Design And Implementation Of A Microcontroller Based Automatic Door And Vistors Counter

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ABSTRACT:

The implementation of a Microcontroller based automatic door control with visitor counter will lead to vast improvement on electronic security designs. Nevertheless, for a system with large volume of movement with little or no security consciousness, a door system to fit the system without unnecessary delay in the free flow of movement usually tends to pose a problem. Usually, in this kind of scenario, an automatic door system with a means of detecting incoming traffic so as to open the door as required, thus the design and operational principles of a microcontroller based automatic door with visitor counter. The design is made of sensors that detect human presence, a dynamic display unit that displays different messages at specific time, the H-bridge driver IC controls the movement of the motor attached to the door. The whole system is controlled by an 8051microcontroller (89s51).

Keywords: Microcontroller, H-bridge driver IC, Sensor, Program, Remote.

INTRODUCTION

Microcontroller based automatic door control with visitor counter was designed to automatically open a door once somebody approaches the door without the need for any switch, button or handle. The system also has a module that serves as visitor counter and as such, counts the number of entries in and out of the building. In this design, the door is made to slide open once the sensor picks up a signal implying that somebody is approaching the door. The door stays open for few minutes while the microcontroller checks the condition of the sensor. If the sensor still senses the presence of somebody, the door stays open. Else, the door closes

while waiting for the next time to open. The design is with multi-message display using seven segment displays.

In this design we have implored the use of both hardware and software to bring about the entire project. The hardware components are solely coordinated by the AT89S51 micro controller chip while the C programming language is used to program the chip.

The application of this Research work covers all works of life. Some of the applications of this project are in cinema halls where the number of people going in is much and as such this system responds to that by opening automatically as well as keeping count of the number of people in and out of the door.

Furthermore, if this design is applied to busy hotels or fast food joints, the need for a waiter or a security personal to constantly open the door for customer is solved since the system is intelligent.

Moreover, this design perfectly suits a garage system; In this case, the garage door opens once a car approaches the door of the garage.

This consists of a sensor unit that senses people approaching the door [1]. Through the output of the sensor, the microcontroller determines when to send the necessary logic to the H-bridge driver so as to control the motor for the door. Also the counter is incremented once the sensor receives signal but unlike the door routine that keeps the door open once somebody stands by the sensor, the counter routine does not continue counting if the sensor is continuously receiving signal like the door.

The use of electronic door became popular just in the 18th century. Electronic doors usually comprises of either electric motors or roller instead of hinges which are applicable to manual doors.

Basically the different types of electronic doors are determined by how the electric motors are activated and controlled.

Some of the types of electronic doors include the following:

➢ Button pressed door: this is the earliest form of electronic door and has little or no security details. In this type of electronic door, the door is opened using a button that acts as a switch. Usually this type of door is usually locked by default and by pressing the button; the motor of the door is activated, thus opening the door.

➢ Code based electronic door: this type of door is more advanced than the button pressed door lock. In this case, the door is locked by default and usually requires an access code for the lock to be deactivated. Once the correct code is entered, the electric motor is activated, hence opening the door.

➢ Key card based lock: this type of door is more advanced than the button pressed door lock. In this case, the door is locked by default and usually requires an access card to unlock the door. It is similar to code based lock. The difference is that the unlocking code is embedded unto a card.

➢ Thumb print lock: this is a highly advanced form of door locking system based on the uniqueness of the human thumb print. Here once the thumb is placed on the scanner, it checks whether the thumb print has access to the lock. If the scanned thumb has access, the electric motor controlling the door.

➤ Retina scan based lock: this type of locking system is similar to the thumb print lock but this focuses on the uniqueness of the human retina.

➤ Sensor based door: this is a type of electronic door system in which the door is manipulated based on the output of a sensor.

Component Description/Analysis

Step-Down Transformer

A transformer is a device consisting of two closely coupled coils (called primary and secondary coils). An AC voltage applied to the primary appears across the secondary with a voltage multiplication proportional to the turn ratio of the transformer and a current multiplication inversely proportional to the turn's ratio. Power is conserved i.e.

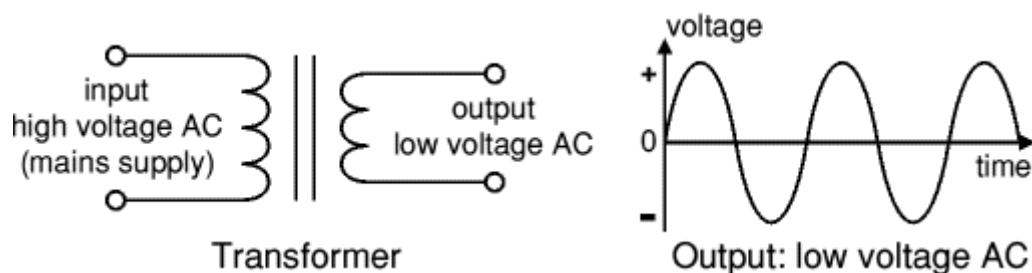Turn ratio =Vp/Vs =Np/Ns and Power out = power in

Or Vs x Is= Vp x Ip

Vp = Primary voltage

Np= Number of turns in primary coil

Ip = Primary (input) current

Vs=Secondary (output) Voltage

Ns= Number of turns on secondary Coil.

For the 12 volts step down transformer needed for this project, the turn ratio is 220/12. It is represented as shown below.

Fig (1) Transformer circuit representation

Diodes

The term diode usually implies a small signal device with current typically in the milliamp range. A semiconductor diode consists of a PN junction and has two (2) terminals, an anode (+) and a cathode (-). Current flows from anode to cathode within the diode.

Diodes are semiconductor devices that might be described as passing current in one direction only.

Bridge rectifier

A bridge rectifier can be made using four individual diodes, but it is also available in special packages containing the four diodes required. It is called a full-wave rectifier because it uses all the AC wave (both positive and negative sections). 1.4V is used up in the bridge rectifier because each diode uses 0.7V when conducting and there are always two diodes conducting, The maximum current they can pass rates bridge rectifiers and the maximum reverse voltage they can withstand (this must be at least three times the supply RMS voltage so the rectifier can withstand the peak voltages).

