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Design and Implementation of Microcontroller Based Ultrasonic Sensor Sliding Door

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Abstract: *Opening and closing of doors have always been a tedious and uninteresting job, particularly in places like; hotels, and shopping where an individual is always required to open and close the door for visitors. This human involvement can be avoided by automating the process using microcontroller based ultrasonic sensor sliding door that detects an approaching individual or person to allow access to automatically. The final output voltage required for the operation of this project is a DC voltage. The power was build up from A12V, 500mA transformer, and a bridge rectifier chip (BDR1), a filter capacitor (C1) and two voltage regulators (LM7809) and (LM 7805) were used. The ultrasonic sensor unit consist of the ultrasonic sensor module, limiting current resistors. Furthermore, the microcontroller unit is made up of the Atmega 328P microcontroller, a C6MHz crystal oscillator, and a pull-urge resistor. However, the sliding door control unit consist of four (4) base resistors R4, R5, R6 and R7 for transistors Q1, Q2, Q3 and Q4, in associate with Diodes D5, D6, D7 and D8. The system utilizes ultrasonic wave's technology to sense or detect an approaching individual or person to allow access automatically. Green LED is an indication of door closed, when person approaching the door; the Red LED light turn on and the door automatically open.*

Key words: *Door, Microcontroller, Sensor, Sliding and Ultrasonic*

1.0 Introduction

The microcontroller based ultrasonic sensor sliding door is an automatic sliding door that uses the ultrasonic waves technology to sense or detect an approaching individual or person to allow access to him/her by automatically. The sliding door opens and closes automatically if the person has entered or has decided to turn go back due to

other reasons. However, due to the fact that nowadays populations in the mega cities all over the world have greatly increased. Therefore, the use of manual doors in commercial buildings such as Banks, shopping malls and shopping complexes will bring about discomfort to the people because of the inconvenient of pushing the hard door to open it. Sometimes it even leads to delays and waste of time due to a queue that might arise. Therefore, this design is another step forwarding aiding the already existing automatic control sliding doors to help solve the problems and challenges that were associated with the manually controlled door system.

2.0 Literature Review

According to Mahmood et al., (2016), current access control systems for automatic door control require a sensor able to detect a moving object or a pedestrian crossing the gate. This approach does not take into account the trajectory of pedestrians, and therefore cannot estimate movements. As an example, if a pedestrian crosses the area in front of the door but does not want to cross the gate, the control access board detects his/her presence and anyway opens the door. In this case, the system is not efficient, since it leads to a waste of energy in terms of electricity, air conditioning, or heating and decrease the system lifetime with unnecessary open/close actions.

Lucky et al., (2013) proposed password protected home automation system with automatic door lock which works on the principle of breaking an infrared beam of light, sensed by a photodiode. It consists of transmitting infrared diodes and receiving photo-diodes. The system is to detect whether someone is coming in or not. The photodiodes are connected to comparators, which give a lower output when the beam is broken and high output when transmitting normally. Furthermore, biometric methods of door access control by numerous researchers. Personal authentication for access control, the system utilizes features such as face recognition, voice recognition, hand shape, finger print, and iris patterns of an individual (Kung et al, 2004; Osadciwet et al, 2002)

Mahmood et al., (2016) designed an automatic door system using a unique wireless ID by using infrared ray or Bluetooth technology. It consists of a sensing unit, control unit and drive unit to open and close doors at the entrance for a car that has the unique ID. This process is controlled by using Arduino Leonard and programmed with IDE free open source software, that receives the signal code from the car which sends the ID through IR LED or Bluetooth by using a mobile application, decode it and switch ON the driver that controls the DC motor.

3.0 Methodology

The analog input is the reflected ultrasonic waves that is transmitted initially by the ultrasonic sensor module intercepted by a person that approaches the sliding door. This analog input is converted to digital by the atmega328p analog to digital input pin.

