmega328p

The Atmega-328p is a high-performance Atmel Pico Power 8-bit AVR RISC-based microcontroller. It has 32KB ISP flash memory with read-while-write capabilities, 1024B EEPROM, 2KB SRAM, 23 general purpose I/O lines. It combines 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, a 6channel 10-bit A/D, programmable watchdog timer with internal oscillator, and five software selectable power saving modes [1].

* Corresponding author. Tel.: +88-01745-602423
E-mail address: armin.aone@gmail.com

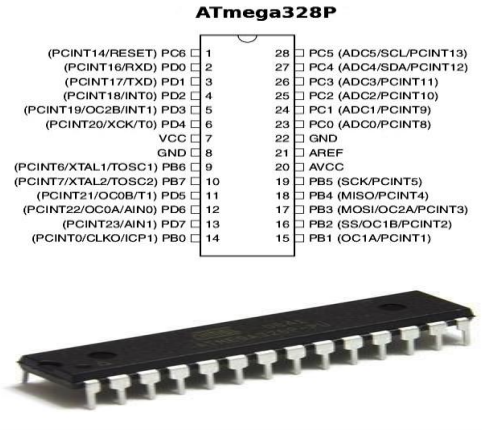

Fig.1 Atmega328p

2.2 Motor DC

Rating: (12V, Model: HN-GH12-1634T - 30:1) The rated voltage of the motor is 12 v DC and voltage operating range is 6-12 v. The rated load of this motor is 0.78Kg-cm. If the rated voltage is exceeded then damage may occur. The rotating speed at 12v DC is 200 RPM +/- 10%. But the rotating speed at Rated Load is (0.78Kg-cm) 163 RPM +/- 10%. Load current of this motor is less than 115mA but Current at Rated Load (0.78Kg-cm) is less than 285mA. The Shaft End-Play is Maximum 0.8m/m. Insulation Resistance is 10M ohm at 300vdc and Withstand Voltage is 300v DC for 1 second. The gear motor is not intended for instant reverse. The gear motor must be stopped before reversing. The gear motor does not include protection from water or dust etc [1].

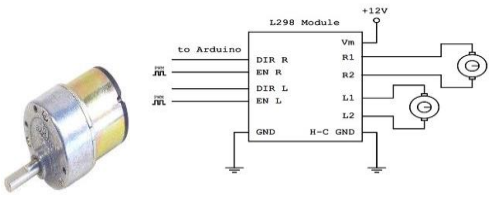

Fig.2 Motor DC

2.3 L293D Motor Driver

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. The L293d can drive both small and big motors as well. L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers. They take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors. For the purpose of best result here two motor driver were used.

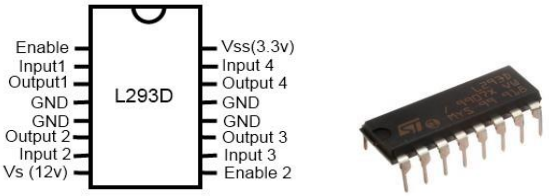

Fig.3 L293D Motor Driver

2.4 Light Sensor TS 12SM-LF

The TSL12SM-LF is a highly integrated light-to-voltage optical sensor with feedback resistor of 80 MΩ. It is cost-optimized, highly integrated light-to-voltage optical sensors each of which combining a photodiode and a Trans-Impedance amplifier (feedback resistor = 80 MΩ, 20 MΩ, and 5 MΩ, respectively) on a single monolithic integrated circuit. The photodiode active area is 0.5 mm sensors respond to light in the range of 320 nm to 1050 nm. Output voltage is linear with light intensity (irradiance) incident on the sensor over a wide dynamic range [2].

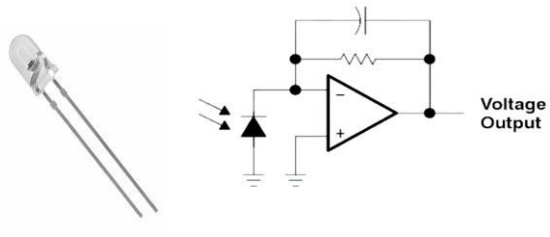

Fig.4 Light sensor

2.5 WS10 series Water Sensor

The Pall WS10 Series water sensor is used in this project. It is an ideal, low-cost, in-line, monitoring solution for measuring dissolved water content in hydraulic, lubricating and insulating fluids. It is specifically designed for use in harsh and often remote industrial environments. It can transmit readings continuously to the user's control systems as a key component in the predictive maintenance of plant and machinery. There are two separate analog 4-20 ma output signals (0-100% Saturation & -13 to 260F). It is rugged all in one modular housing and sensing probe [2].

