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Development of Auto Roll Prayer Mat for Musolla

Muhammad Dafit Herman Sagitarius[1,3], Marlia Morsin[1,2*], Farhanahani Mahmud[1,2], Nur Zehan An'Nisa Md Shah[1,2], Nur Liyana Razali[1,2]

[1]Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Batu Pahat, Johor, MALAYSIA

[2]Microelectronics & Nanotechnology - Shamsuddin Research Centre (MiNT-SRC), Institute of Integrated Engineering (I2E), Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Batu Pahat, Johor, MALAYSIA

[3]Cardbiz Solutions Sdn Bhd,
Level 30, MYEG Tower, No.8 Jalan Damansara, PJU 8, Empire City, 47820 Petaling Jaya, Selangor[3], MALAYSIA

*Corresponding Author

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Abstract: During Friday or 'Hari Raya' festival, mosques will be flooded with Muslims who wish to perform prayers. Normally, mosques or 'musolla' require a large prayer space and certainly committees of the mosques would like to provide a comfortable space to perform prayer. However, the problem comes when the area provided is small and therefore the mosque's person in charge which is known as 'tok siak' needs to prepare additional prayer mat for them. In this study, Auto Roll Prayer Mat (ARPM) is a new innovation idea system that was designed to ease the burden and at the same time to make the task more efficient. ARPM can perform in two conditions, which are it can stretched out prayer mat automatically and the other is that the prayer mat also can roll back to its actual condition. The overall system was supported with a main component of the system which was a power window motor accompanied with pulse width modulation (PWM) motor controller circuit. Moreover, ARPM was also equipped with secondary function of an automatic cleaning process where the ARPM system was able to clean the prayer mat by using a servo motor and Arduino UNO microcontroller, while simultaneously stretching out the prayer mat.

Keywords: Prayer mat, power window motor, PWM motor controller, arduino UNO, servo motor, DC power supply.

1. Introduction

A prayer rug or prayer mat is a piece of fabric, sometimes a pile carpet, used by Muslims, placed between the ground and the worshipper for cleanliness during the various positions of Islamic prayer or known as 'solat'. These involve prostration and sitting on the ground. A Muslim must perform wudu' (ablution) before performing prayer. Many new prayer mats are manufactured by weavers in a factory. The design of a prayer mat is based on the village of where it came from and its weaver.

The advancement of prayer mat technology [1]-[3] is done to assist the Muslim community in Malaysia and other countries, yet to ease Muslim to perform prayers. In recent years, we can identify and observed plenty of projects related to the technology of prayer mat that was invented namely Prayer Mat Electronic [4],[5]. Besides, other innovations called as 'Smart mosque' or more specifically named as 'Automatic prayer mat roller with scheduling mechanism', by Pikumbuh [6] and E-Prayer mat by Khairuddin M. [7] which can show the correct direction of Qibla also have been developed.

*Corresponding author: marlia@uthm.edu.my

Hence, this project namely 'Development of Auto Roll Prayer Mat' will highlight a different concept to perform prayer in a large number of Muslim people. On the other hand, the system allowed prayer mats to be cleaned automatically when they are rolled in and out. This project will help the Muslims community especially in the mosque or 'musolla' during performing Friday prayers. In this project, an auto roll prayer mat system that can be stretched out and folded back by using a power window motor has been developed. A servo motor was implemented in this system for prayer mat cleaning process using Arduino UNO microcontroller.

2. Methodology

The main hardware types of equipment used in ARPM system are a power window and a servo motor, while the motor controller and Arduino UNO as the main components. The power window was used to roll the prayer mat in and out and the servo motor was used to do the cleaning part as the brush was attached with it. For overall description process of the system is illustrated in Figure 1. The ARPM system has been developed in four phases as follows;

