Global Scientific JOURNALS

GSJ: Volume 8, Issue 7, July 2020, Online: ISSN 2320-9186
www.globalscientificjournal.com

DEVELOPMENT OF MEMS AND GSM BASED ATM SECURITY SYSTEM

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ABSTRACT

The Project is designed using MEMS technology. According to this technology, the communication takes place between two devices MEMS and microcontroller. The MEMS is a sensor device which identifies the tilt produced by the ATM machine due to the irregular movement that occur during theft. This paper makes best use of MEMS as a sensor device which identifies the tilt produced by the ATM machine due to the irregular movement that occur. The design basically consists of a MEMS sensor which identifies the tilt by the machine and activates the microcontroller to start the following sequence in which shutting the door using stepper motor and sending SMS to vigilance system using GSM is involved. This system stops any sort of robbery by taking MEMS as its input functional bock. It is the MEMS that is activating the total design by identifying the tilt caused by the thief during breaking down the ATM machine. Once the microcontroller is activated a sequence is started which involves shutting of the door using stepper motor and alerting the vigilance system by a SMS using GSM.

Index Term-- Micro electro mechanical system, AT89S52 Microcontroller.

1.0 INTRODUCTION

Embedded system is a combination of software and hardware designed and programmed to perform one or more particular task(s). The hardware is designed for specific application and then software is embedded in this hardware to perform the task. Both software and hardware are dedicated to that particular application. The heart of the system is either processor or controller. The processor or controller may be general purpose or special purpose that controls whole system. There may be more than one processor or controller if system is complex. It may be possible that there is one general purpose processor or controller and one or more special purpose processors or controllers. For example, in 3G (or 4G) cell phones there is one general purpose processor that handles user commands, memory and display etc. And there are special purpose processors like DSP for voice communication and network management, display controller to generate real and reach images on color LCD screen.

An embedded system is a special-purpose system in which the computer is completely encapsulated by or dedicated to the device or system it controls. Physically embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants. In terms of complexity embedded systems can range from very simple with a single microcontroller chip, to very complex with multiple units, peripherals and networks mounted inside a large chassis or enclosure. Nearly 99 per cent of the processors manufactured end up in embedded systems. They include; consumer appliances, office automation, industrial automation, medical electronics, telecommunications, wireless technologies, security and finance.

Examples of embedded systems are; Calculators, Laser Printer, Security Systems, Musical Instruments, Medical Equipment's, Automatic Teller Machines (ATMs), Cellular telephones and telephone switches, Inertial guidance systems for aircraft and missiles, Computer peripherals such as routers and printer's engine controllers and antilock brake controllers for automobiles.

A Micro controller consists of a powerful CPU tightly coupled with memory RAM, ROM or EPROM), various I / O features such as Serial ports, Parallel Ports, Timer/Counters, Interrupt Controller, Data Acquisition Interfaces-Analog to Digital Converter (ADC), Digital to Analog Converter (ADC), everything integrated onto a single Silicon Chip.

It does not mean that any micro controller should have all the above said features on chip, depending on the need and area of application for which it is designed, the ON-CHIP features present in it may or may not include all the individual section said above. Any microcomputer system requires memory to store a sequence of instructions making up a program, parallel port or serial port for communicating with an external system, timer / counter for control purposes like generating time delays, baud rate for the serial port, apart from the controlling unit called the Central Processing Unit. If a system is developed with a microprocessor, the designer has to go for external memory such as RAM, ROM or EPROM and peripherals and hence the size of the PCB will be large enough to hold all the required peripherals. But, the micro controller has got all these peripheral facilities on a single chip so development of a similar system with a micro controller reduces PCB size and cost of the design. One of the major differences between a micro controller and a microprocessor is that a controller often deals with bits, not bytes as in the real world application, for example switch contacts can only be open or close, indicators should be lit or dark and motors can be either turned on or off and so forth.

The prime use of a microcontroller is to control the operation of a machine using fixed programs that is stored in ROM that does not change over the life time of the system. The processors have most of their op-codes moving data from external memory to the CPU. Generally, controllers move data and code from internal memory to ALU. Processors have most of their instructions operating on a byte. Controllers on the other hand, have many bit handling instructions making it ideal for control applications.

Enhancing the security system of the ATM machine is very important because the present existing system is not sufficient to stop the thief when he tries to break down the ATM machine. If we introduce the project, then it would be easy to stop the thief.