Alternate pairs of diodes conduct, changing over the connections so the alternating directions of AC are converted to the one direction of DC

Voltage Regulators

A Voltage Regulator (also called a "regulator") has only three legs and appears to be a comparatively simple device but it is actually a very complex integrated circuit. A regulator converts varying input voltage and produces a constant "regulated" output voltage. Voltage regulators are available in a variety of outputs, typically 5 volts, 9 volts and 12 volts. The last two digits in the name indicate the output voltage in the table below.

Table (1) Voltage Regulators output Voltages

Name	Voltage
LM7805	+ 5 volts
LM7809	+ 9 volts
LM7812	+ 12 volts
LM7905	- 5 volts
LM7909	- 9 volts
LM7912	- 12 volts
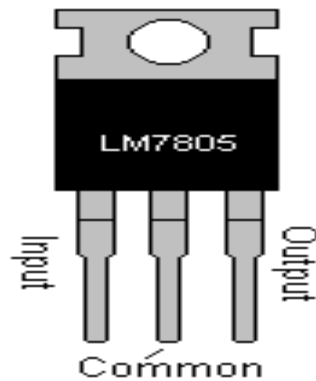
Figure (2) Diagram of 7805

Resistors

Resistance is the property of a component which restricts the flow of electric current. Energy is used up as the voltage across the component drives the current through it and this energy appears as heat in the component.

Resistance is measured in ohms, the symbol for ohm is an omega Ω. 1 Ω is quite small for electronics so resistances are often given in kΩ and MΩ. 1 kΩ = 1000 Ω 1 MΩ = 1000000 Ω.

Resistors used in electronics can have resistances as low as 0.1 Ω or as high as 10 MΩ.

Fig (3) Resistors

Transistors

Transistors can be regarded as a type of switch, as can many electronic components. They are used in a variety of circuits and you will find that it is rare that a circuit built in a school Technology Department does not contain at least one transistor. They are central to electronics and there are two main types; NPN and PNP.

Most circuits (e.g. this project design) tend to use NPN. There are hundreds of transistors that work at different voltages but all of them fall into these two categories.
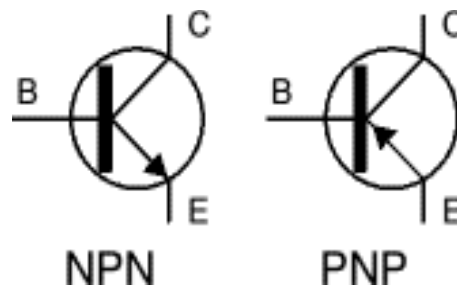
Types of Transistor

Figure (4) Transistor circuit symbols

There are two types of standard transistors, NPN and PNP, with different circuit symbols. The letters refer to the layers of semiconductor material used to make the transistor. Most transistors used today are NPN because this is the easiest type to make from silicon. This page is mostly about NPN transistors.

The leads are labeled base (B), collector (C) and emitter (E).

The base-emitter junction behaves like a diode. A base current I_B flows only when the voltage V_{BE} across the base-emitter junction is 0.7 V or more. The small base current I_B controls the large collector current Ic.

Ic = $h_{FE} \times I_B$ (unless the transistor is full on and saturated) h_{FE} is the current gain (strictly the DC current gain), a typical value for h_{FE} is 100 (it has no units because it is a ratio) The base current IB controls the collector-emitter resistance RCE:

$I_B = 0$ R_{CE} = infinity transistor off

I_B small R_{CE} reduced   transistor partly on

I_B increased $R_{CE} = 0$ transistor full on ('saturated')

Additional notes:

A resistor is often needed in series with the base connection to limit the base current I_B and prevent the transistor being damaged. Transistors have a maximum collector current Ic rating. The current gain h_{FE} can vary widely, even for transistors of the same type!

A transistor that is full on (with $R_{CE} = 0$) is said to be 'saturated'. When a transistor is saturated the collector-emitter voltage V_{CE} is reduced to almost 0 V. When a transistor is saturated the collector current Ic is determined by the supply voltage and the external resistance in the collector circuit, not by the transistor's current gain. As a result the ratio Ic/I_B for a saturated transistor is less than the current gain h_{FE}.

The emitter current I_E = Ic + I_B, but Ic is much larger than I_B, so roughly I_E = Ic.

Light Dependent Resistor (LDR)
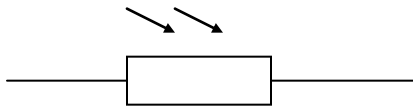
Figure (4) Light Dependent Resistor Symbol

LDRs or Light Dependent Resistors are very useful especially in light/dark sensor circuits. Normally the resistance of an LDR is very high, sometimes as high as 1000 000 ohms, but when they are illuminated with light resistance drops dramatically.

Hardware subsystem

The project is made up of five modules namely:

1. Sensor unit
2. Display unit
3. Control unit
4. Power supply unit
5. door control unit

Power supply unit

The power supply is designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices [2]. A power supply can by broken down into a series of blocks, each of which performs a particular function.
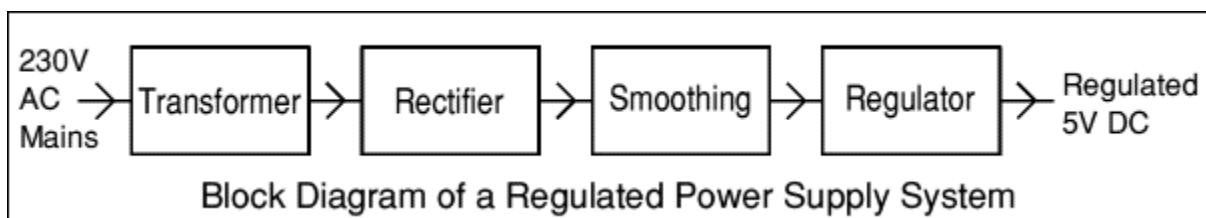

Figure (5) 5V regulated supply

- Transformer: steps down high voltage AC mains to low voltage AC.
- Rectifier: converts AC to DC, but the DC output is varying.
- Smoothing: smoothes the DC from varying greatly to a small ripple.