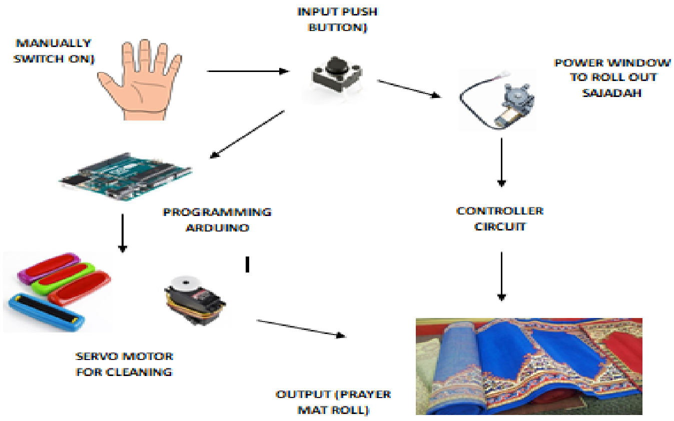

Fig. 1 - Block diagram of ARPM system

2.1 Project Planning (Phase 1)

In order to develop this project, it had been divided into three parts which are hardware, software and integration between hardware and software. The system starts from the input when the push button is pressed. The prayer mat that is initially being stick together in the station panel will roll out horizontally when the system "on" by using the power window motor. The motor stops when all mats are successfully rolled out. At the same time, the cleaning process by the servo motor will run simultaneously with auto roll process. The overall operations are presented through flowcharts in Figure 2 (a) and (b).

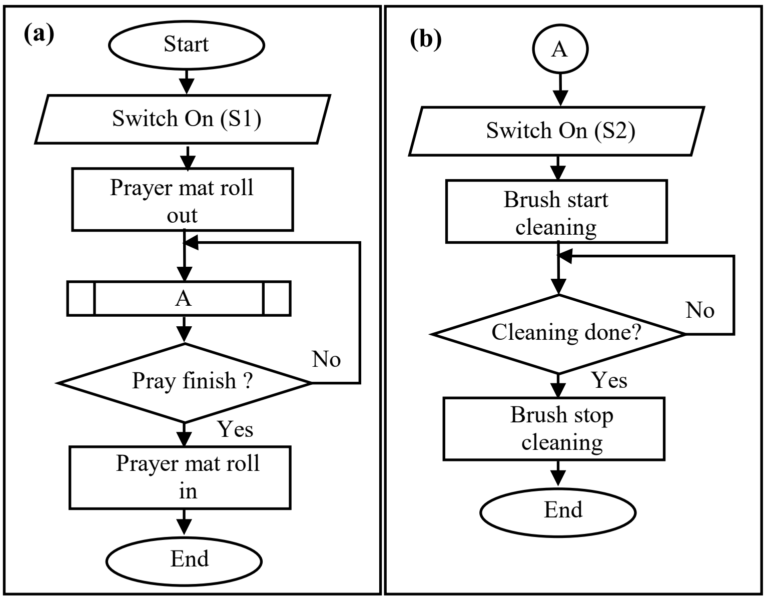

Fig. 2 - Overall operations; (a) flow process of ARPM system; (b) flow process of cleaning for the prayer mat

2.2 Software and Programming Development (Phase 2)

This is the section where software and programming development were performed. Before the hardware development and the design were being developed, simulation works must be done first. Proteus 8 Professional was the chosen software to design and simulate the controller circuit for the power window motor. Next, Arduino IDE was used as the platform of the coding development for the Arduino UNO board, as the instruction and command of the servo motor can be assigned from it [8]. The detail parts of the software are as follows;

a. Proteus 8 Professional

Proteus was used to design the schematic circuit for the power window controller circuit. This circuit as shown in Figure 3 was constructed to control the power window motor movement. The operating voltage of this circuit is from 6.5V to 30V DC voltage. The control current is rated to 6A and the quantity power used is up to 200W. The Pulse Width Modulation (PWM) duty cycle is 0% with frequency 16KHZ. This circuit ideally used for normal DC motor but since the output is used for the power window, this circuit also can be implemented due to limitation of its DC voltage is in the same range. Figure 4 shows the block diagram of the operation for power window controller circuit. Input for the circuit was the Double Pole Double Throw (DPDT) switch which was the forward/reverse switch for motor. The controller parts were the IC Timer and the motor driver, and the output part was the power window motor.