As the thief tries to open the machine the MEMS is activated this gives signal to the microcontroller which shuts the door and alerts the vigilance system. In this design, the MEMS sensor is placed in the upper or lower panel of the ATM machine, when a thief tries to open the machine he has to break the panel and open either the upper panel or lower panel. When he does so the MEMS sensor will be activated as it reads the tilt produced while lifting the panel, this will activate the microcontroller. As the microcontroller is activated it then has to start a sequence which should stop the thief from running away from the machine, for this purpose we need to shut the door, in order to shut the door, we are using a stepper motor, also we have to alert the vigilance system here we are using GSM to send the SMS.

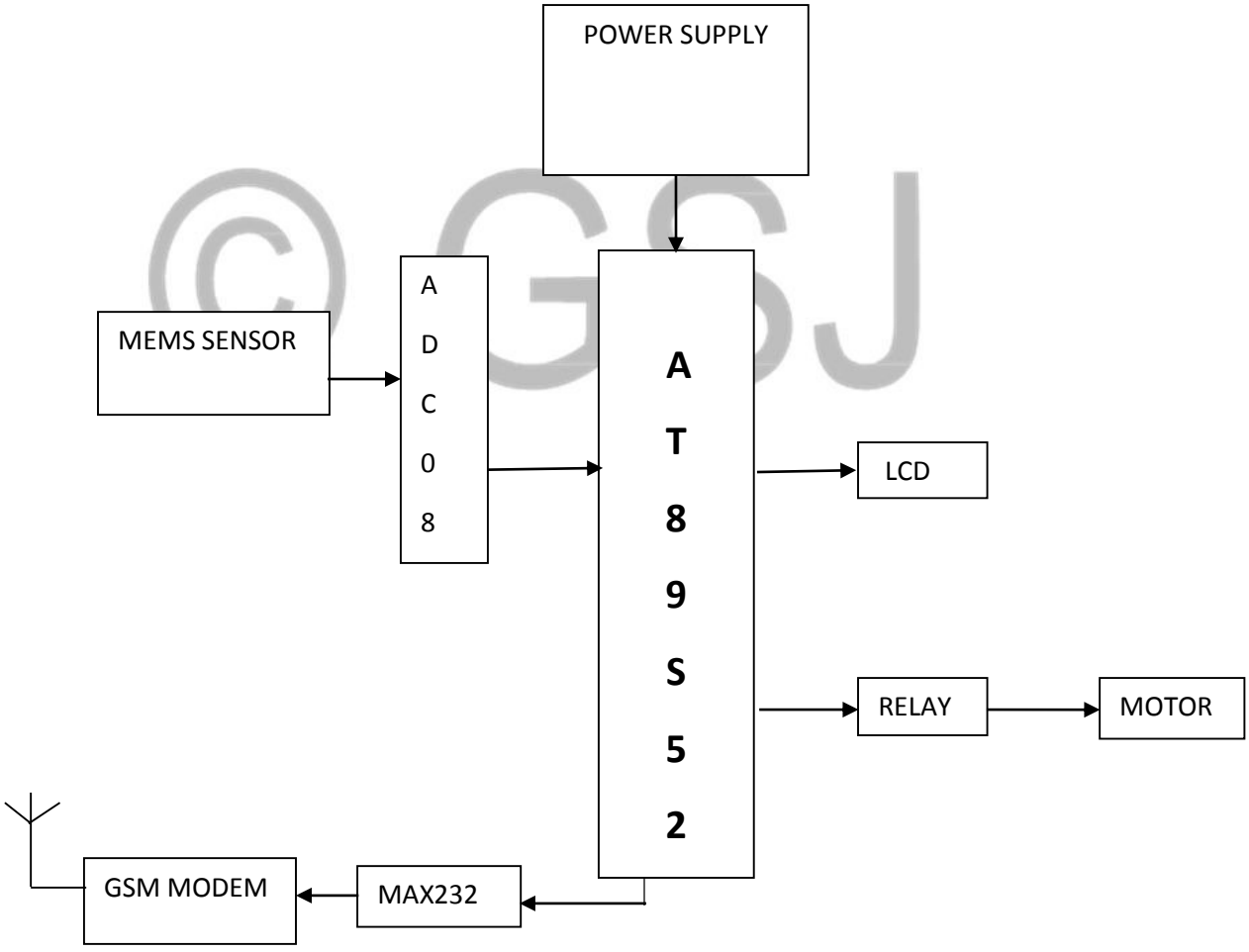

Figure 1: Block Diagram of the design

1.1 BLOCK DIAGRAM DESCRIPTION

The hardware involved in the design is a Power Supply, a LCD to display the concerned information, a GSM is interfaced to the Microcontroller through MAX 232, MEMS is interfaced through ADC 0804. While execution, the tilt identified by the mems activates the microcontroller.