- Regulator: eliminates ripple by setting DC output to a fixed voltage.

Power supplies made from these blocks are described below with a circuit diagram and a graph of their output:

- Transformer only
- Transformer + Rectifier
- Transformer + Rectifier + Smoothing
- Transformer + Rectifier + Smoothing + Regulator

Transformer Only:
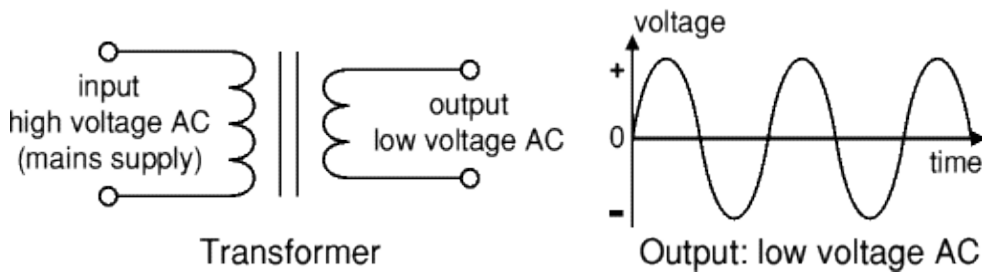
Figure (6) Transformer circuit and waveform representation

The low voltage AC output is suitable for lamps, heaters and special AC motors. It is not suitable for electronic circuits unless they include a rectifier and a smoothing capacitor.

Transformer + Rectifier
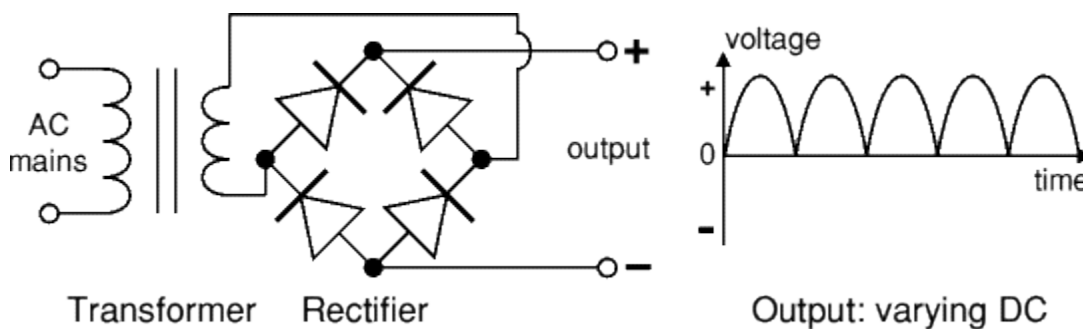
Figure (7) Transformer + Rectifier

The varying DC output is suitable for lamps, heaters and standard motors. It is not suitable for electronic circuits unless they include a smoothing capacitor.
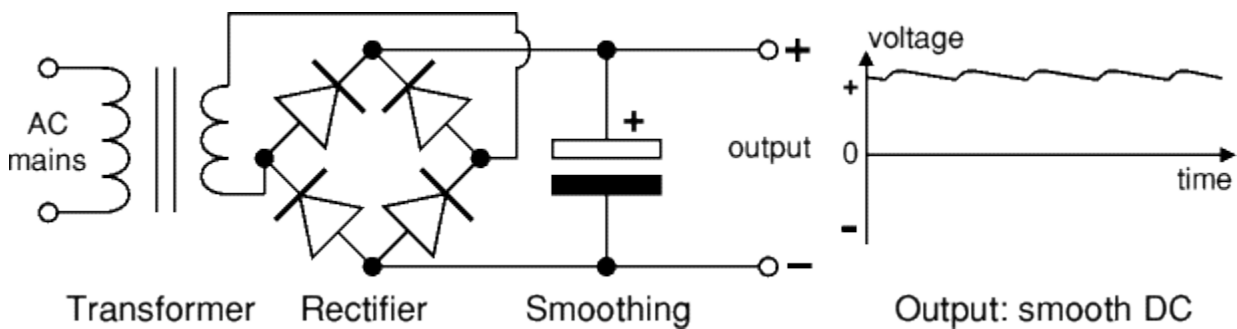
Figure (8) Transformer + Rectifier + Capacitor

The smooth DC output has a small ripple. It is suitable for most electronic circuits.
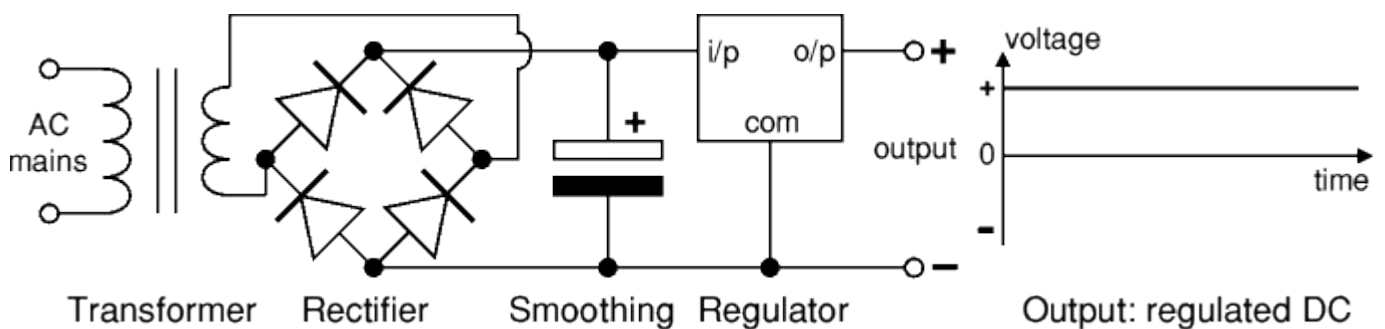
Transformer + Rectifier + Smoothing + Regulator

Figure (9) Transformers + Rectifier + Capacitor + Regulator

The regulated DC output is very smooth with no ripple. It is suitable for all electronic circuits.

