IMPLEMENTATION OF MICROCONTROLLER – BASED AUTOMATIC ROLLING UP/DOWN OF BILLBOARD USING AN ANEMOMETER AND A MASTER SWITCH IN LPU – LAGUNA

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ABSTRACT

These days, different forms of advertisements are spread throughout the vicinity. One of the most prevalent forms in the Philippines is the traditional billboard which is mostly established in urban areas. The current method of rolling up or down of billboards causes high risk in danger to the surrounding buildings and people, especially to the hired workers. The researchers developed an automated system that includes motor, microcontroller, master switch and cup anemometer to improve the present method in handling billboards. The cup anemometer will monitor the wind speed and signals the microcontroller. The system can be manually or automatically controlled depending on the user's desired process.

Keywords: *Traditional billboard; Cup anemometer; Motor; Microcontroller; Automatic rolling up/down of billboard.*

INTRODUCTION

Advertisements are sometimes spoken of as the nervous system of the business world. As nervous system is constructed to give control to the body, so as advertisement is comparable to the nervous system which has a big impact to control the sales of a product that marketers are introducing to the public [1]. Advertising has the power to persuade and has the power to influence the mind and shape destiny. It has the power to change markets and improve profit margins [2].

One of the medium in advertising products is by using billboard. Billboard is mostly seen whenever people are in transit – in PUVs or private vehicle. According to 2009 Arbitron National In-Car Study, the average people spend nearly 20 hours per week in a car – either as the driver or as a passenger. Some people especially those with longer commutes - greater percentage of their waking hours in a car than they do watching television, reading magazines or listening to the radio, which are all vehicles that provide advertising opportunities. So, billboard is determined to be the most effective advertising in both product sales and consumer awareness **[3]**. Billboard advertising has a lower cost per thousand than any other type of advertising. Billboard cost 80% less than television commercials, 60% less than newspaper ads, and 50% less than radio ads [4]. That's why advertisers lead to use this method rather than other medium of advertising.

Since this technique is being used by many companies here in the Philippines, huge billboards were installed in public places such as streets, roads and parks. This may lead to harm the people around the area especially whenever typhoons are entering in the country. One great example of this is when typhoon Milenyo entered the Philippines' area of responsibility in 2006 when billboards collapsed due to strong winds and heavy rains which led to loss of lives and properties [5]. After that incident, Metropolitan Manila Development Authority decided to launch "Operation Roll Down, Baby", which includes the rolling down of print-ads from advertising billboards before the typhoon landed on the area to prevent the repeat of what had happened before, but unfortunately most of outdoor advertisers were against the campaign and filed charges against the agency. With these mentioned circumstances, the proponents came up with this study.

Statement of the Problem

Many types of billboards (i.e. traditional billboard, mobile billboard and video billboard) are used to promote advertising but the only existing and common kind in the Philippines is the print billboard and the Light Emitting Diode (LED) billboard. There are factors to be determined in putting up a billboard for advertising such as the structure, cost, effectiveness and also the safety of the operators and the residence in the location.

The current standard of the contemporary billboard structure consists of a steel frame on which a high resolution advertising material is tied using steel wires and illuminated using front-lit metal halides using steel light supports. The weight of the frame is supported by a series of web-like large steel angle bars and thrushes engineered to fully secure the structure in case of adverse weather conditions. The base is bolted through a concrete slab which is buried deeply beneath the ground [6]. The said structure of the print billboard is very heavy yet fragile that it can collapse due to strong wind. This scenario could destruct the houses and other establishments around the billboard. Also, these billboards are very hazardous for the residence around the location.

Meanwhile, an apparatus for supporting operation of an LED sign, comprises of a video data processor including first and second video data processor circuit cards, each having a video source input, a backplane frame input and a backplane frame output; a sign interface unit for routing video data to a plurality of distribution boards that are provided within an LED sign and are connected to respectively corresponding pluralities of LED drivers that drive LEDs in the sign, said sign interface unit including a sign interface circuit card having a backplane frame input, and having a video data output for coupling to the associated distribution boards; and a backplane chassis connected to said first and second video data processor circuit cards and said sign interface circuit card, said backplane chassis coupling said backplane frame output of said first video data processor circuit card to said backplane frame input of said second video data processor circuit card, said backplane chassis also coupling said backplane frame output of said second video data processor circuit card to said backplane frame input of said sign interface circuit card [7]. This shows that structure of the LED billboard is also delicate. Meaning, the structure is not also secure for the people around the billboard.

In addition, digital billboards constantly use energy, which makes them less efficient than normal billboards. Although LED billboard is effective in advertising, it is wasteful and harmful to the environment [8]. This makes the LED billboards more costly because of the energy consumption.

In terms of cost, although a traditional billboard is less expensive than an LED ad, it can't be changed without hiring someone to climb up and repaper it, which is usually time-consuming and expensive [9]. This means, that both print and LED billboards are costly in a way that the LED billboard is expensive in the structure itself while the print billboard is also costly for hiring some to roll up or down the billboard.