The microcontroller then starts the following sequence, it gives command to shut down the door in order to avoid the thief to run away and also a SMS is sent to the vigilance system to alert them so that they can approach to the place as soon as possible to catch the burglar. This Project mainly consists of Power Supply section, Microcontroller section, Mems section, GSM section, LCD display section, Max 232 serial driver section, ADC 0804 section, Motor section and Relay section.

1.1.1 Power Supply Section

This section is meant for supplying Power to all the sections mentioned above. It basically consists of a Transformer to step down the 230V ac to 9V ac followed by diodes. Here diodes are used to rectify the ac to dc. After rectification the obtained rippled dc is filtered using a capacitor Filter. A positive voltage regulator is used to regulate the obtained dc voltage.

1.1.2 Microcontroller Section

This section forms the control unit of the whole project. This section basically consists of a Microcontroller with its associated circuitry like Crystal with capacitors, reset circuitry, pull up resistors (if needed) and so on. The Microcontroller forms the heart of the paper because it controls the devices being interfaced and communicates with the devices according to the program being written.

1.1.3 MEMS Section

This is the input functional block which is used to identify the tilt that are occurred in the ATM machine when a thief tries to break open the ATM machine.

1.1.4 ADC 0804 Section

The ADC0808 data acquisition component is a monolithic CMOS device with an 8-bit analog-to-digital converter, 8-channel multiplexer and microprocessor compatible control logic. The 8-bit A/D converter uses successive approximation as the conversion technique. The converter features a high impedance chopper stabilized comparator, a 256R voltage divider with analog switch tree and a successive approximation register. The 8-channel multiplexer can directly access any of 8-single-ended analog signals. The device eliminates the need for external zero and full-scale adjustments.

1.1.5 GSM Section

GSM (Global System for Mobile communications) is a cellular network, which means that mobile phones connect to it by searching for cells in the immediate vicinity. GSM networks operate in four different frequency ranges. Most GSM networks operate in the 900 MHz or 1800 MHz bands.

1.1.6 MAX 232 Section

The microcontroller can communicate with the serial devices using its single Serial Port. The logic levels at which this serial port operates is TTL logics. But some of the serial devices operate at RS 232 Logic levels. For example, PC and Smart Card Reader etc. So in order to communicate the Microcontroller with either Smart Card Reader or PC, a mismatch between the Logic levels occurs. In order to avoid this mismatch, in other words to match the Logic levels, a Serial driver is used. And MAX 232 is a Serial Line Driver used to establish communication between microcontroller and PC (or Smart Card Reader)

1.1.7 LCD Display Section

This section is basically meant to show up the status of the project. This design makes use of Liquid Crystal Display to display / prompt for necessary information.

1.1.8 Motor Section

A stepper motor is an electromechanically device which converts electrical pulses into discrete mechanical movements. The shaft or spindle of a stepper motor rotates in discrete step increments when electrical command pulses are applied to it in the proper sequence. The motors rotation has several direct relationships to these applied pulses is directly related to the direction of motor shafts rotation. The speed of the motor shafts rotation is directly related to the frequency of the input pulses and the length of rotation is directly related to the number of input pulses applied.

1.1.9 Relay Section

A relay is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. A relay is able to control an output circuit of higher power than the input circuit, it can be considered to be, in a broad sense, a form of an electrical amplifier.

2.0 CIRCUIT DESCRIPTION

ATM security system using GSM and MEMS Modules is one of the hot topics in embedded systems industry. For providing Security at ATMs GSM and MEMS Modules are controlled by using ATMEL Processor based AT89S52 Microcontroller.

Probably the most useful thing to know about the global system for mobile communication is that it is an international standard. If you travel in parts of world, GSM is only type of cellular service available. Instead of analog services, GSM was developed as a digital system using TDMA technology.

Micro Electrical Mechanical Systems (MEMS) is the integration of mechanical elements, sensors, actuators, and electronics on a common silicon substrate through micro fabrication technology. The broadest requirement for these very small devices is ability to sense the environment, to collect necessary data and to create a signal or action to make desired changes to the environment.