DISPLAY UNIT:

The display unit consists of two sets of seven-segment displays attached to the port of the microcontroller and LEDs for User interface [3]. These seven-segment display arrangement shows the three different messages "CLOSED" when the door is shut, "OPEN" when the door is opening and "ENTER" the door has fully opened. The display unit also shows the count of people at any particular point in time.

The seven-segment display used in the design is common Anode which is a type of seven-segment in which the anodes of all the individual segments are linked together. Therefore for any of the segments to be lighted, OV is supplied to its cathode.

The choice of common Anode seven-segment display in my design because the microcontroller sinks TTL logic better than sourcing it. The segments of the display are connected to port O of the microcontroller and

the display is made to display any figure or character by sending the corresponding hexadecimal value to port O.

Table (2) Common anode seven segment display Number pattern

NUM	G	F	E	D	C	B	A	Hex
0	1	0	0	0	0	0	0	0x40
1	1	1	1	1	0	0	1	0x79
2	0	1	0	0	1	0	0	0x24
3	0	1	1	0	0	0	0	0x30
4	0	0	1	1	0	0	1	0x19
5	0	1	1	0	0	1	0	0x12
6	0	0	0	0	0	1	0	0x02
7	0	1	1	1	0	0	0	0x38
8	0	0	0	0	0	0	0	0x00
9	0	0	1	1	0	0	0	0x18
-	0	1	1	1	1	1	1	0x3f

Table (3) Common anode seven segment display character pattern

XTER	G	F	E	D	C	B	A	Hex
O	1	0	0	0	0	0	0	0x40
P	0	0	0	1	1	0	0	0x0c
E	0	0	0	0	1	1	0	0x06
N	1	0	0	1	0	0	0	0x48
C	1	0	0	0	1	1	0	0x46
L	1	0	0	0	1	1	1	0x47
S	0	0	1	0	0	1	0	0x12
T	0	0	0	0	1	1	1	0x07

All the anodes of the seven segment LEDs are internally connected together and brought out to Vcc, which is connected to the emitter of the switching transistor (NPN C 945), and its collector is connected to the Vcc, and its base is then connected to our terminal of 4.7Kλ resistor which in turn is connected from the microcontroller. So remaining terminal of the 2KΩ resistor is connected to the VCC.

Light emitting diode(LED) characteristics

As the name indicates, it iss a forward-biased P-Njunction which emits visible light when energised. The colour of the emitted light depends on the type of material used in producing the LED.

- GaAs- Infrared radiation (invisible)
- GaP- Red or green light
- GaAsP- Red or yellow (amber) light

LEDs that emits blue light are also available but red is the most common. LEDs emit no light when reverse biased.

LEDs are manufactured with domed lensses in order to lesssen the reabssorption problem ; they are always encased in order to protect their delicate wires. Being made of semiconductor material, it is rugged and has a life of more than 10,000 hours.

Since LEDs operate at voltage levels from 1.5v to 3.3v, they are highly compatible with solid state circuitry [2].

LED Seven segment display

This type of display comes in a variety of colours, sizes and packaging styles. While red is still the most favored colour, green, yellow and orange LED readouts are also available. The readouts come packaged in standard DIP configurations with clear or modified diffused lens – the latter, for "Full-flood" visibility.

Its mode of fabrication is based in either a common-cathode or common-anode arrangement. But common –anode arrangement was used in this project for easier configuration. The seven-segment display gets its name from the fact seven illuminated segments are used to configure the digits 0-9 (and a few lower and upper case letters). Its arrangement is in the figure of number eight. It's read out and list of segments required for it to illuminate is given below.

In common cathode, all the cathode are internally tied together and brought out to circuit ground through an external current limiting, or pull-down resistor. A high voltage to an individual anode turns the LED segment "ON".

Also, in common anode arrangement all anodes are internally connected and brought out to + Vcc through an external current limiting, or pull-up resistor. A low voltage to any LED cathode turns it on [3]. As read out, LED display offers two distinct advantages, which are as follows:

Allows digital designers maximum flexibility due to their sizes and shapes.

They are visible in subdued light.But the operation of LED in bright light (outdoor displays) makes the display to be washed off by direct sunlight (invisible). The diagram of the seven segment display and LEDs are shown below.
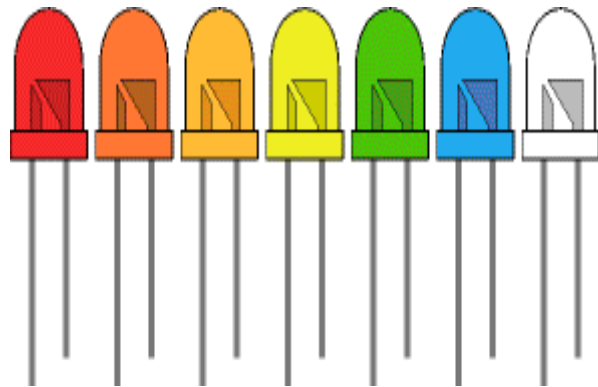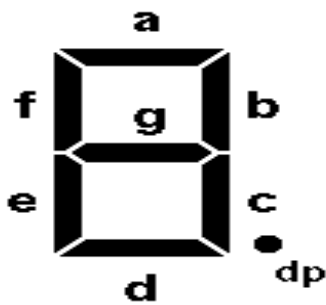