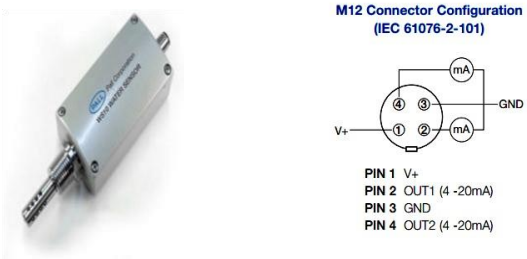

Fig.5 Water sensor

2.6 Zebra Curtain

It is also known as soft gauze rainbow curtain. It has dimming roller blinds and the double roller blinds are spaced by a small piece of a small piece of equal width fabrics and gauze woven into a textile material. It has one end fixed and the other end with the scroll action to achieve the purpose of regulating the light softer light when the gauze and gauze coincidence, to some extent reduce the direct light, the light is completely covered when the cord and cord coincide, and ultimately to block out light [3].

Fig.6 Zebra curtain

2.7 Sliding Window

In our project the window that was used for experiment had two sliding doors. We used Thai aluminum glass window for our work. The two doors can easily move through the guideway, each of which has a handle to slide it on the guideway. In experiment we worked with only one door of the window.

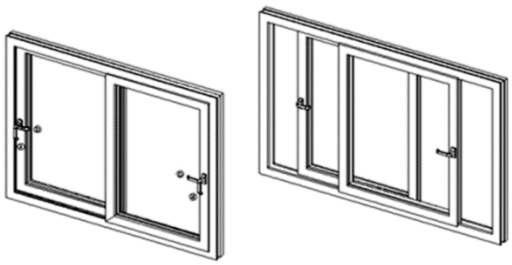

Fig.7 Sliding Window

3. Design and Implementation of Control System

The design and implementation process of whole project is given below:
First Atmega328p microcontroller was set in the project board. PORT D was taken as the input port of the microcontroller. Light sensor TS 12SM-LF was connected with the PORT D 0 pin through a switch. As well as water sensor WS10 series was connected with PORT D 1 pin through switch in the same way. Now PORT B was taken as output port. PORT B 1 pin was connected with the DC motor-1 by a motor driver (L293D) and PORT B 2 pin was connected with the DC motor-2 by a motor driver (L293D). The motor drivers (L293D) were used for output power amplification.

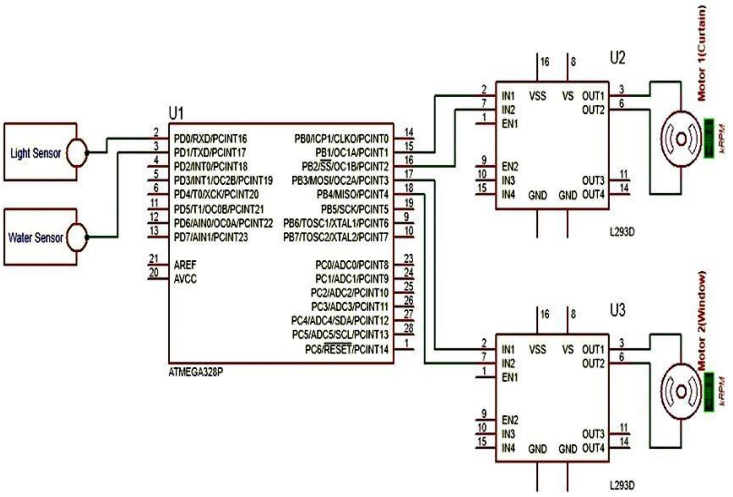

Fig.7 Circuit Diagram

DC motor-1 was connected with zebra curtain and DC motor-2 was connected with the one door of the window. When a light intensity (above 300 lux) was fallen on the curtain, the light sensor then sent it to the microcontroller pin PORT D 0 and output result was find from PORT B 1 pin which makes the motor-1 to rotate. When water drops were fallen on the curtain, the water sensor also sent the sense to the microcontroller pin PORT D 1 and output result were find from pin PORT B 2 which makes the motor-2 to rotate, thus working [4][6]. The circuit diagram and block diagram of the whole process is given below:

