ARM Based Haze Monitoring System

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Abstract: The heavy haze, described as a pall of smoke caused widespread health problems especially among the elderly, the young and kids. Haze is an atmospheric phenomenon where dust, smoke and other particles obscure clarity of sky. Pollution has implications serious health well as for the whole environment. This paper described a mobile monitoring system developed to detect the level of haze particulates. Data collection was achieved with the huge of gas sensor, and mobile alert implementation was developed with global system mobile connection and short messaging system.

Keywords: GSM; SMS; haze.

I. INTRODUCTION

The increase in the development of technology and the human race, we failed to take care about the surroundings in which we live in. Thus we polluted the environment and thereby reducing the quality of the place we live. Electronic noses were originally used for quality control applications in the food, beverage and cosmetics industries. Current applications include detection of odors specific to diseases for medical diagnosis, and detection of pollutants and gas leaks for environmental protection. This project uses sensor like smoke sensor. These sensors are mounted on a PCB and visual indicator with audible buzzer is provided for alert signal. When the sensor is activated it sends the SMS using GSM modem. The LPC2148 are based on a 16/32 bit ARM7TDMI-S™ CPU with real-time emulation and embedded trace support, together with 128/512 kilobytes of embedded high speed flash memory. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at maximum clock rate. For critical code size applications, the alternative 16-bit Thumb Mode reduces code by more than 30% with minimal performance penalty. With their compact 64 pin package, low power consumption, various 32-bit timers, 4-channel 10-bit ADC, USB PORT, PWM channels and 46 GPIO lines with up to 9 external interrupt pins these microcontrollers are particularly suitable for industrial control, medical systems, access control and point-of-sale. With a wide range of serial communications interfaces, they are also very well suited for communication gateways, protocol converters and This project is much useful for mines detection and surveillance applications.

II. HARDWARE REQUIREMENTS

Embedded soft modems as well as many other general- purpose applications

1. ARM7 LPC2148 TDMI
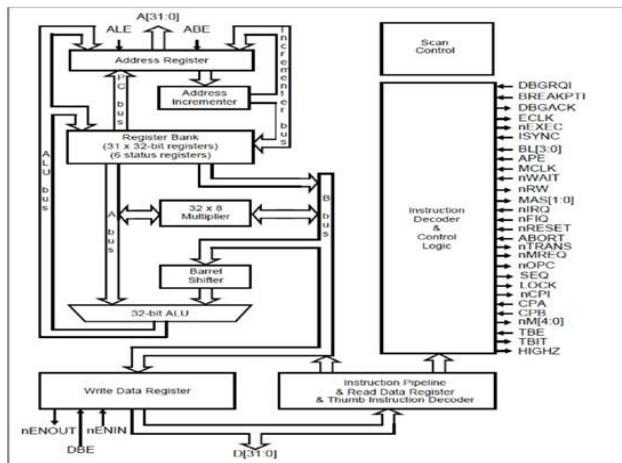
Fig.1. ARM7 TDMI Core Diagram

Over the last few years, the ARM architecture has become the most pervasive 32-bitarchitecture in the world through wide range of ICs available from various IC manufacturers. The ARM processors are embedded in products ranging from cell/mobile phones to automotive braking systems. Worldwide community of ARM partners and third-party vendors has developed among semiconductor and product design companies including hardware engineers, software developers, and system designers. ARM7 is one of the widely used micro-controller family in embedded system application. This section is humble effort for explaining basic features of ARM-7. The ARM is a family of instruction set architectures for computer processors based on a reduced (RISC) architecture developed by British company ARM Holdings. A RISC-based computer design approach means ARM processors require significantly fewer transistors than typical processors in average computers. Here this approach reduces costs, heat and power use. These are desirable traits for portable, light, battery-powered devices—including smart laptops, phones, and tablet.