In this light, the proponent undertook the study to address the following problems:

a. How to develop a control system using Arduino as the microcontroller, and wind sensor and a manual switch as switches?

b. How to develop a control system using Arduino to control the motor's rotation and speed, activate the motor and to monitor the input given by the anemometer?

c. How to develop a prototype that shows the operation of the sensor – based automated billboard system?

Thus, a proposal to build an automatic billboard using Arduino with anemometer as a wind sensor is proposed by the researchers. It cannot be destroy by the strong wind because a wind sensor will switches the billboard to roll down. Also, the cost of the device will be cheaper than the print and LED billboard. With the same effectiveness, this kind of billboard is more efficient and secure.

Objectives

The proposed study aims at providing an improvement in the billboard system which will serve as the automatic mechanism for billboards. Generally, the objective of this proposed study is to develop and construct a sensor-based automated billboard system prototype that will automatically do the rolling up and rolling down of billboards. Specifically, this study aims at:

- creating a prototype or model that shows the operation of the sensor-based automated billboard system;
- designing the system program using C++ as the system language, and On-Off Controller for the algorithm;
- controlling the system using Arduino as the microcontroller, and anemometer as the wind sensor along with a switch as the inputs; and,
- testing and evaluating the performance of the system in terms of Arduino's control system, motor, anemometer and the switch.

Scope and Limitations

This study includes the subsystems which are:

- the frame which is fabricated to hold the 6 ft x 4 ft tarpaulin, the wiper motor, and all other components used in the system.
- the program with an algorithm that will control the system to run and stop at a given condition.
- the sensor part, which will detect if a certain parameter reaches the maximum set point making an input signal to alert the system.

The constraints of this study include the following:

- the lack of automatic installation procedure.
  - nuts and bolts are used to hold the tarpaulin.
  - the eyelets of the tarpaulin must be in line with the fixed holes in the frame.
  - the tarpaulin size not greater than 6 ft x 4 ft can also be used but would not maximize the billboard design.
- when the billboard is placed in a different location the behavior of the wind is changed, thus the parameter set point being measured must be adjusted by manually changing the set points within the program of the microcontroller.
- the wind behavior considered for the set point is based on the measured wind in LPU – Laguna on March 2015.

The prototype is specifically made for the study and fulfillment of its stated objectives and is attuned for the safety of future billboard designs as well as to undertake automating billboard in the Lyceum of the Philippines University – Laguna.

Significance of the Study

This study will design and develop a prototype of an automatic rolling up or down of billboard using Arduino as the microcontroller unit in controlling the motor's rotation and speed, activate the motor and to monitor the input given by the anemometer wherein the on – off controller will be used. The novelty of this research is it is the first ever project to convey and construct a prototype of the operation of the sensor – based automated billboard system using the anemometer as wind sensor and a master switch in LPU - Laguna. This research helps the proponents to enhance the knowledge in Arduino technology and on – off control algorithm.

The proposed study can help the company to reduced expenses. The three main reasons are: first, because the study is less expensive than spending money in fixing the damaged billboards, not just once but n^{th} times. Second, the company will no longer need to pay personnel to manually roll up or down the print advertisement. Lastly, the company can control the rolling up or down of their desired print ads whenever they want with the use of the master switch which is connected to the micro-controller of the study.

In addition, manually rolling up or down the print-ads in high billboards are very risky, especially during rainy season. Workers' wellbeing are put in danger. Through this project, risking of lives can be reduced or even be prevented.

Also, the residence around a specific billboard will become safer with the help of this study. Because, whenever there is a storm, lots of billboards are damaged and crashed due to not successfully rolling up the print ads which may cause it to fall from the nearby residence. Many properties might be affected by this accident like houses, cars, or any establishments nearby.

All in all, the project will be beneficial to industrial or advertising companies, to the workers and to the residence. This study may also be used as a good reference for future studies.

METHODOLOGY

Project Flow

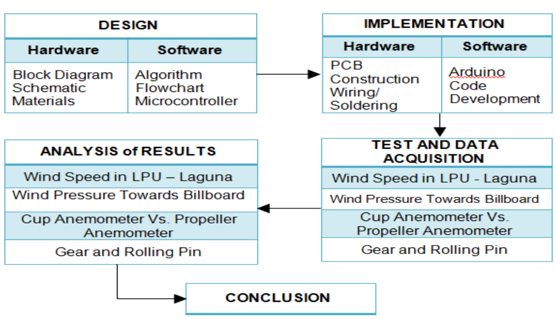

Figure 3.1.Project Flow.

The process of constructing the automatic rolling up/down of billboard prototype consists of five (5) procedures as follows:

a. Design

The project design is subdivided to hardware and software because the researchers aim to build a prototype that conveys the project and also consists of a microcontroller that controls the system.