In this paper ATMEL based AT89S52 Microcontroller monitors MEMS Module, GSM and motor was used in the design. MEMS module is placed on the outer panel of the ATM Machine, if any tilt is identified by this block, MEMS send a signal to AT89S52 and as the signal is received, it locks the ATM door and Alert message is send to the Security using GSM Module.

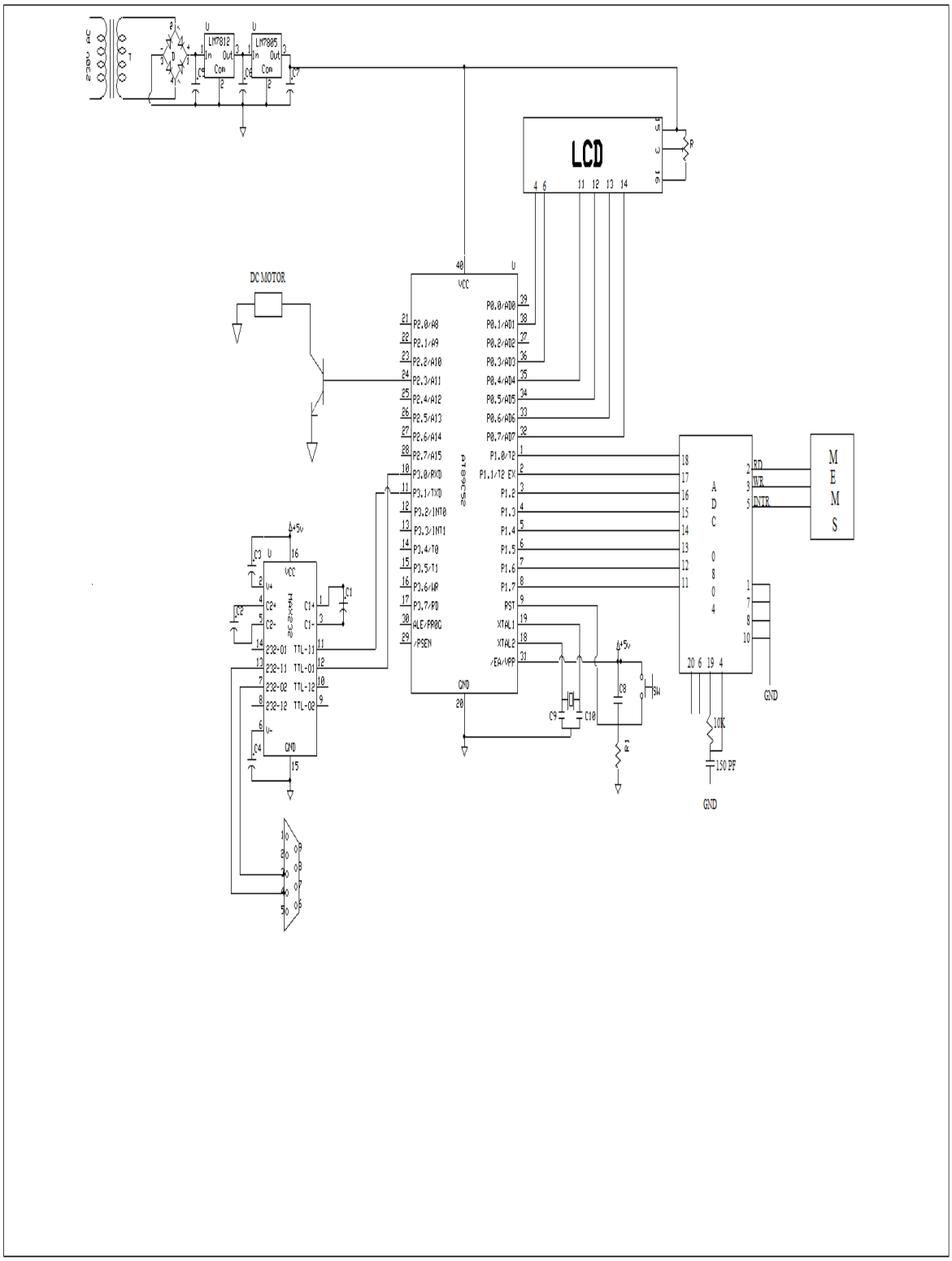

Figure 2: Schematic Diagram of the design

2.1 SCHEMATIC DESCRIPTION

Firstly, the required operating voltage for Microcontroller 89S52 is 5V. Hence the 5V D.C. power supply is needed by the same. This regulated 5V is generated by first stepping down the 230V to 9V by the step down transformer.