A simpler design facilitates more efficient multi-core CPUs and higher core counts at lower cost providing higher processing power and improved energy efficiency for servers and supercomputers. It Provides 8kB of on-chip RAM accessible to USB by DMA. One or two (LPC2141/2 vs. LPC2144/6/8) 10-bit A/D converters provide a total of 6/14analog inputs with conversion times as low as 2.44 us per channel.

- Single 10-bit D/A converter provide variable analog output.
- Two 32-bit timers/external events counter PWM unit and watchdog.
- Low power real-time clock with independent power and dedicated 32 kHz clock input.
- Multiple serial interfaces including two UARTs (16C550) two Fast I2C-bus, SPI and SSP with buffering and variable data length capabilities.
- Vectored interrupt controller with configurable priorities and vector addresses.
- 45 of 5 V tolerant fast general purpose I/O pins in a tiny LQFP64.
- Nine edge or level sensitive external interrupt pins available.

On-chip integrated oscillator operates with an external crystal in range from 1 MHz to30 MHz and with an external oscillator up to 50 MHz.

1. Global System for Mobile Communication (GSM) Definition: GSM, which stands for Global System for Mobile communications, reigns (important) as the world's most widely used cell phone technology. Cell phones use a cell phone service carrier's GSM network by searching for cell phone towers in the nearby area. Global system for mobile communication (GSM) is a globally accepted standard for digital cellular communication. GSM is the name of a standardization group established in 1982 to create a common European mobile telephone standard that would formulate specifications for a pan-European mobile cellular radio system operating at 900 MHz. It is estimated that many coun- tries outside of Europe will join the GSM partnership.

Table I. Some Commands used in GSM data Transfer module of the system

| AT Command	Meaning
+CMGI	Module ok
+CMGS	Send message
+CMGW	Write message to memory
+CMGD	Delete message
+CMGC	Send command
+CMSS	Send message from storage
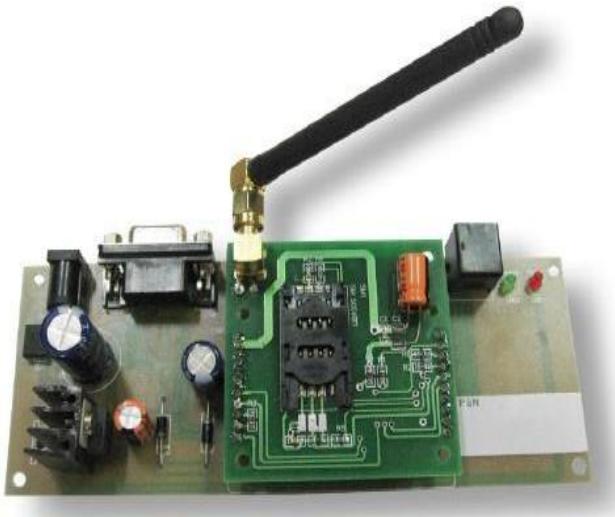
Fig.2.

2. MQ-2 Smoke Sensor

Sensitive material of MQ-2 smoke sensor is SnO2, which with lower conductivity in clean air. When the target combustible smoke exist, the sensor's conductivity is higher along with the smoke concentration rising. Please use simple electro circuit, Convert change of conductivity to correspond output signal of smoke concentration.MQ-2 smoke sensor has high sensitive to LPG, Propane and Hydrogen, also could be used to Methane and other combustible steam, it is with low cost and suitable for different application. It can detect: LPG, i-butane, propane, methane, alcohol, Hydrogen, smoke