Under the hardware category, there is the block diagram which represents the structure of the project by blocks connected by lines that show the relationship of the blocks. Further, the schematic diagram displays the layout of the electronic circuit using graphic symbols. Enlistment of the materials used is also necessary under the hardware.

The software includes the algorithm and its flowchart. Also, the microcontroller is included which is the Arduino.

b. Implementation

This is the execution of the design in both hardware and software side of the project. The Arduino board is connected to different components that are used such as the anemometer, switches, motor, etc.

Also, the program is developed and coded in the Arduino. This is the programming phase in which the programmer converts the program specifications into computer instructions or into programs.

c. Test and Data Acquisition

This is the process of gathering and measuring information on variables of interest. In this study, the proponents conducted tests measuring the speed of the wind in LPU – Laguna. Using the data from the test, the wind pressure towards the billboard was attained. Several tests comparing the cup anemometer and propeller was also performed to distinguish the most suitable anemometer for the project. A number of trials for the motor driver, relay and TIP transistor were also done. Additional to these is the observation of the behavior of gears and rolling pin to the system

d. Analysis of Results

Data accumulated during the research will need to be summarized and presented. This emphasizes the underlying concepts in describing and analyzing and interpreting the test results.

e. Conclusion

This is where drawing the conclusion from the analyzed data is made. Also, this is the summary of the main points of the research. It also demonstrates the significance of the analyzed data and raises recommendations.

DESIGN CONSIDERATION

Conceptual Framework

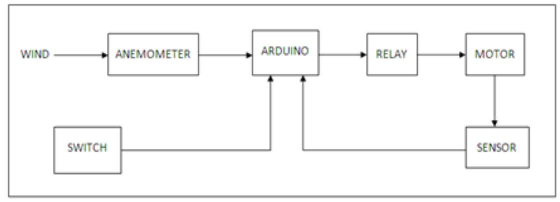

Figure 4.1.Conceptual Framework.

Rolling up or down of print-ads in the advertising billboard is performed through the following processes. There are two processes in the system, the manual and automatic process, which is controlled by the master switch. The automatic process is the anemometer measures the wind speed. The output of the anemometer is fed to the microcontroller, which is Arduino. The Arduino will decide whether the measured speed will drive the motor or not by means of a relay. When the microcontroller drives the motor, it means that the measured speed is beyond the typical level. But if it is not, the microcontroller declared that the measured speed is still on a typical level. The flow of the program of the microcontroller that was being used in the system can be seen in Figure 4.3. Referring to Figure 4.1, the sensor is used to monitor the rolling up or down of the billboard which in turn send a feedback signal to the controller to decide whether the rolling up or down will stop or continue until such time that the billboard is completely rolled.

The other method of driving the motor is by means of switch. The schematic diagram of this switch can be seen in Figure 3.3. The switch serves as another option of controlling the operation of the rolling up or down of prints-ads in the advertising billboard. Like in the output of the anemometer, the switch is also serves as input in the microcontroller. The purpose of this switch is for the billboard operators, for them to control the rolling up or down of the billboard without depending on the speed of the wind.

Schematic Diagram

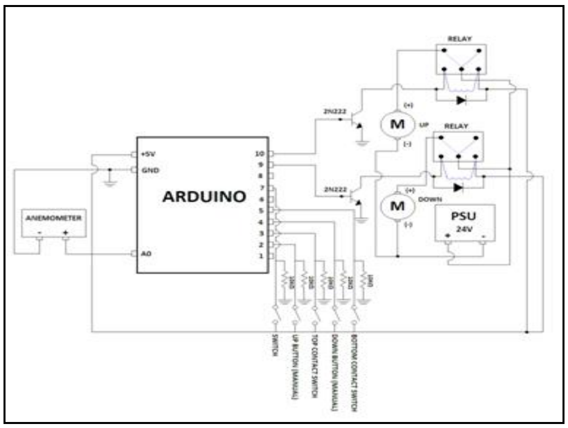

Figure 4.2.Schematic Diagram.

This diagram shows the circuit connection of the system. The master switch that controls which process, manual or automatic, to be performed is connected to digital pin, 7. The two main inputs of the system which are the anemometer and the manual switches (DOWN and UP switches) are connected to the microcontroller, Arduino, via the analog pin, A0, and digital pins, 2 and 4, respectively. The sensors or the contact switches of the system that stops the operation of each process is connected to the microcontroller via the digital pins, 3 (bottom contact switch) and 5 (top contact switch), respectively. While the outputs of the microcontroller which are the digital pins, 9 and 10, respectively, are connected to two separate transistors that control two separate relays that control when each motors are turned off or on, consecutively.

One of the pin for coil of the two relays is connected to the 5V supplied by the microcontroller. This serves as the power source to energize the relays. The common pin for the two relays is connected to the 12 – 24V power supply that supplies power to the motor when it is on. The normally open pin of the relays is connected to the two positive terminals of the motor, separately. When the relay is turned on the motor is turned on as well, and when it is off, the same thing happens to the motor.