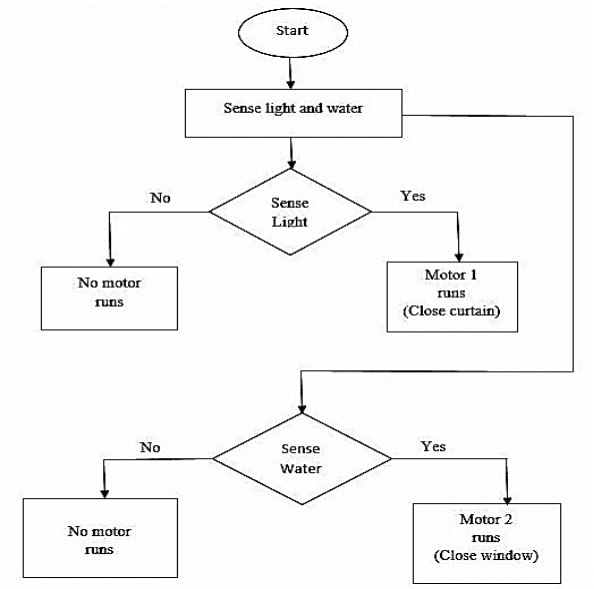

Fig.8 Flow Chart of logical expression

4. Modeling

The modeling process for the system is described below:
For modeling the process, two sensors were set up on their position, water sensor in the middle of the door of the

window and light sensor in the middle of the curtain. Then the two sensors were connected with control system at one upper corner of the window. When the light sensor sensed by light intensity, motor-1 started to rotate. One end of an strong thread was tied with the shaft of the motor and another end of the thread was tied with the handle (by turning manually the handle zebra curtain shuts down) of zebra curtain [5]. When motor-1 started to rotate itself and rolled the thread on the shaft, by rotating, the curtain came to close. From Fig.9 the process can be observed.

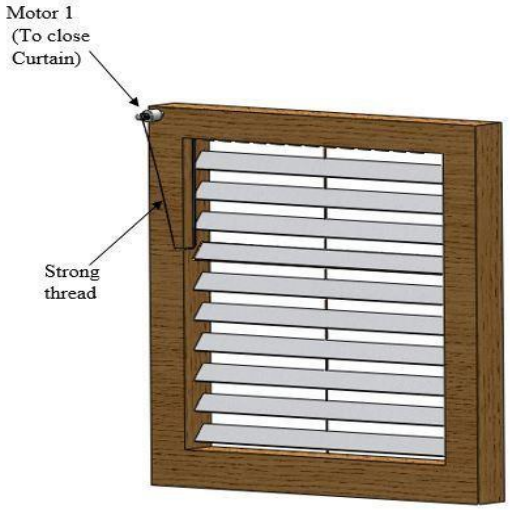

Fig.9 When motor-1 starts to rotate it rolls the thread on the shaft surface, thus closing the curtain.

In the same way, when the water sensor sensed by water drops, motor-2 started to rotate. One end of the thread was tied with the shaft of the motor and another end of the thread was tied with an extra handle which was at top position of the door. When motor-2 started to rotate and rolled the thread on the shaft it turned the door to the off position, through guide way. This process is presented at figure 10.

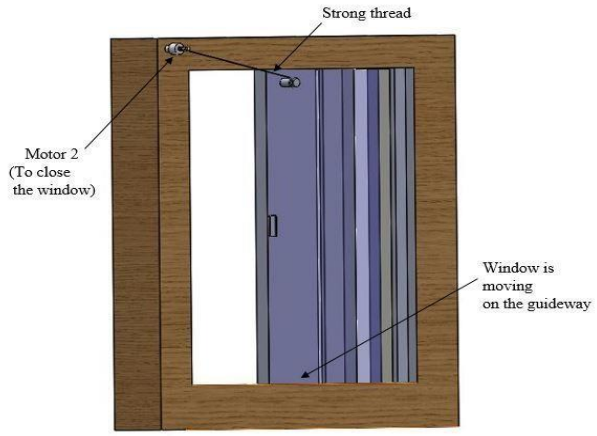

Fig.10 When motor-2 starts it rolls the thread around the body of the shaft and turns the window close.

[For convenience to understand two operations are shown in two different figures]

5. Methodology

The whole system is made to perform automatically. The light sensor is connected with the zebra curtain in the middle and the water sensor is connected with the window door in the same way. When the light sensor gets light intensity of at least 300 lux it sends the sense to microcontroller pin PORT D 0 and the microcontroller then provides the necessary output at pin PORT B 1.Then motor-1 which connected with the motor driver starts to rotate. If the light sensor does not get minimum light intensity, it will not send any sense to microcontroller pin PORT D 0 for which PORT B 1 will not give any output result and motor -1 will not rotate as a result the curtain will remain open.