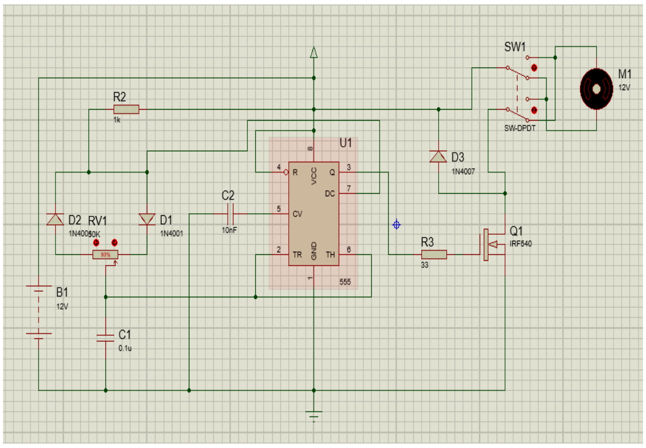

Fig. 3 - Power window motor controller circuit design in Proteus

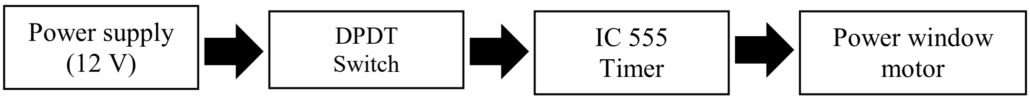

Fig. 4 - Block diagram operation of the power window motor

b. Arduino Uno IDE software

Arduino IDE software is used to connect the Arduino microcontroller. The programming details represented the movement of the servo motor in terms of the speed-torque of motor and also the direction of the motor either forward and reverse. Figure 5 shows the operation block diagram of the servo window with the implementation of Arduino UNO.

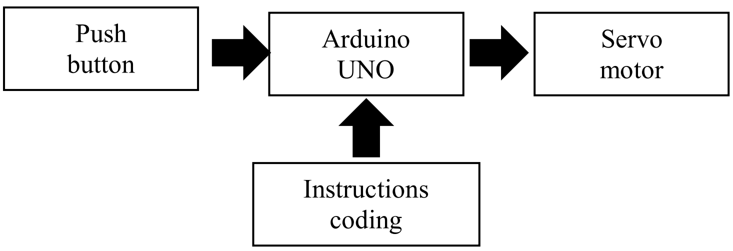

Fig. 5 - Block diagram of the servo motor operations

Figure 6 shows the result of the IDE programming successfully verified. Then, this programming is uploaded into the Arduino board to generate the output of servo motors. The servo motor is set to move into two directions which are from 0° to 180° where the motor turns to the right direction and then from 180° to 0° where the motor turns to the left direction. These directions of motor provide the cleaning process for the system to clean the prayer mat after the operation of the prayer mat rolled out from the panel. This servo motor is the generator to move the brush that is the cleaning tool to prayer mat. Figure 7 (a) and (b) depicts the instruction for motor to move the brush.

```
File  Edit  Sketch  Tools  Help
leftrightmotor
#include <Servo.h>

Servo myservo;                      // create servo object to control a servo
int pos= 0;                        // variable to store the servo position in degrees

void setup() {

myservo.attach(6);                 // attaches the servo on pin 6 (pwm) to the servo object

}
void loop() {

for (pos= 0; pos<= 90; pos+= 1) {   // goes from 0 degrees to 90 degrees
                                   // in steps of 1 degree

myservo.write(pos);                // tell servo to go to position in variable 'pos'
delay(15);                         // waits 15ms for the servo to reach the position
}

for (pos= 180; pos>= 90; pos-= 1) { // goes from 180 degrees to 90 degrees

myservo.write(pos);                // tell servo to go to position in variable 'pos'
delay(15);                         // waits 15ms for the servo to reach the position

}

}

Done compiling.

Sketch uses 2160 bytes (6%) of program storage space. Maximum is 32256 bytes.
Global variables use 52 bytes (2%) of dynamic memory, leaving 1996 bytes for local variables. Maximum is 2048 bytes.
```