The negative terminal of the motor is directly connected to the negative or ground terminal of the 12 – 24V power supply. The diode serves as the current-blocking component to stop any unwanted current to pass through the relay and directly to the transistor that is connected to the other coil pin of the relay. The anemometer monitors the wind speed and sends signals via voltage output to the microcontroller. The microcontroller monitors and reads the inputs and performs the necessary procedures.

The Prototype (Illustrations and Descriptions)

Figure 4.1A Prototype of the Billboard Design.

This study involves both electronics and electromechanical systems which include 7 x 6 feet metal frame, cup anemometer as wind sensor, Arduino as the microcontroller, push buttons as sensors, toggle switches as inputs for the manual process, relay for switching on and off the motor, wiper motor, chains and gears.

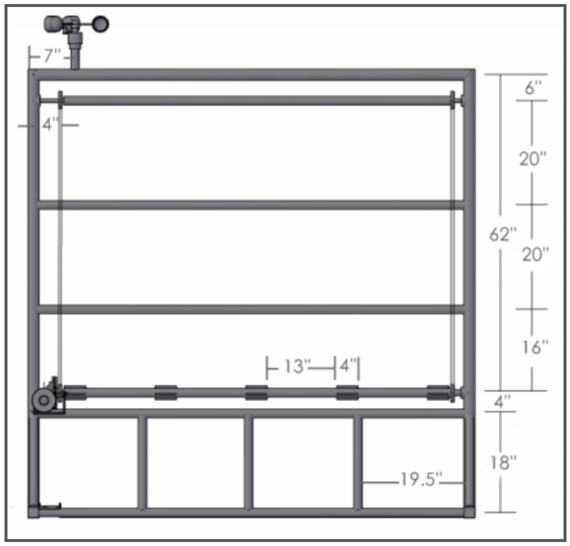

Figure 4.1B Billboard Design Dimensions (Front View)

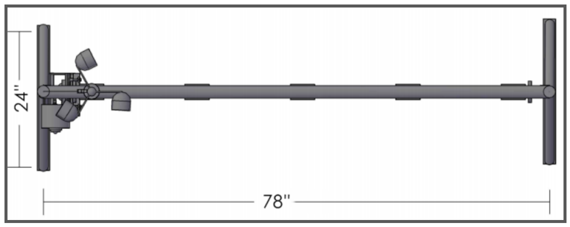

Figure 4.1C Billboard Design Dimensions (Top View)

There are two power supply units (PSU) used in the system that converts the alternating current (AC) electric power from the mains to low voltage and supplies direct current (DC) to the components in the system. One of the two power supply is a 12V DC unregulated power supply used for the wiper motor. The other PSU is used to supply 5V DC to the microcontroller.

The wiper motor's positive terminals are connected to the each relay, while, the negative terminal is directly connected to the negative or ground terminal of the power supply.

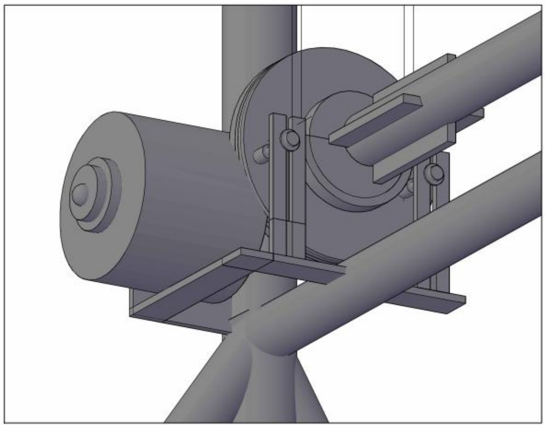

Figure 4.1E Wiper Motor.

There are two processes in the system in which the user can choose from, the manual and automatic process, by means of toggling the master switch. When the master switch is toggled to automatic, the manual process will not work, and likewise when the manual process is selected. Within both processes there are another two processes the microcontroller selects from, the roll-up process and roll-down process.

In the roll-up process, the microcontroller drives the first relay to turn on the motor and rotate in counterclockwise rotation, thus, rolling the tarpaulin upwards. The motor will stop when the steel bar that holds the upper end of the tarpaulin presses the push button or the top sensor placed on the upper left corner of the metal frame.

In the roll-down process, the microcontroller drives second relay to turn on the motor and rotate in clockwise rotation, thus, rolling the tarpaulin downwards. The motor will stop when the steel bar presses the push button or the bottom sensor placed on the lower left corner of the metal frame.