The step downed a.c. voltage is being rectified by the Bridge Rectifier. The diodes used are 1N4007. The rectified a.c voltage is now filtered using a 'C' filter. Now the rectified, filtered D.C. voltage is fed to the Voltage Regulator. This voltage regulator allows us to have a Regulated Voltage which is +5V.The rectified; filtered and regulated voltage is again filtered for ripples using an electrolytic capacitor 100μF. Now the output from this section is fed to 40th pin of 89S52 microcontroller to supply operating voltage.

The microcontroller 89S52 with Pull up resistors at Port0 and crystal oscillator of 11.0592 MHz crystal in conjunction with couple of capacitors of is placed at 18th & 19th pins of 89S52 to make it work (execute) properly.

The LCD is interfaced to Microcontroller. The data pins and control pins of LCD are connected to Port 0 as shown in schematic. The GSM is interfaced to microcontroller through a voltage level converter i.e. MAX 232.

The GSM o/p & i/p pins i.e. RX and TX are connected to MAX 232 serial drivers 7th and 13th pins and its output to Microcontroller from 11th & 12th of MAX to TX and RX pins of Microcontroller.

A Motor is connected across port 2 at 24th pin.

And the main functional input block MEMS is interfaced at port 1, at p1.0 to p1.7 with 18th to 11th pins of ADC 0804 and in turn this ADC 0804 is connected with mems at 2nd, 3rd and 5th pins.

2.2 HARDWARE COMPONENTS

The Hardware components used in this project are:

- ✓ Regulated Power Supply
- ✓ Microcontroller
- ✓ MEMS Sensor
- ✓ ADC 0804
- ✓ GSM
- ✓ MAX 232
- ✓ LCD
- ✓ Motor
- ✓ Relay

2.3 SOFTWARE COMPONENTS

2.3.1 About Software

Software used is:

*Keil software for C programming

*Express PCB for lay out design

*Express SCH for schematic design

2.3.2 KEIL µVision3

What's New in µVision3?

µVision3 adds many new features to the Editor like Text Templates, Quick Function Navigation, and Syntax Coloring with brace high lighting Configuration Wizard for dialog based startup and debugger setup. µVision3 is fully compatible to µVision2 and can be used in parallel with µVision2.

What is µVision3?

µVision3 is an IDE (Integrated Development Environment) that helps you write, compile, and debug embedded programs. It encapsulates the following components:

- A paper manager.
- A make facility.
- Tool configuration.
- Editor.
- A powerful debugger.

2.3.3 Express PCB

Express PCB is a Circuit Design Software and PCB manufacturing service. One can learn almost everything you need to know about Express PCB from the help topics included with the programs given.

Details: Express PCB, Version 5.6.0

2.3.4 Express SCH

The Express SCH schematic design program is very easy to use. This software enables the user to draw the Schematics with drag and drop options.

A Quick Start Guide is provided by which the user can learn how to use it.

Details:

Express SCH, Version 5.6.0

2.4 EMBEDDED C

The programming Language used here in this paper is an **Embedded C** Language. This Embedded C Language is different from the generic C language in few things like

a) Data types
b) Access over the architecture addresses.

The Embedded C Programming Language forms the user friendly language with access over Port addresses, SFR Register addresses etc.

Embedded C Data types:

Data Types	Size in Bits	Data Range/Usage
unsigned char	8-bit	0-255
signed char	8-bit	-128 to +127
unsigned int	16-bit	0 to 65535
signed int	16-bit	-32,768 to +32,767
sbit	1-bit	SFR bit addressable only
Bit	1-bit	RAM bit addressable only
sfr	8-bit	RAM addresses 80-FFH only

3.0 FUTURE ASPECTS

The microcontroller in this paper can be interfaced with smoke sensor to identify fire accidents and can be approached in time. A smart card system can be developed that which helps in opening the door after locking down the door when MEMS is activated. This smart card will be available only with the authorized person.

4.0 CONCLUSION

The paper presented a technique for a more efficient way of preventing ATM theft, which has been successfully designed and tested. Integrating features of all the hardware components used have developed it. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit. Secondly, using highly advanced IC's and with the help of growing technology the paper has been successfully implemented.