Fig. 6 - Programming for the servo motor successfully verified

```
for (pos= 0; pos<= 180; pos+= 1) {   // goes from 0 degrees to 90 degrees
                                    // in steps of 1 degree

myservo.write(pos);                 // tell servo to go to position in variable 'pos'
delay(15);                          // waits 15ms for the servo to reach the position
```

(a)

```
for (pos= 180; pos>= 0; pos-= 1) { // goes from 180 degrees to 90 degrees

myservo.write(pos);                // tell servo to go to position in variable 'pos'
delay(15);                         // waits 15ms for the servo to reach the position
```

(b)

Fig. 7 - Instruction for motor turns (a) 0-180 degrees; (b) 180-0 degrees

2.3 Hardware Development and Integration (Phase 3)

In this phase, the PCB development has been done with circuit testing and troubleshooting.

a. Printed Circuit Board (PCB) development.

After the process of creating a motor controller circuit in a schematic drawing, next is the process of developing a PCB board. Several procedures have been done to complete the PCB board. Figure 8 (a) shows the drilling process onto the PCB board and Figure 8 (b) shows the complete PCB board.

Fig. 9 - Printed circuit board (PCB) development; (a) Drilling process onto the PCB board and (b) Complete PCB board

b. Circuit Testing and Troubleshooting

Circuit testing process has been done to ensure that the circuit works well and to test whether a component that has been installed is working properly and stable. The troubleshooting process also has been done if the designed circuit is not working by detecting faults or errors in the circuit.

2.4 Casing Construction and Troubleshooting (Phase 4)

This project required big casing construction to locate both the power window motor together with the prayer mat. In addition, two circuits which included motor controller circuit and Arduino microcontroller were also attached together to fully operate the system. In the first part of the system which is the power window motor, one steel was needed to be attached to the gear of the motor (act as a shaft) to assist the motor to operate the prayer mat movement, either rolls out (forward condition) or rolls in (reverse condition). Figure 10 (a) shows the preparation of a motor shaft in this system.

Next, the base of the casing was built together with attachment of the power window motor and the shaft as the platform for the prayer mat. Figure 10 (b) depicts a platform base of the system and prayer mat platform. On the shaft, one strap was pasted and the other straps were pasted on each of the prayer mats with a total of five prayer mats will be connected together to perform rolling action as shown in Figure 10 (c). In the next stage, the casing also required another base platform where both power window motor and servo motor were located. Figure 10 (d) shows the measurement process on the plywood to build the platform base. Plywood was chosen to accomplish the requirement as it was needed to locate both power supply and circuit as shown in Figure 10 (e). Finally, the last stage of the casing construction and hardware is a cabling process where all cable that involved in every part of the system were attached on the suitable situation. The full system of ARPM is shown in Figure 10 (f) and platform base for circuit and power supply are depicted in Figure 10 (g).