In the same process the water sensor is connected with the window door. When the water sensor gets water drops on it, it sends the sense to microcontroller pin PORT D 1 and the microcontroller then provides output result at pin PORT B 2. Then motor-2 which is connected with the motor driver starts to rotate. If the light sensor does not get any water drops or fog on the window door, it will not send any sense to microcontroller pin PORT D 1 for which PORT B 2 will not give any output result and motor -2 will not rotate for which the window will not close. It will remain open. Working procedure of the system is given by a block diagram below:

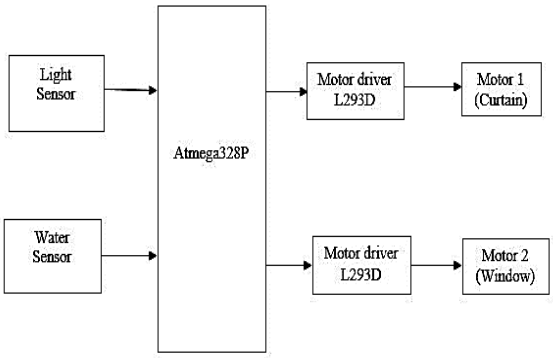

Fig.11 Block Diagram

6. Analysis of Result

The whole system was tested for few times to get the fastest and accurate result. For example, in some test few water drops were dropped on the window. When the water sensor sensed the water drops it was taking different time in different tests to close the window. In some test it took a little late to close the window because of some friction between guide way and window. In case of light sensor which was connected with the zebra curtain, several tests were made. In some tests sunlight of different intensity were drop on the curtain. Every time it was taking almost same time to shut down the curtain. The result of some tests were given in a table: (Start time of motor was observed from the control system)

Table1 Test Results

Time Required				
No of tests	Motor 1 (Curtain) To Start	Motor 2 (Window) To Start	Curtain To Close	Window To Close
Tests no 1	1 Sec	1 Sec	4 Sec	5 Sec
Tests no 2	1 Sec	2 Sec	4 Sec	5 Sec
Tests no 3	2 Sec	1 Sec	5 Sec	5 Sec
Tests no 4	1 Sec	1 Sec	3 Sec	5 Sec

7. Discussion

The test was conducted by the system in a real house room**.** It gave perfect results as expected. Though in some tests it took maximum 5 sec to response but in some test the system provided a very fast result of minimum 3 sec to perform which. Because of some existing friction between the window and the guide way it was taking a little more time to response. Here the whole system is described. This system will be very beneficial not only for office but also in domestic house. Almost all type of sliding window as well as all kind of zebra curtain can be used to set up with the control system. It is a great attempt to promote human comfort. This project can really minimize a little bit human toil to close the window while raining and to close the curtain at high light even when no one is at home. People can keep the system off if they wish.

8. Conclusion

In this project, a microcontroller based system is designed and implemented something like for enhancing human comfort. Atmel ATmega328p, Light sensor TS 12SM-LF, Motor Driver L293D and Water sensor WS10 series were utilized. The system will be really an useful one as it works with the sudden change of weather even the user is not alert about it. This system will not be a costly one to use everywhere and can really reduce a little bit human slog by doing its work automatically.

REFERENCES

[1] Yao-Chiang Kan, Hsueh-Chun Lin,Wen-Pei Sung, "Developing An Intelligent Control System Of Automatic Window Motor With Diverse Wireless Sensor Network Devices", Indian Academy Of Sciences, Sadhana Vol. 39, Part 4, August 2014, Pp. 809–818

[2] N. M.Z. Hashim, S. H. Husin, A. S. Ja'afar, N. A.A. Hamid, "Smart Wiper Control System", International Journal Of Application Or Innovation In Engineering & Management (IJAIEM), ISSN 2319-4847, Volume 2, Issue 7,July 2013

[3] Shukla Abhishek, Dwivedi Rohan, "Design and Implementation Of Vision System Aid In Windscreen Assembly", International Journal Of Computer Applications (0975 – 8887) Volume 7– No.12, (2010), Pp. 6-10.

[4] Ucar Mehmet, Ertunc Huseyin M., Turkoglu Onder, "The Design and Implementation Of Rain Sensitive Triggering System For Windshield Wiper System" IEEE, (2001), Pp 329-336.

[5] Mehran Kamyar, Takagi Sugeno, "Fuzzy Modeling for Process Control", Industrial Automation, Robotics And Artificial Intelligence (EEE8005) School Of Electrical, Electronic And Computer Engineering Newcastle University 2008.

[6] **Tis**a T.A, Nisha Z.A, Kiber A; "Design Of An Enhanced Temperature Control System For Neonatal Incubator*",* Bangladesh Journal Of Medical Physics, Vol. 5, No. 1, Bangladesh 2012