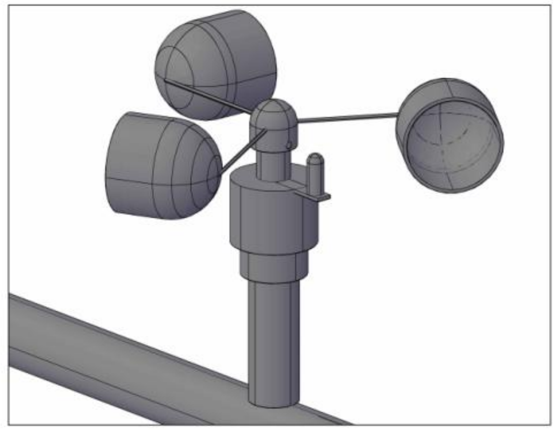

Figure 4.1D Cup Anemometer.

In the automatic process, the cup anemometer serves as the input that will continuously monitor the wind speed and send input signals to the microcontroller. The microcontroller will disregard the data it receives from the wind sensor unless it satisfies either set point. There are respective set points for the roll-up process and roll-down process.

For the automatic roll-down process, when the wind speed is greater than or equal to the given roll-down set point, it proceeds to the roll-down process. During the roll-down process, the motor will not stop even if the wind speed drops less than the specified set point. It will only stop when it presses the bottom sensor.

For the automatic roll-up process, when the wind speed is less than or equal to the given roll-up set point, it proceeds to the roll-up process. During the roll-up process, the motor will not stop even if the wind speed exceeds the set point. Though, it must return to the specified set point before it reaches the top sensor to stop the motor.

Pseudo Code

1. Start the program.
2. What process is to be used?

2.1 If manual process

2.1.1 Is the billboard is to be rolled down

2.1.1.1 Press the DOWN switch.

2.1.1.2 Arduino drives relay.

2.1.1.3 Relay turns on the motor.

2.1.1.4 Motor runs in clockwise rotation.

2.1.1.4.1 Is the billboard completely rolled down?

2.1.1.4.1.1 If no, the motor will continue to run until it satisfies the previous condition.

2.1.1.4.1.2 If yes, the motor stops. Return to 2.1.

2.2 If automatic process

2.2.1 Is the wind's speed greater than or equal to 28kph*?

2.2.1.1 If yes, Arduino drives the relay

2.2.1.1.1 Relay1 turns on the motor

2.2.1.1.2 Motor runs in clockwise rotation

2.2.1.1.2.1 Is the billboard completely rolled down?

2.2.1.1.2.1.1 If no, the motor will continue to run until it satisfies the previous condition.

2.2.1.1.2.1.2 If yes, the motor stops. Return to 2.2.

2.2.1.2 If no, is the wind's less than 5kph*

2.2.1.2.1 Arduino drives the relay

2.2.1.2.2 Relay2 turns on the motor

2.2.1.2.3 Motor runs in counterclockwise rotation

2.2.1.2.3.1 Is the billboard completely rolled down?

2.2.1.2.3.1.1 If no, the motor will continue to run until it satisfies the previous condition.

2.2.1.2.3.1.2 If yes, the motor stops. Return to 2.2.

Flow Chart

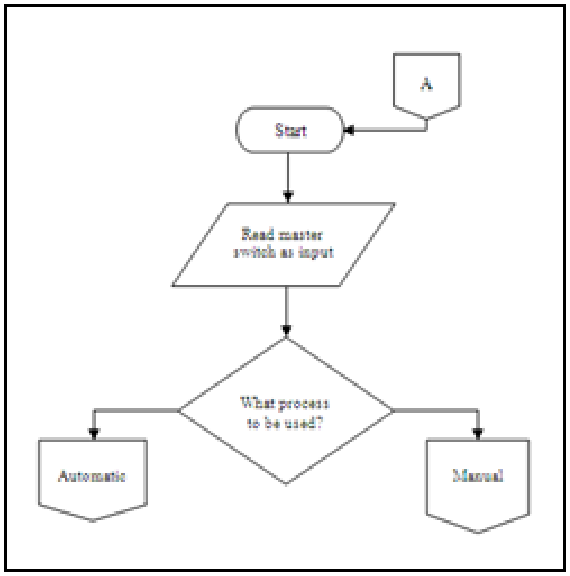

Figure 4.3A Flow Chart.

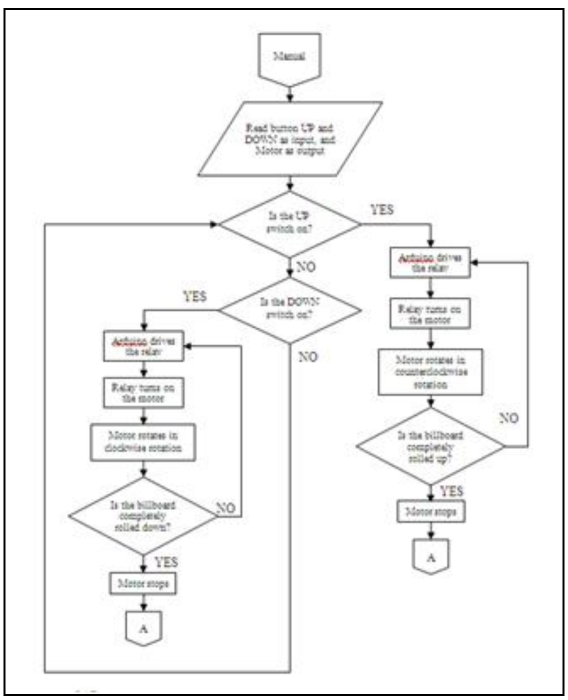

Figure 4.3B Flow Chart.