Fig.3. MQ-2 Gas Sensor

Description: MQ-2 Semiconductor Sensor for Combustible Gas Sensitive material of MQ-2 gas sensor is SnO2, which with lower conductivity in clean air. When the target combustible gas exist, the sensors conductivity is higher along with the gas concentration rising. Please use simple electro circuit, Convert change of conductivity to correspond output signal of gas concentration. MQ-2 gas sensor has high sensitivity to LPG, Propane and Hydrogen, also could be used to Methane and other combustible steam, it is with low cost and suitable for different application.
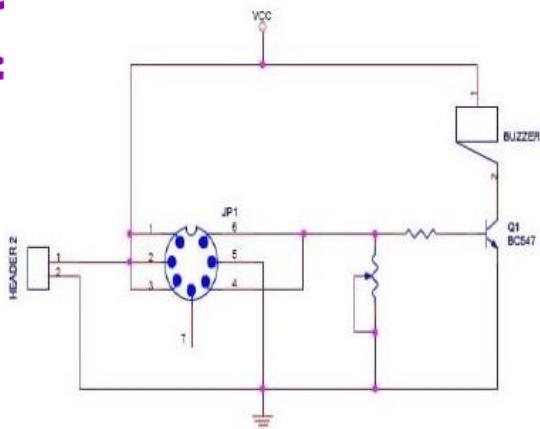
Fig.4. Schematic representation of sensor

III. BLOCK DIAGRAM

This project uses regulated 3.3V, 500mA power supply. Unregulated 12V DC is used for relay. 7805 three terminal voltage regulator is used for voltage regulation. Bridge type full wave rectifier is used to rectify the ac output of secondary of 230/12V step down transformer.
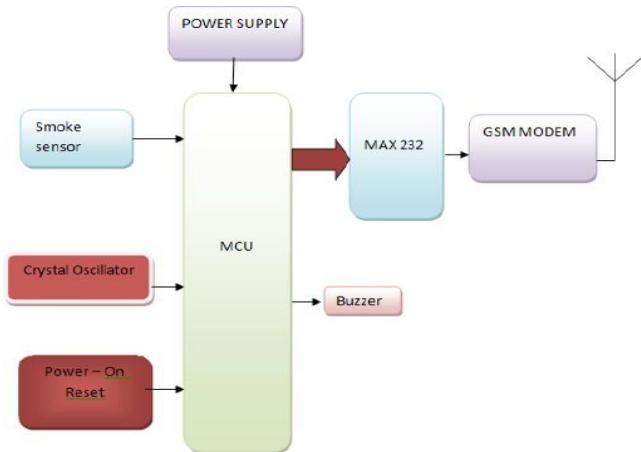

Fig.5.Block diagram of the system

1. Buzzer

The aPR33AX series of voice recording/playback ICs are powerful audio processors with high performance ADCs and DACs. The aPR33AX series C2.0 is specially designed to record and playback with fixed 1, 2, 4 and 8 message Modes. In this project we used aPR33A3 IC.
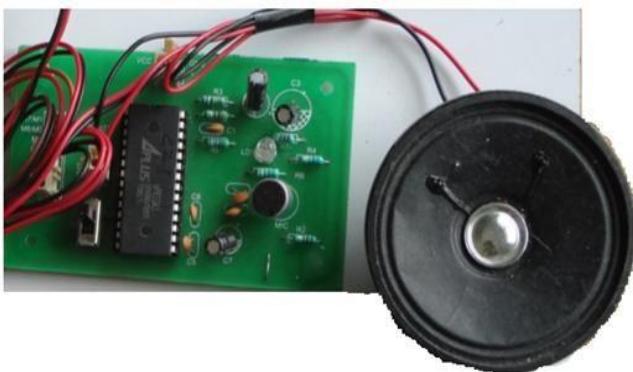
Fig.6. PR33A3 Voice Playback Module with Speaker Buzzer.

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke. Buzzer consumes less power and can be used with automatic inserters.

Fig7. Electronic Buzzer.

2. Liquid Crystal Display (LCD)

LCD is a display module finding its application in many electronic devices and circuits. LCDs are preferred to LEDs since they are easily programmable and can display various special characters. We use JHD 162A LCD. A 16x2 LCD displays 16 characters per line with 2 lines in total. It has two registers Command and Data.