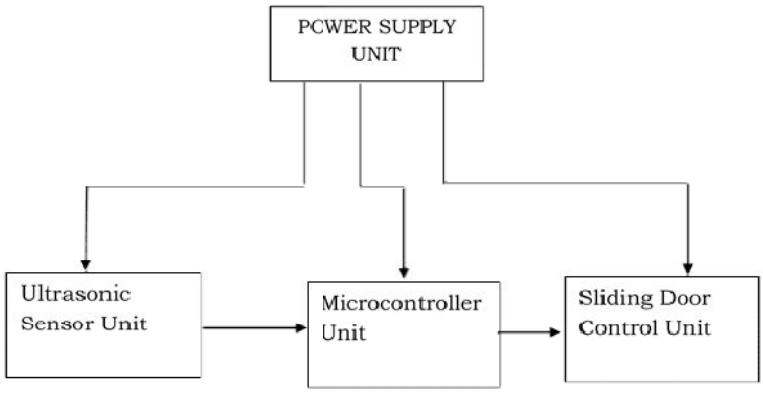

Fig. 3.1 Block Diagram of the ultrasonic Sensor Sliding Door

3.1 Design of the Automatic Sliding Door

3.1.1 *Power Supply Unit*

The final output voltage required for the operation of this project is a DC voltage. The power was build up from A12V, 500mA transformer, a bridge rectifier chip (BDR1), a filter capacitor (C1) and two voltage regulators (LM7809) and (LM 7805) as shown in fig. 3.2

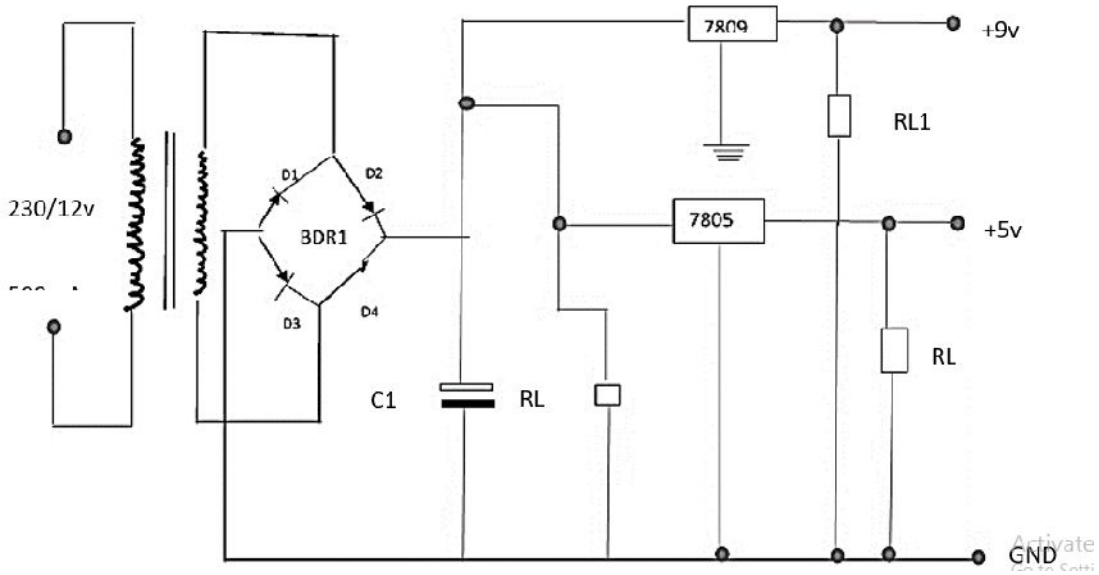

Fig. 3.2. The Power Supply Unit for Ultrasonic Sensor Sliding Door

3.1.2 *Ultrasonic Sensor Unit*

The ultrasonic sensor unit consist of the ultrasonic sensor module, limiting current resistors R1 and R2 as shown in fig. 3.3

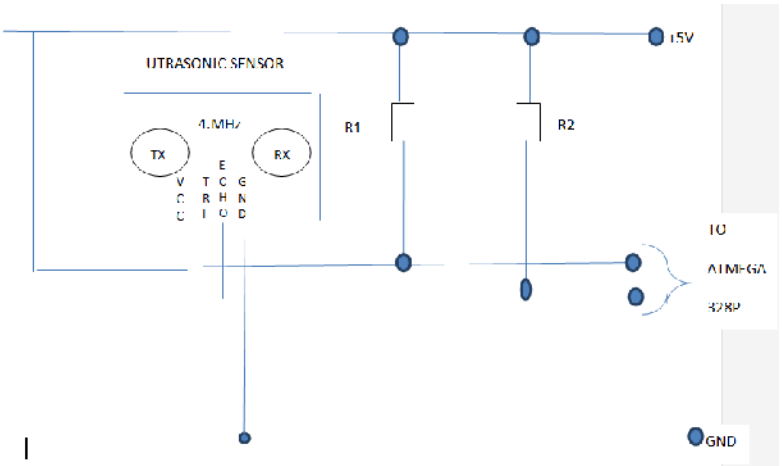

Fig. 3.3 The Ultrasonic Sensor

3.1.3 *The AtmegA 323 Microcontroller Unit*

The microcontroller unit is made up of the Atmega 328P microcontroller, a C6MHz crystal oscillator, and a pull-urge resistor as shown in fig. 3.4.