Fig (10)a SEVEN SEGMENT DISPLAY   **Fig (10)b DIFFERENT COLOURS OF LEDS**
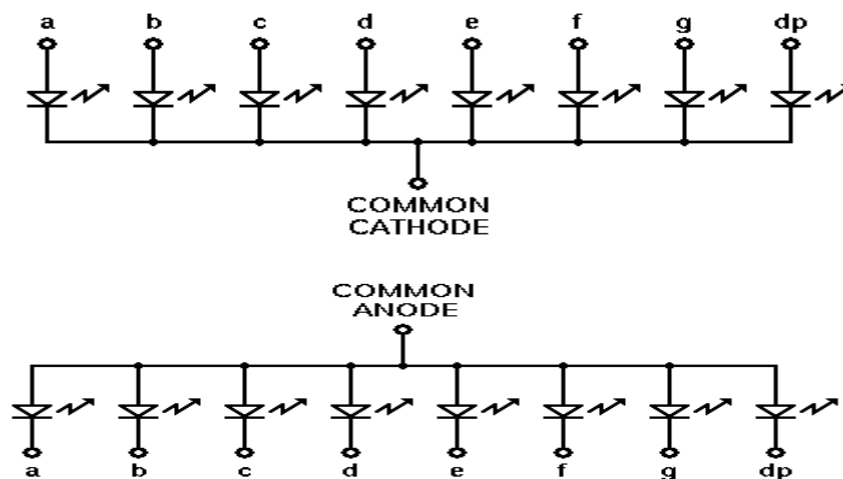

Fig (11) Internal Circuitry Of The Two Types Seven Segment Display

The Input Interface Design

The input interface is a circuitry that enables the system to fetch signal (visitor presence) from the monitored position. Its design is achieved by the use of Light Dependent Resistors (LDR), Light emitting Diode (LED), Resistors and Transistors connected using **Voltage Divider** principle. As shown in the figure below
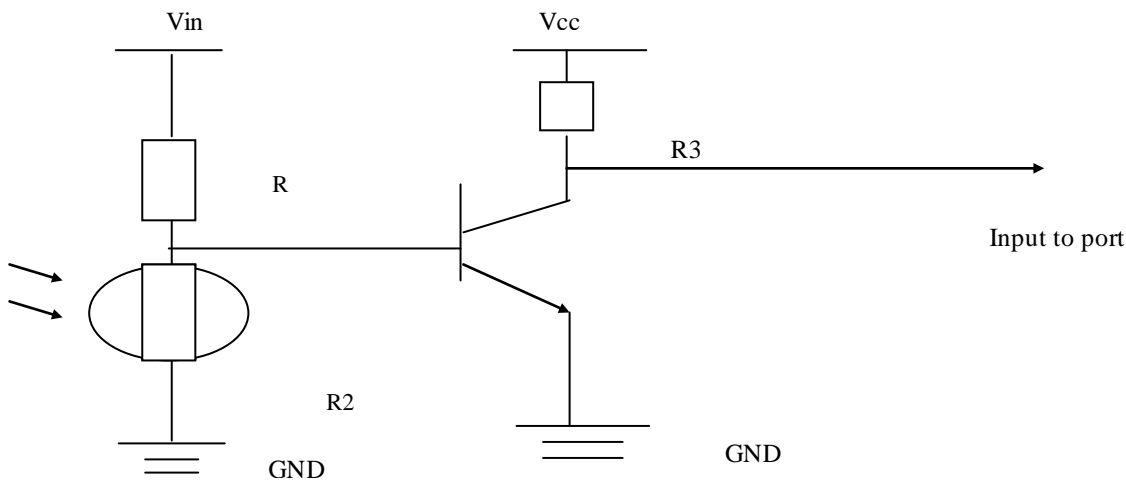
Figure (12) Input Sensor Design

Most input transducers (sensors vary their resistance and usually voltage divider is used to convert this to a varying voltage which is more useful. The voltage signal in this context is fed as an input into a NPN (C945) transistor switch.

Choosing the Resistor Value

The value of the resistance R will determine the range of the output voltage. Using a multimeter to find the minimum and thee maximum values of the sensor's (LDR) resistance (Rmin*Rmax).

In this context :Rmin = 1.50KΩ

        Rmax = 780kΩ

R=square root of (Rmin*Rmax) = Square root of (1.50kΩ * 780kΩ)

Since the system is capable of monitoring four different positions, the above design was repeated four times to serve as input to the parallel port status pins.

The transistor input

Vout = (Vln x R2)/ (R1+ R2)

Vin = 5v

Thus, in darkness:

Vout = 5 x $780x10^3$ / $4.7x10^3$ + $780x10^3$

Vout = $39x10^5$ / 784700

Vout = 4.97v

This increases the base current that drives the transistor to saturation.

In bright light:

Vout = 5 x 9.5 / $4.7x10^3$ + 9.5

Vout = 47.5 / 4709.5

Vout = 0.01v

Where Vout =V_{BE}.

Analysis

Since LDR has large resistance when dark and a low resistance when brightly lit, thus if R2 is much larger than R1, Vout is large because most of the voltage are across R2

Thus when intruder's shadow is cast on the LDR , there is increase in the LDR's resistance bringing about increase base current I_b enough to drive the NPN transistor to saturation, this causes the collector current to flow into the parallel port input.

Ic = Vcc/Rc

Microcontroller unit:

The AT89C51 is a low power, high performance cmos 8-bit microcomputer with 4Kbytes of flash programmable and erasable read only memory (PEROM). The device is manufactured using Atmel`s high density nonvolatile memory technology and is compatible with the industry standard MCS-51 instruction set and pin out. The on-chip flash allows the program memory to be reprogrammed in system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with flash on a monolithic chip, the Atmel AT89C51 is a powerful microcomputer, which provides a highly flexible and cost effective solution to many embedded control application.