3. Key Features:

- High contrast display
- 16 Characters x 2 Lines
- Built-in HD44780 Equivalent LCD Controller with extension driver
- Works directly with ATMEGA, ARDUINO, PIC and many other microcontroller/kits.
- 4 or 8 bit data I/O interface (in our project 4 bits used)
- Low power consumption.
- Power supply of +5v or 3.3v or 2.7v
- Operating temperature of -20 to +70°C
- EA DIP 162-DNLED: Green color display with LED backlight
- EA B200-9 a 9-PIN socket is used to detach LCD from kit.

Fig.8. LCD.

MAX 232

In the Fig.8 MAX 232 IC used as level logic converter. The MAX232 is a dual driver/receiver that has a capacitive voltage generator to supply EIA 232 voltage levels from a single 5v supply. Each receiver converts EIA-232 to 5v TTL/CMOS levels. Each driver converts TLL/CMOS input levels into EIA-232 levels.

Function Tables

EACH DRIVER

INPUT TIN	OUTPUT TOUT
L	H
H	L

H = high level, L = low level

EACH RECEIVER

INPUT RIN	OUTPUT ROUT
L	H
H	L

H = high level, L = low level

logic diagram (positive logic)

|	11		14	
T1IN				T1OUT
T2IN	10		7	T2OUT
R1OUT	12		13	R1IN
R2OUT	9		8	R2IN
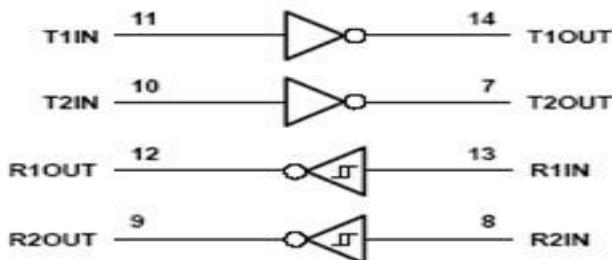
Fig.9. Function Tables and Logic Diagram for MAX 232

4. Power Supply

All electronic circuits works only in low DC voltage, so we need a power supply unit to provide the appropriate voltage supply for their proper functioning .This unit consists of transformer, rectifier, filter & regulator. AC voltage of typically 230volts rms is connected to a transformer voltage down to the level to the desired ac voltage. A diode rectifier that provides the full wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation . A regulator circuit can use this dc input to provide dc voltage that not only has much less ripple voltage but also remains the same dc value even the dc voltage varies somewhat, or the load connected to the output dc voltages changes.

Transformer → Rectifier → Filter → Regulator → DC
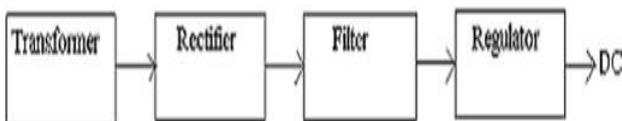
Fig.10. General Block of Power Supply Unit

5. Transformer

A transformer is a static piece of which electric power in one circuit is transformed into electric power of same frequency in another circuit. It can raise or lower the voltage in the circuit, but with a corresponding decrease or increase in

current. It works with the principle of mutual induction. In our project we are using a step down transformer to providing a necessary supply for the electronic circuits. Here we step down a 230volts ac into 12volts ac.

6. Rectifier

A dc level obtained from a sinusoidal input can be improved 100% using a process called full wave rectification. Here in our project for full wave rectification we use bridge rectifier. From the basic bridge configuration we see that two diodes(say D2 & D3) are conducting while the other two diodes (D1 & D4) are in off state during the period t = 0 to T/2.Accordingly for the negative cycle of the input the conducting diodes are D1 & D4 .Thus the polarity across the load is the same. In the bridge rectifier the diodes may be of variable types like 1N4001, 1N4003, 1N4004, 1N4005, IN4007 etc… can be used. But here we use 1N4007, because it can withstand up to 1000v.