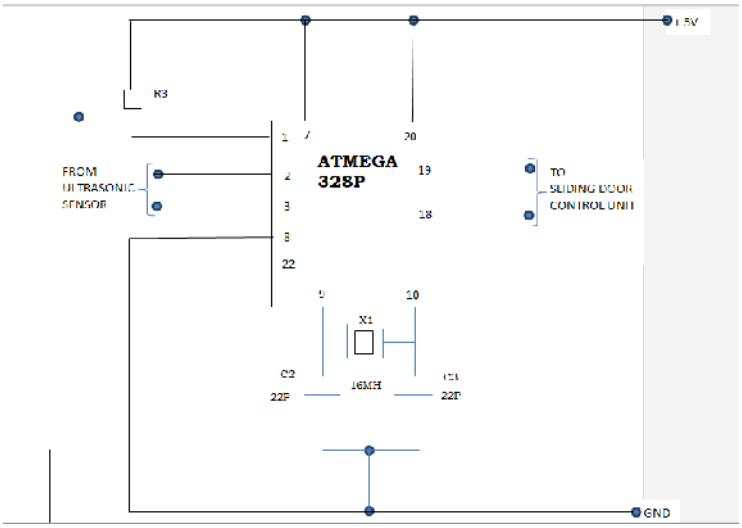

Fig. 3.4 the Microcontroller Unit

The values of capacitors C2 and C3 were chosen to be 22pf, which are used to stabilize the frequency of 16MHz of the crystal oscillator from interference, surges and other external factors.

3.1.4 *The Sliding Door Control Unit*

The sliding door control unit consist of four (4) base resistors R4,R5,R6 and R7 for transistors Q1,Q2,Q3 and Q4, in associate with Diodes D5,D6,D7 and D8 as shown in fig. 3.5.

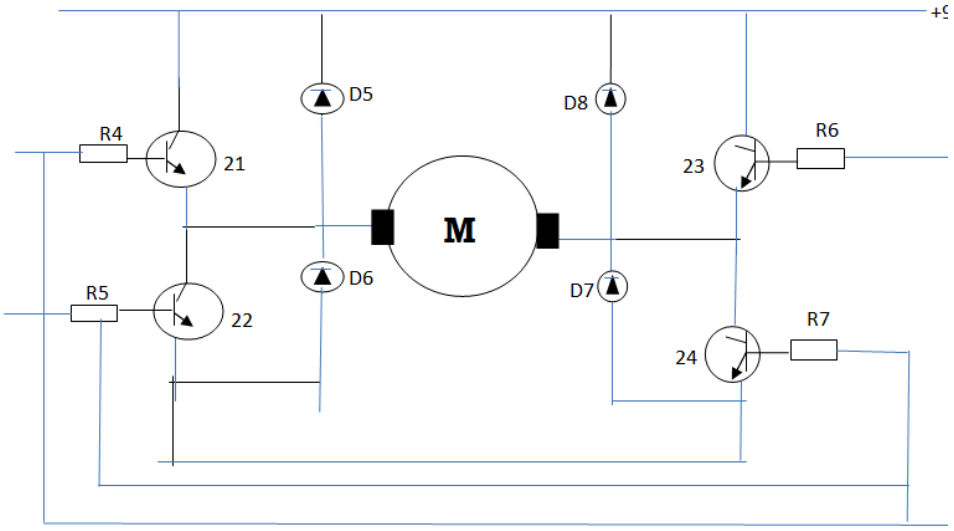

Fig. 3.5 The sliding Door control Unit

3.2 The Description of the Atmega 328P Microcontroller

The Atmega 328p Microcontroller is a 28pin, 8 bit microcontroller with 32KB flash memory with read – while – write capabilities. The Atmega 328p microcontroller is shown in fig. 3.6.