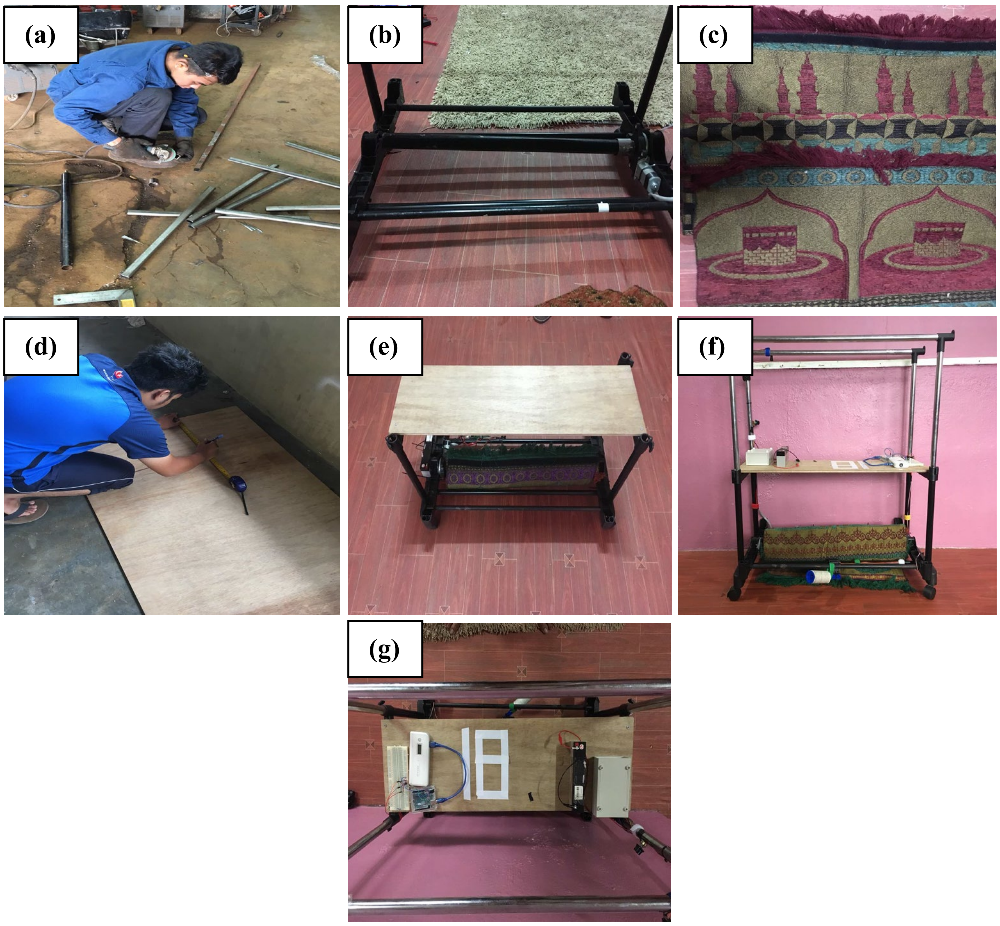

Fig. 10 - (a) preparation for the motor shaft; (b) platform base of the system and prayer mat platform; (c) prayer mats were connected to each other; (d) measurement on the plywood for the platform base; (e) platform base for circuit and power supply; (f) full complete ARPM system; (g) platform base for circuit and power supply

3. Results and Analysis

The ARPM hardware system is divided into two main parts which are the power window parts and the servo motor part. Both of the outcomes of the part were analyzed based on the simulation results which were obtained before construction and prototype outcomes.

3.1 Simulation Results

The power window motor controller circuit was designed by using Proteus 8. The obtained results in Table 1 show the condition of a power window motor as an output. There were two outputs for the motor which either the motor turns clockwise or anti-clockwise.

Table 1 - Power window motor condition

Dc motor condition	Motor direction	Prayer mat condition
Turn clockwise	Forward-bias	Rolls out
Turn anti-clockwise	Reverse-bias	Rolls in

The servo motor controller circuit by using the Arduino UNO board was programmed by using Arduino IDE programmer software. According to Table 2, two outputs of the servo motor turned left or turn right according to the angle direction set as the input.

Table 2 - Servo motor condition

Direction angle (º)	Motor condition
0 – 180	Turns right (clockwise)
180 – 0	Turns left (anti-clockwise)

3.2 Prototype of ARPM

The functionality of the power window motor and servo motor were observed during prototype testing. Several demonstrations were taken to monitor the ability and effectiveness of the system on a different kind of situation and condition. Based on the prototype testing, the system started when the forward button switch was pressed and the prayer mat rolled out smoothly according to the speed adjusted. The system continued to run until the switch pushed back into the normal condition. Figure 11(a – b) shows the prayer mat rolls out from the platform and the prayer mat rolls into the platform. Moreover, the cleaning brush was attached on the gear of the motor to perform the cleaning part. The brush simply moved from right to left according to the instruction coded in the Arduino board as shown in Figure 11 (c). In general, the prototype system had shown the same results with the simulation.

Fig. 11 - (a) Prayer mat rolls out from the platform; (b) prayer mat rolls into the platform; (c) brush turns from left to the right

Voltage drop by variation of potentiometer values was measured using simulation through Proteus either the motor is in forward condition or the reverse condition. It can be seen from Table 3 and 4 that the motor speed can be controlled by the function of the potentiometer as to control the amount of variable resistance supplied to the full complete circuit. Figure 12 shows the AC Voltmeter parameter were attached parallel with the DC motor to measure voltage drop on the output of the circuit.