The AT89C51 is designed with static logic for operation down to zero frequency and support two software selectable power saving modes. The idle mode stops the CPU while allowing the RAM, timer/counters,

serial port and interrupt system to continue functioning. The power down mode saves the RAM contents but freezes the oscillator disabling all other chip functions until the next hardware reset
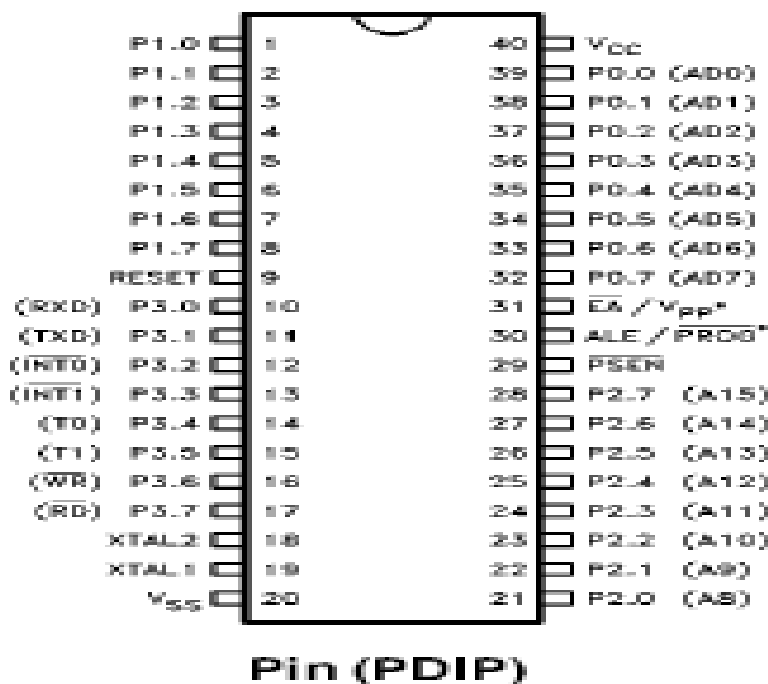
Fig. (13) Pin configuration of AT89S51

Door control segment:

The door control segment consists of an H-Bridge driver IC that guarantee's the clockwise and the anti-clockwise movement of the electric motor attached to the door system. The H-Bridge driver IC L293D is designed to control 2 DC motors. There are 2 input and 2 output pins for each motor. The 2 pairs of input determine the behavior of electric motor attached to it. The chip has two enable pins that must be high (+5V) for operation.

The behavior of motor for various input conditions are as follows:

Table 3.5: H-bridge motor control

	A	B
Stop	Low	Low
Clockwise	Low	High
Anti-clockwise	High	Low
Stop	High	high

H-bridge

Figure (14) H-bridge Door control

DESIGN PROCESS:

A micro-controller based project design process is characterized by the following;

❖ Definition of task

❖ Requirements

❖ Factor that influence choice

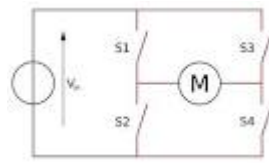In defining a task, every design comes from an idea or a problem that requires a solution. Questions may be generated on what exactly that is required to be achieved and the feasibility of the ideas as regards to the implementation.

If these questions are analyzed critically with tangible solutions to the problem, a development of this idea into a reality is the next step.

Requirements for design process have to be considered once an idea has been established. The need to determine whether or not the idea requires a PC or not, depending on the complexity of the circuitry, or whether the circuits to be designed needs to make a complex decision or deal with complex data.

 Comparing these factors with using IC's (AND gates) which two inputs when high logic changes outputs. Preferably, a micro-controller will be the best option based on the circuits to be designed with less hardware connections and flexibility. Writing a program that performs a desired function accesses the ability of the micro-controller. However, it came to our thought that among all the components used here the one that consumes the highest power is the Light Emitting Diodes (LEDs), which need as much as 15-volt to glow and draw as maximum as 2-ampere of current. As a result of this, we decided to use 15-volts, 2-ampere rated transformer for this design. After the voltage is stepped down 15-volts using a transformer, a full wave rectifier circuit was designed using four Diodes (IN4001). This value of Diodes is used here because from the specification of voltage/Diode rectifying data book, this value is adequate for lower voltages, say 0-24 volt. The load current of the rectifier is given as follows;

Idc = 2 1m/3.1

When 1m = maximum current = 2 amp

Idc = load current which is in dc form after recification.

Hence idc = 2*3 / 3.14 =4/3.14, idc = 1.27 amps

Therefore 1.27amps is the maximum load current that can be drawn in the whole system. Also it is known that after rectification, the same voltage (15-volts) continues to flow into the filter. As a result the load voltages 15-volts

Thus Vdc = Load voltage = 15 volts.