REFERENCES

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[3] http://www.8052.com/tut8051

[4] www.tkk.fi/Misc/Electronics/circuits/ir_send.html

[5] http://www.8052.com/tuttimer.phtml

APPENDIX

SOURCE CODE

==========

//<<<<<<<<<<ATM Security System Using GSM and MEMS MODULE>>>>>>>>>>//

==========

```
#include<reg52.h>
#include<lcd.h>
#include<intrins.h>
sbit motor=P0^0;
sbit sw=P0^1;

void SEND_CHR(unsigned char);
void RECEIVE_CHR();
void SEND_SMS(unsigned char *nm);
void GSM_INIT(void);
unsigned char rch;
unsigned char buff[40];

void print(char *str)
{
while(*str)
{
SBUF = *str++;
while(TI == 0);
TI = 0;
```

```
}
}
/*void RECEIVE_MEM()
{
unsigned int i=0;
while(1)
{
do
{
RECEIVE_CHR();
}while(rch != '$');
RECEIVE_CHR();
if(rch == '3')
        {
        RECEIVE_CHR();
        if(rch == 'A')
                {
                RECEIVE_CHR();
                if(rch == '0')
                        {
                        RECEIVE_CHR();
                        if(rch == 'M')
                                {
                                RECEIVE_CHR();
                                if(rch == 'D')
                                        {
                                        RECEIVE_CHR();
                                        if(rch == 'S')
```

```
                                    {
                                    i = 0;
                                    do
                                    {
                                    RECEIVE_CHR();
                                    buff[i] = rch;
                                    }while(buff[i++]!='$');
                                    goto nex;
                                    }
                                    }
                                }
                            }
                        }
                    }
}
nex:;
} */
```



```
void main()
{
unsigned char i=0;
motor=0;
sw=1;
TMOD = 0x20;
SCON = 0x50;
TH1 = 0xFA;
TR1 = 1;
```

```
init_lcd();
display_lcd("MAES BASED");
cmd_lcd(0xC0);
display_lcd("SECURITY SYSTEM");
delay_ms(300);
init_lcd();
//GSM_INIT();
print("AT+CMGF=1\r\n");
delay_ms(300);
TH1 = 0xFD;
init_lcd();
while(1)
{
TH1=0xFD;
delay_ms(75);
init_lcd();
display_lcd("MEMS BASED");
cmd_lcd(0xC0);
display_lcd("SECURITY SYSTEM");
for(i=0;i<32;i++)
{
RECEIVE_CHR();
buff[i]=rch;
}
//init_lcd();
if(buff[29]=='L' || buff[29]=='R' || buff[29]=='S' || buff[29]=='I')
{
TH1=0xFA;
```

```
delay_ms(75);
motor=1;
SEND_SMS("9032323048");
//SEND_SMS("9701515557");
motor=0;
delay_ms(200);
init_lcd();
display_lcd("WAIT FOR DOOR");
cmd_lcd(0xC0);
display_lcd("OPEN");
while(sw==1);
motor=1;
init_lcd();
display_lcd("DOOR OPENED");
delay_ms(300);
motor=0;
TH1=0xFD;
}
}
}
void RECEIVE_CHR()
{
while(RI==0);
rch = SBUF;
RI=0;
}
void SEND_CHR(unsigned char c)
{
```

```
SBUF = c;
while(TI==0);
TI=0;
}
void SEND_SMS(unsigned char *nm)
{
unsigned int i=0,j=0;
TH1=0xFA;
cmd_lcd(0x01);
display_lcd("SENDING SMS...");
print("AT+CMGS=");
SEND_CHR('"');
print(nm);
SEND_CHR('"');
print("\r\n");
delay_ms(500);
print("SOMEBODY IS TRYING TO ROBERY");
print("\r\n");
print("\r\n");
i=0;
SEND_CHR(0x1A);
SEND_CHR(0x1A); //END OF MESSAGE INDICATION. (ctrl + z)
delay_ms(500);
}


void GSM_INIT(void)
{
```

```
        cmd_lcd(0x01);
        display_lcd("GSM INITIALIZING");
        cmd_lcd(100);
        print("AT\r\n");
        delay_ms(300);
        print("AT\r\n");
        delay_ms(300);
        print("AT\r\n");
        delay_ms(300);
        print("AT+IPR=4800\r\n");
        delay_ms(300);
        print("AT+CMGF=1\r\n");
        delay_ms(300);
        print("AT+CNMI=0,1,0,0,0\r\n");
        delay_ms(300);
        print("ATE0\r\n");
        delay_ms(300);
        print("AT&W\r\n");
        delay_ms(300);
        print("AT+CREG?\r\n");
        delay_ms(300);
        print("AT+CREG?\r\n");
        delay_ms(300);
}
```