Table 3 - Voltage drop of the DC motor for forward condition (Simulation)

No	Potentiometer Value (%)	Resistance (Ω)	Voltage (V)
1	0	0	4.57
2	10	10k	4.33
3	20	20k	4.06
4	30	30k	3.84
5	40	40k	3.45
6	50	50k	2.98
7	60	60k	2.68
8	70	70k	2.37
9	80	80k	2.04
10	90	90k	1.54

Table 4 - Voltage drop of the DC motor for reverse condition (Simulation)

No	Potentiometer Value (%)	Resistance (Ω)	Voltage (V)
1	0	0	4.57
2	10	10k	4.32
3	20	20k	3.98
4	30	30k	3.55
5	40	40k	3.15
6	50	50k	2.79
7	60	60k	2.54
8	70	70k	2.22
9	80	80k	1.77
10	90	90k	1.36

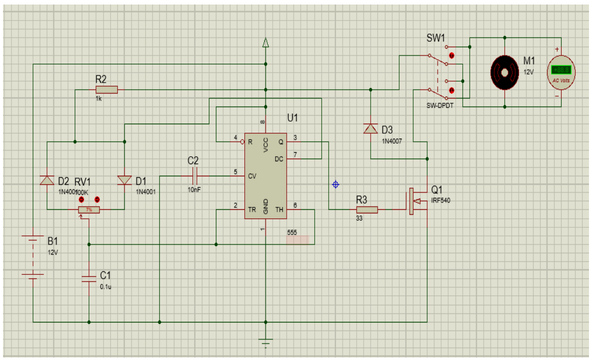

Fig. 12 - Voltage drop on the power window motor

To confirm the simulation results, the voltage drop was measured on the output of the circuit at power window motor of ARPM prototype system using a digital multimeter. The manipulated variable which was the amount of the resistance was produced by the potentiometer by varying the potential knob. The increasing value in percentage of the potentiometer determined the amount of resistance applied through the circuit. Table 5 shows the voltage drop for the forward and reverse condition.

Table 5 - Voltage drop of the power window motor for forward and reverse condition (Prototype)

No	Potentiometer value (%)	Resistance (kΩ)	Voltage (V)	
			Forward	Reverse
1	0	90.8	0	0
2	10	90.8	0.01	-1.72
3	20	89.4	0.87	- 2.25
4	30	84.1	1.92	- 3.41
5	40	75.9	2.91	- 4.97
6	50	63.7	4.48	- 5.37
7	60	47.3	6.75	- 6.85
8	70	33.5	7.74	-7.06
9	80	20.1	9.14	- 8.39
10	90	11.2	10.58	- 9.42

In addition, several test and demonstration were performed to measure the time taken by the system to perform each task by using different quantities of prayer mat at different speeds. The time taken results is illustrated in Table 6. Table 6 shows the system demonstration by the implementation of minimum two, four and six prayer mats for both forward and reverse the condition. The results were recorded based on the time taken for the system to finish both operations.

Table 6 - Time taken for prayer mat connection to roll

Motor condition	25 % of Potentiometer value	50 % of Potentiometer value	75 % of Potentiometer value
	2 prayer mats connection		
Forward	25 s	13 s	8s
Reverse	26 s	12 s	7s
	4 prayer mats connection		
Forward	58 s	24 s	15 s
Reverse	46 s	26 s	14 s
	6 prayer mats connection		
Forward	62 s	30 s	19 s
Reverse	63 s	28 s	18 s

4. Conclusion

The 'Development of Auto Roll Prayer Mat (ARPM)' system was able to perform both tasks as planned which were the rolling part and the cleaning part. The system can be implemented in small range mosques or 'musolla' that require more additional prayer mat for prayer times. Moreover, this system also user-friendly where any amount of prayer mat can be implemented on the system according to the suitability of the location and it also can be removed and carry to anywhere. Finally, the system can also perform the cleaning process during the prayer mat rolls in and out as one brush was attached together on the system to perform the task.

Acknowledgement

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