And Vdc = 21 m*RL / 3.14

RL = Load resistance

RL = 47.13/4

RL = 11.78* 3.14 = 1.78

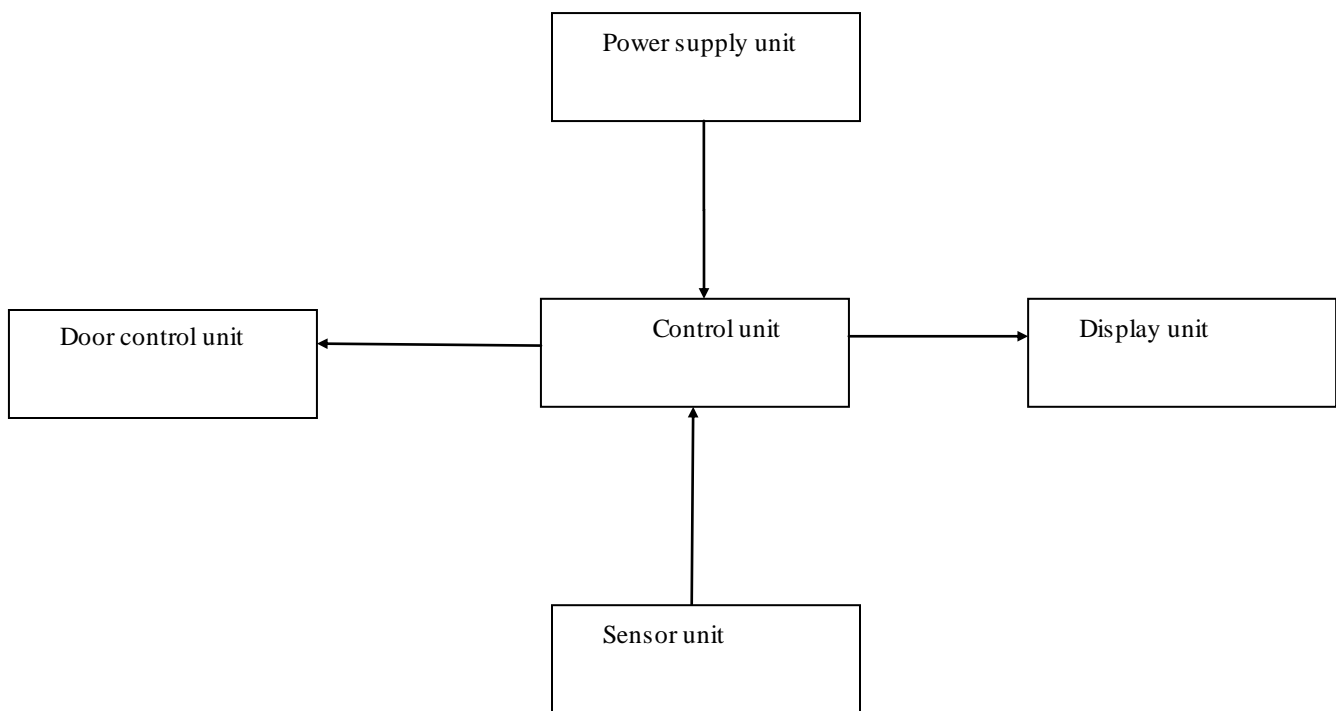From this, it is obvious that V = IR = 1.27 * 1.2

SYSTEM BLOCK DIAGRAM

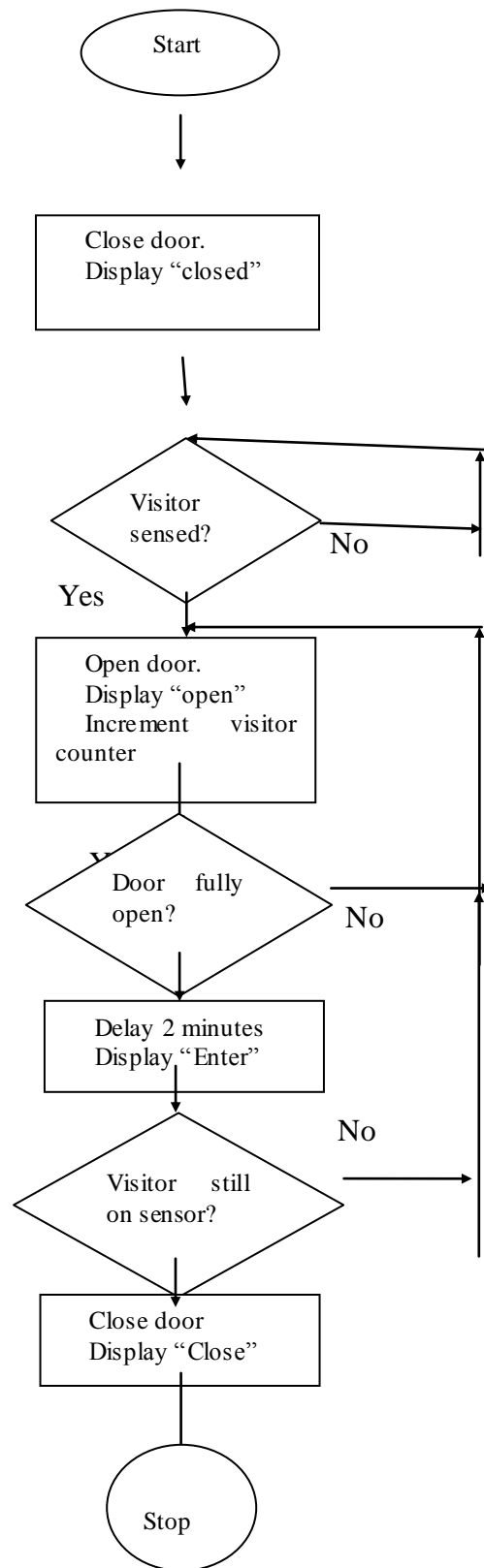Figure (15) Block Diagram of Microcontroller Based automatic door System with visitor counters

```
                    ┌─────────┐
                    │  Start  │
                    └─────────┘
                         │
                         ▼
              ┌────────────────────┐
              │ Close door.        │
              │ Display "closed"   │
              └────────────────────┘
                         │
                         ▼
                    ◇ Visitor ◇ ──── No ────►
                    ◇ sensed? ◇
                         │
                        Yes
                         │
                         ▼
              ┌────────────────────┐
              │ Open door.         │
              │ Display "open"     │
              │ Increment  visitor │
              │ counter            │
              └────────────────────┘
                         │
                         ▼
                    ◇ Door  fully ◇ ──── No ────►
                    ◇ open?       ◇
                         │
                         ▼
              ┌────────────────────┐
              │ Delay 2 minutes    │
              │ Display "Enter"    │
              └────────────────────┘
                         │
                         ▼             No
                    ◇ Visitor  still ◇ ──────►
                    ◇ on sensor?     ◇
                         │
                         ▼
              ┌────────────────────┐
              │ Close door         │
              │ Display "Close"    │
              └────────────────────┘
                         │
                         ▼
                    ┌─────────┐
                    │  Stop   │
                    └─────────┘
```