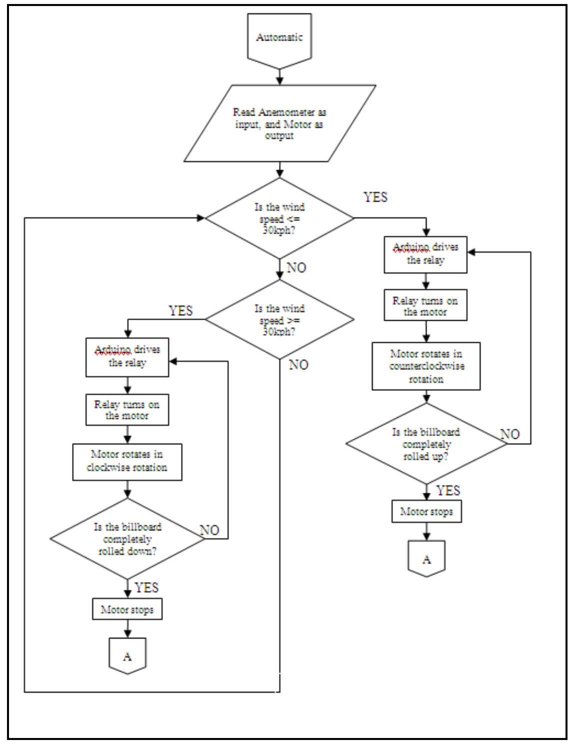

Figure 4.3C Flow Chart.

RESULTS AND DISCUSSION

Table 4.1 Comparison Between The Cup Anemometer and The Digital Propeller Anemometer Facing Parallel To The Wind.

TRIALS	CUP ANEMO-METER (kph)	DIGITAL ANEMOMETER FACING PARALLEL TO THE WIND (kph)
1	7.9	7.3
2	16.1	16.2
3	14	13.9
4	12.3	12.6
5	9.3	9.8
6	5.8	5.3
7	6.4	6.9
8	12.4	12.4
9	5.7	6.0
10	5.5	5.3
11	14.6	13.9
12	10.8	10.8
13	6.5	6.9
14	8.1	7.9
15	10	10.7
ẋ	9.693333333	9.726666667

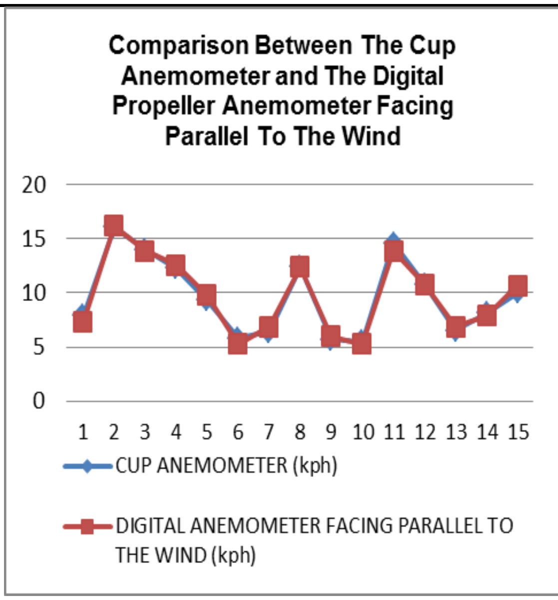

Figure 4.1 Comparison Between The Cup Anemometer and The Digital Propeller Anemometer Facing Parallel To The Wind.

$$\text{Percentage Error}_{\text{minimum}} = \frac{10.8 - 10.8}{10.8} \times 100$$

$$\text{Percentage Error}_{\text{minimum}} = 0\%$$

$$\text{Percentage Error}_{\text{maximum}} = \frac{10.7 - 10.0}{10.7} \times 100$$

$$\text{Percentage Error}_{\text{maximum}} = 6.54\%$$

$$\text{Percentage Error}_{\text{mean}} = \frac{9.73 - 9.69}{9.73} \times 100$$

$$\text{Percentage Error}_{\text{mean}} = 0.41\%$$

Table 4.2 Comparison Between The Cup Anemometer and The Digital Propeller Anemometer Facing Perpendicular To The Wind