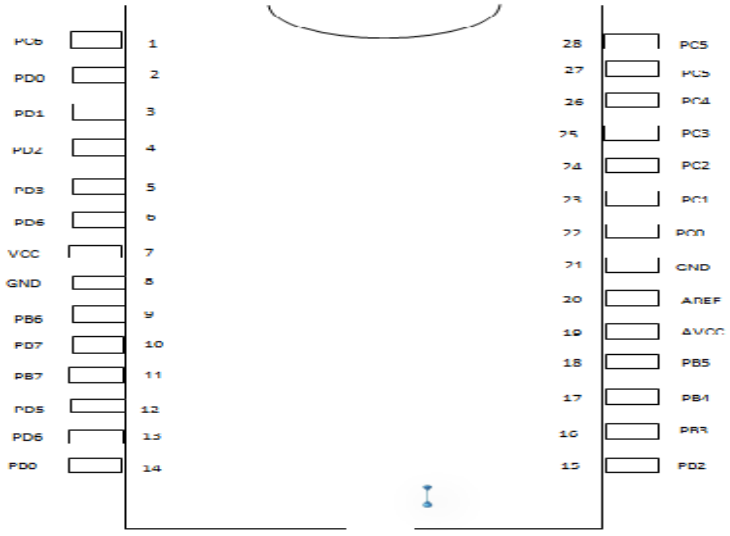

Fig. 3.6: The Atmega 328p Microcontroller

The pin Description of the Atmega 382p is shown in Table 3.1

Table 3.1 Description of Atmega 328p pins

Pin Number	Description	Function
i.	PC6	RESET
ii.	PD0	Digital Pin (RX)

iii.	PD1	Digital Pin (xx)
iv.	PD2	Digital Pin
v.	PD3	Digital Pin (pwm)
vi.	PD4	Digital Pin
vii.	VCC	Positive Voltage (Power)
viii.	GND	Ground
ix.	XTAL1	Crystal Oscillator
x.	XTAL2	Crystal Oscillator
xi.	PD 5	Digital Pin (pwm)
xii.	PD 6	Digital Pin (pwm)
xiii.	PD 7	Digital Pin
xiv.	PB0	Digital Pin
xv.	PB1	Digital Pin (pwm)
xvi.	PB 2	Digital Pin (pwm)
xvii.	PB 3	Digital Pin (pwm)
xviii.	PB 4	Digital Pin
xix.	PB 5	Digital Pin
xx.	AVCC	Positive voltage (ADC)
xxi.	AREF	Reference voltage
xxii.	GND	Ground
xxiii.	PC 0	Analog Input
xxiv.	PC 1	Analog Input
xxv.	PC 2	Analog Input
xxvi.	PC 3	Analog Input
xxvii.	PC 4	Analog Input
xviii.	PC 5	Analog Input

The Atmega 328p is also designed to have an endurance of 1000 write/erase cycles which means that it can be erased and programmed to a maximum of 1000 times without being damage or destroyed.

3.2.1 *The Voltage Regulator*

The LM7809 and LM7805 voltage regulators are fixed linear voltage regulator integrated circuit (IC). They belong to the family of the 78xx. The "78" is the positive output series, while the xx represents the output voltage. The LM7809 has an output of +9v and LM 7805 has an output of +5v, respectively. The voltage regulators are shown in fig. 3.7

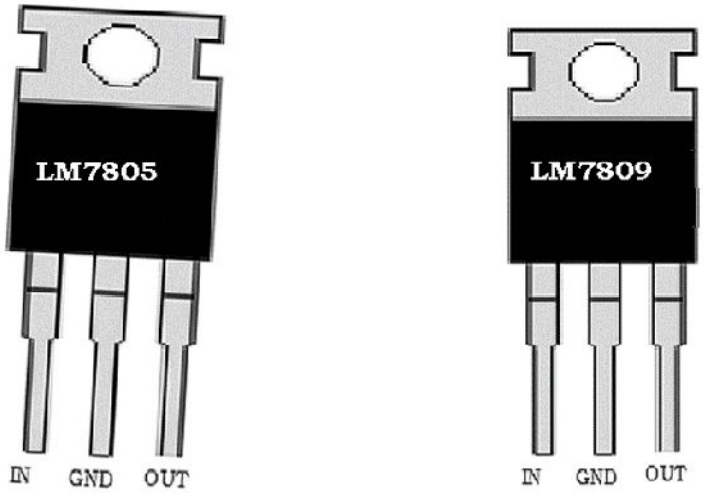

Fig. 3.7 Voltage Regulators

The LM7809 voltage regular was used to supply a regulated +9v to the sliding door motor, while the LM 7805 supplies +5v to the Atmega 328p microcontroller.

3.3 Components Used and Values

The Components used for the constructions of the ultrasonic sensor sliding door and their design values were shown in Table 3.2

Table 3.2 Components Used and Values

Components Used	Design Values	Standard values	Measured Values
Capacitors			
C1	$554\mu F$	$1000\ \mu F$	$992.7\mu F$
C2	22pf	22pf	21.82pf
C3	22pf	22pf	21.87pf
Resistors			
R1	12.76Ω	12Ω	11.93Ω
R2	12.76 Ω	12Ω	11.89Ω
R3	12.76Ω	12Ω	11.91Ω
R4	42.8kΩ	42kΩ	41.99kΩ
R5	42.8kΩ	42kΩ	41.94kΩ
R6	42.8kΩ	42kΩ	41.96kΩ
R7	42.8kΩ	42kΩ	41.97kΩ