FIG (16) Flow chart of microcontroller based automatic door with visitor counter.
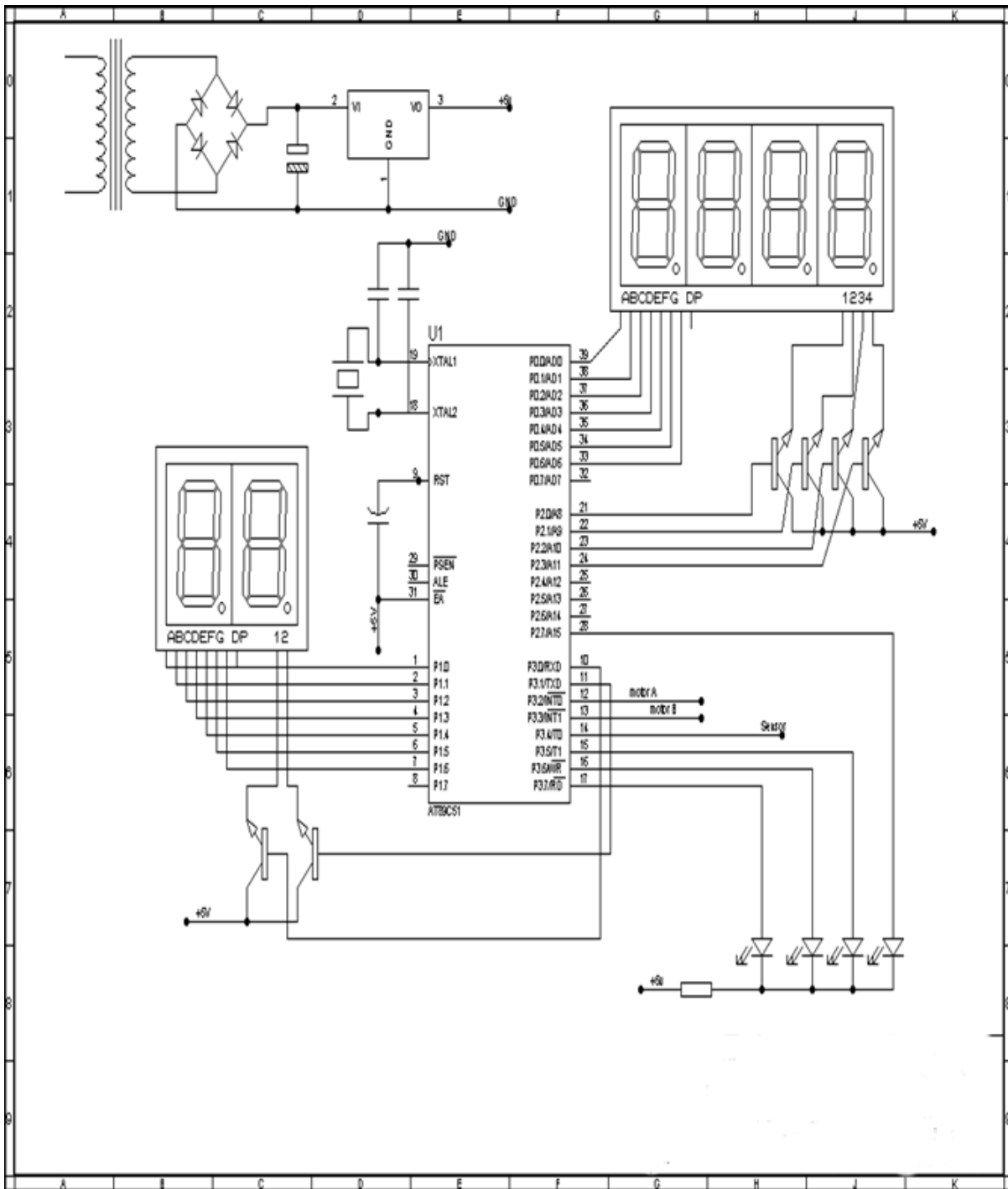
Fig (17) Circuit diagram

Control Program

```c
#include "at89x51.h"

code unsigned char digit[16]={0x40,0x79,0x24,0x30,0x19,0x12,0x02,0x78,0,0x10,0x08,0x03,0x46,0x21,0x06,0x0e};

code unsigned char digiti[]={0xff,0x40,0x0c,0x06,0x48,0x46,0x47,0x12,0x07,0x4e,0x09,0x09,0x30,0x19,0x12,0x02,0x78,0,0x10,0xff,0x03,0x46,0x21,0x06,0x0e};

code unsigned int dec[]={0x0,0x1,0x2,0x3,0x4,0x5,0x6,0x7,0x8,0x9,0x10,0x11,0x12,0x13,0x14,0x15,0x16,0x17,0x18,0x19,
0x20,0x21,0x22,0x23,0x24,0x25,0x26,0x27,0x28,0x29,0x30,0x31,0x32,0x33,0x34,0x35,0x36,0x37,0x38,0x39,
0x40,0x41,0x42,0x43,0x44,0x45,0x46,0x47,0x48,0x49,0x50,0x51,0x52,0x53,0x54,0x55,0x56,0x57,0x58,0x59,
0x60,0x61,0x62,0x63,0x64,0x65,0x66,0x67,0x68,0x69,0x70,0x71,0x72,0x73,0x74,0x75,0x76,0x77,0x78,0x79,
0x80,0x81,0x82,0x83,0x84,0x85,0x86,0x87,0x88,0x89,0x90,0x91,0x92,0x93,0x94,0x95,0x96,0x97,0x98,0x99
.
.
.
.
};
dat1=3,dat2=4,dat3=8,dat4=3,dat5=9;
            //delay(1000);

            delay(2000);
            while(!P3_2){;}
            delay(2000);
            blin();
            }
```

```
        }
    else{dat1=5,dat2=6,dat3=1,dat4=7,dat5=3;
        P3_4=1;
        P3_5=0;
        P3_6=1;
        P3_7=0;
//door_close();
        }
        }
    }
```

Conclusion

This paper have demonstrated how to reduce the work load on some staffs working as waiters, security men and also to open doors to visitors which I witnessed at some cafeteria, fast food and some hotel, through the help of Microcontroller based Design. It will be more appreciated if the system is designed to have integrated voice output playback.

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