TRIALS	CUP ANEMOMETER (kph)	DIGITAL ANEMOMETER FACING PERPENDICULAR TO THE WIND (kph)
1	16	13.2
2	13.2	9.9
3	9.4	10.1
4	5.3	9.2
5	5.5	6.8
6	9.8	8.9
7	13.4	3.8
8	6.2	7.9
9	13.5	10.1
10	19.6	7.7
11	7.9	17.9
12	10.6	9.1
13	10.9	10.7
14	16.5	14.4
15	10.9	9.1
ẋ	11.24666667	9.92

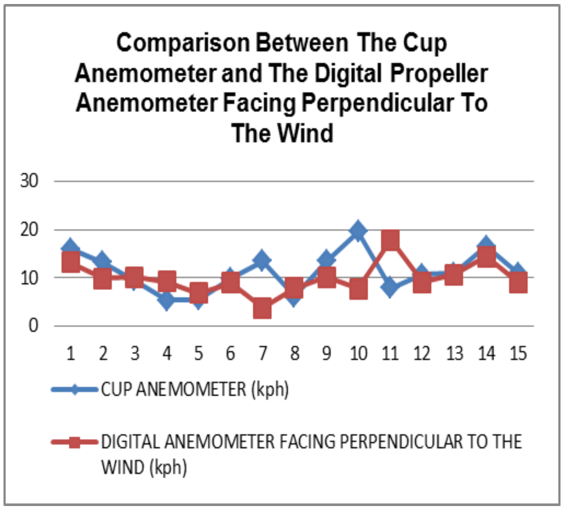

Figure 4.2 Comparison Between The Cup Anemometer and The Digital Propeller Anemometer Facing Perpendicular To The Wind.

$$\text{Percentage Error}_{\text{minimum}} = \frac{10.1 - 9.4}{10.1} \times 100$$

$$\text{Percentage Error}_{\text{minimum}} = 6.93\%$$

$$\text{Percentage Error}_{\text{maximum}} = \frac{19.6 - 7.7}{19.6} \times 100$$

$$\text{Percentage Error}_{\text{maximum}} = 60.71\%$$

$$\text{Percentage Error}_{\text{mean}} = \frac{11.25 - 9.92}{11.25} \times 100$$

$$\text{Percentage Error}_{\text{mean}} = 11.82\%$$

The table 4.1 and table 4.2 show the comparison between the readings of the wind using the improvised cup anemometer and the propeller anemometer. There are two tables provided as such that the propeller anemometer is tested facing the wind in two different directions, in parallel and in perpendicular direction. As seen on the data gathered there are small discrepancies between the readings of the improvised cup anemometer and of the propeller anemometer when it is faced parallel to the wind, while, the reading greatly differs when the propeller anemometer is faced perpendicular to the wind.

The cup anemometer senses winds perpendicular to its cup's direction, while, the propeller anemometer sense winds parallel to its propellers. Therefore, to achieve the same reading the cup anemometer must be perpendicular to the wind while the propeller anemometer is parallel. In this experiment only the propeller anemometer changes the position in accordance with the wind direction because the cup anemometer is already set to a position where it will not move. This experiment is conducted to prove that it is acceptable to use the improvised cup anemometer instead of the propeller anemometer because they provide similar wind speed readings. Since, the percentage error of the cup anemometer and the propeller anemometer facing parallel to the wind is at most 6.54% it is concluded that the improvised cup anemometer is suitable to be used.

Table 4.3 Time of Rolling Up/Down of Billboard Using Manual Process and Automatic Process

Trials	Manual Switching		Automatic Switching	
	Rolling Up	Rolling Down	Rolling Up	Rolling Down
1	13.58	13.82	13.59	13.05
2	13.86	13.69	13.47	13.42
3	13.54	13.82	13.99	13.46
4	13.41	13.69	13.47	13.33
5	13.81	13.70	13.57	13.46
6	14.31	13.57	13.45	13.28
7	13.63	13.82	13.55	13.64
8	13.59	13.78	13.86	13.50
9	13.14	13.42	13.75	13.42
10	13.50	13.64	13.53	13.42
Mean Time (sec)	**13.637**	**13.695**	**13.623**	**13.398**