Transistors			
21	$\beta = 20000$	$\beta = 20000$	$\beta = 198$
22	$\beta = 20000$	$\beta = 20000$	$\beta = 199$
23	$\beta = 20000$	$\beta = 20000$	$\beta = 192$
24	$\beta = 20000$	$\beta = 20000$	$\beta = 196$
ICS			
IC 1			
LM7809	+9v	+9v	+8.9v
IC 2			
LM7805	+5v	+5v	+4.98v
IC 3			
ATMEGA 328P	+5v	+5v	+4.95v

3.4 Software Development/Design

A computer software program called "source Code" controls the construction of the ultrasonic sensor sliding door. A source code is a collection of computer instructions or commands that controls a hardware. The source code was written in accordance to the flow chart shown fig. 3.9

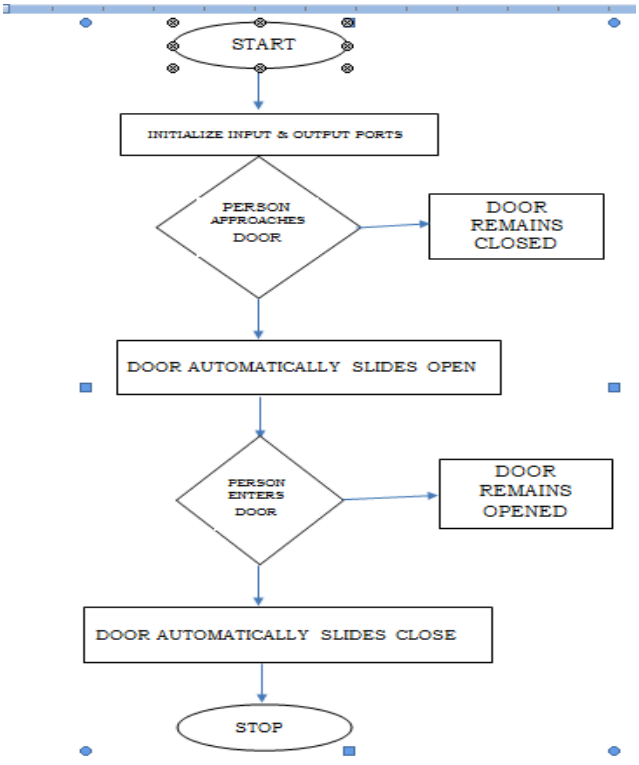

Fig. 3.9 flow chart for ultrasonic sensor sliding door

4.0 Results and Discussion

4.1 Results

Before assembling all units together to achieve the construction of the microcontroller based ultrasonic sliding door, the individual components of each unit is

tested including the microcontroller to make sure there were no faulty components before soldering them together. Some of the units tested include; the power supply unit, test on the ultrasonic sensor unit, test on the microcontroller, testing of slide door motor, and debugging the software program.

The final testing of the project work was carried out after soldering all units together. Table 4.1 shows the results of working process of the project.

Table 4.1 Test of overall project

Ultrasonic Sensor Detects			**Indicator lights**		**Sliding Door**
Person Coming	Person Standing	Person Standing	Green led	Red led	Door status
No	No	No	Off	On	Closed
Yes	No	No	On	Off	Opening
No	No	Yes	On	Off	Opening
No	Yes	No	Off	On	Closing

4.2 Discussions

The results of the tests performed above suggested that the system sub-units are effectively designed and when coupled will give a satisfactory results with regard to the system as a whole. After completing all the various units, the project was cased in a plastic casing for compact presentation and protection. The project operator on mains power supply but also has an alternative source of DC power from a battery.

When the project is powered on, the ultrasonic sensor detects if any person is approaching the sliding and if no one is approaching the red LED turns ON and the sliding door remains closed while the Green LED also remains OFF. Now if the ultrasonic sensor detects that someone or a person is approaching the sliding door, the red LED turns OFF and the Green LED turns ON and the sliding door automatically slides open. If the person enters the door, it automatically slides close, but if the person continues to stand in front of the door, it will remain open and the Green LED will remain ON, and if at any time the person leaves the proximity, the door automatically closes and the Green LED turns OFF while, the Red LED turns ON.

Conclusion

The study designed microcontroller based ultrasonic sensor sliding door. The following conclusions were drawn based on the tested results

(i) The system utilizes ultrasonic wave's technology to sense or detect an approaching individual or person to allow access automatically.

(ii) Green LED is an indication of door closed, when person approaching the door; the Red LED light turn on and the door automatically open.

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