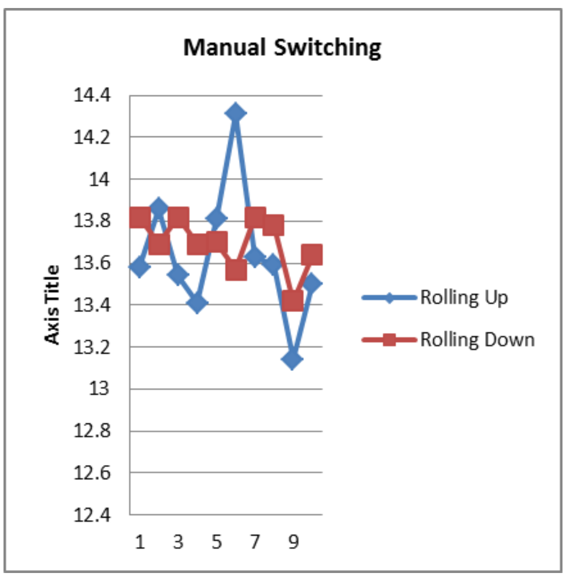

Figure 4.3.A Time of Rolling Up and Down of Billboard Using Manual Process

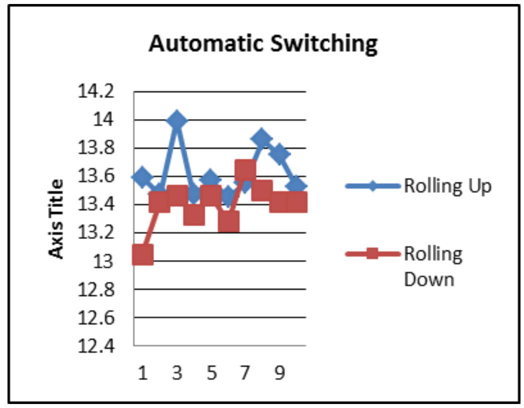

Figure4.3.B Time of Rolling Up and Down of Billboard Using Automatic Process

To evaluate the performance of the project, we tested the time (in seconds) of the rolling up and down of manual and automatic switching shown on table 4.3. Notice that the time for rolling down is within the range of 13.6 to 13.7 seconds while the rolling up is 13.3 to 13.6 seconds. Rolling up the billboard is almost the same.

Project Capabilities

This system is designed to deal with safety regarding the current method of rolling down the billboard. It also offers convenience to the owner(s) of the billboard advertisement as they are not required to hire workers to roll down the billboards.

The system is automated by means of the microcontroller and motor. It provides two processes: manual and automatic. In manual process, the user can select whether he or she wants to roll down or roll up the billboard by the use of switches found in the circuit box. In automatic process, without any human intervention the system is capable of detecting and determining when the billboard should be rolled up or down by the use of anemometer that is placed on top of the metal frame.

The proponents choose to use Arduino as the microcontroller as the main component in controlling the system since it is easy to understand and use, and it is less expensive in comparison to other microcontrollers available. Also, because of its user-friendly environment, future researchers who would tackle this study would easily be able to improve the system to their desired purposes.

However, there are limitations to the system. One of the limitations is that there is no delay included in the program. In the automatic process, whenever the set point for the roll up is attained, the system will immediately perform the roll up process, and likewise for the roll down process. A gust of strong wind can immediately activate the roll down process when the roll down set point is met. Another limitation is that in the roll up process when the wind exceeds the roll up set point, the motor will not stop even if the top sensor is pressed unless the wind returns to the required set point.

CONCLUSION

In conclusion, this study has endow with present technology and has given its part is in line with improving the billboard system which will serve as the automatic mechanism for billboards. The proponents have created a prototype that shows the operation of the microcontroller-based automated billboard system but given all its limitations and recommendations for improvement, this study is feasible because the researchers have conducted series of test to show its competence and calculated necessary parameters to present efficiency which was for the fulfillment of the objectives of this research.

This experimental research has designed the system program using C++ as the system language, and On-Off Controller for the algorithm and controlled the system using Arduino as the microcontroller, and anemometer as the wind sensor along with a switch as the inputs. This system was to promote safety of the innovated designs for billboard systems in the country, particularly in the Lyceum of the Philippines – Laguna.

RECOMMENDATION

For the development and future related studies of the project, the following recommendations are given:

- Installation of the tarpaulin can also be considered important in the system. Hence, the proponents recommend the future researchers to improve the installation of the tarpaulin in the system since it is not automated.
- When there is power failure, the system is not capable of providing an alternative power supply. Therefore, the proponents encourage the future researchers to provide a power supply that is uninterruptable (i.e. Battery).

- The proponents recommend the future researchers to make an adjustable set point since the system does not cover it. Also, to put a Liquid Crystal Display (LCD) so that the desired set point can be visualized.

- In automatic state, when the detected wind speed is greater than or equal to the roll down set point, the tarpaulin will roll down right away. As well as when the wind speed is less than or equal to the roll up set point, the tarpaulin will also roll up right away. So, the proponents encourage the future researchers to add a delay on the program to assure that the detected wind speed reached the said set point.

- The proponents commend the future researchers to consider and work with additional features utilizing the best resources brought about by modern technology to make the existing automated billboard system more efficient.

REFERENCES

[1] The Psychology of Advertising by Walter D. Scott

[2] Advertising Effectiveness by Jerry W. Thomas

[3] The Point of Purchase Institute, Washington, D.C

[4] EPIC

[5] Department of Public Works and Highways

[6] Traditional billboard - Gatuslao, 2010

[7] LED billboard - Robertus, 2006

[8] http://www.ehow.com/list_6138075 _disadvantages-digital-billboard.html

[9] http://smallbusiness.chron.com/print-vs-led-billboard-advertising-38820.html