7. Filters

In order to obtain a dc voltage of 0 Hz, we have to use a low pass filter. So that a capacitive filter circuit is used where a capacitor is connected at the rectifier output& a dc is obtained across it. The filtered waveform is essentially a dc voltage with negligible ripples & it is ultimately fed to the load.

8. Regulators

The output voltage from the capacitor is more filtered & finally regulated. The voltage regulator is a device, which maintains the output voltage constant irrespective of the change in supply variations, load variations & temperature changes. Here we use fixed voltage regulator namely LM7805.The IC LM7805 is a +5v regulator which is used for microcontroller.

Advantages
- It reduces the man power
- Smoke detecting efficiency is high
- Accuracy is high

Application
- Hospitals
- Mines detection
- Industries

IV. RESULTS AND DISCUSSIONS

The selected regions for data collection are Subang Jaya, Bandar Sunway and Shah Alam which are three adjacent cities in the state of Selangor, Malaysia these areas are known to be highly congested with vehicles since these area serves as major towns in the state of Selangor. Initial observation on these three locations showed that vehicles activity happening almost 24 hours a day. Table II tabulates sample of data collected in those three places. Data collected by the system is automatically converted into Air Pollutant Index (API) reading in parts per million (PPM). Comparatively, data collected in Bandar Sunway showed the highest readings of 0264PPM as compared to the other two. Reading in Shah Alam was 0227PPM and Subang Jaya with 0225PPM.

Table II. Samples of data collected

Location /Result (PPM)	1	2	3	4	5	6	Average Results
Subang Jaya	0224	0224	0223	0224	0231	0224	0225
Bandar Sunway	0283	0271	0265	0255	0255	0255	0264
Shah Alam	0224	0195	0196	0240	0255	0252	0227

All these readings were taken after the end of office hours between 5.00PM to 6.30PM. During this time duration, town dwellers were busy commuting from their offices to get home. The highest reading recorded at Bandar Sunway support the evidence of having a lot of vehicles at that area during that time compared to the other locations. The car exhaust emissions somehow affect the quality of air of the area under observation.

Fig.11. Graph of samples collected data
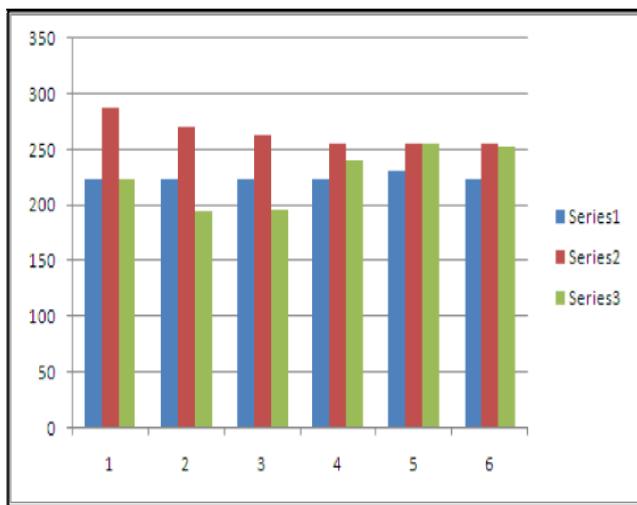
Fig.11 illustrates a plot of data collected from the three areas Series 1 indicates reading taken in Shah Alam, Series 2 is reading plot for Bandar Sunway and Series 3 is data collected at Subang Jaya. From the graph, it is clearly shown that haze reading in Bandar Sunway gives the highest average value. During the selected time frame six different readings were taken for approximately every 10 minutes gap.

Based on Table III, it is clearly shown that all readings taken from the three chosen places in Table II fall under the category of very unhealthy. This support the fact that, during which the readings was taken, a lot of vehicle exhaust emissions can be traces since people were busy commuting from one location to another.
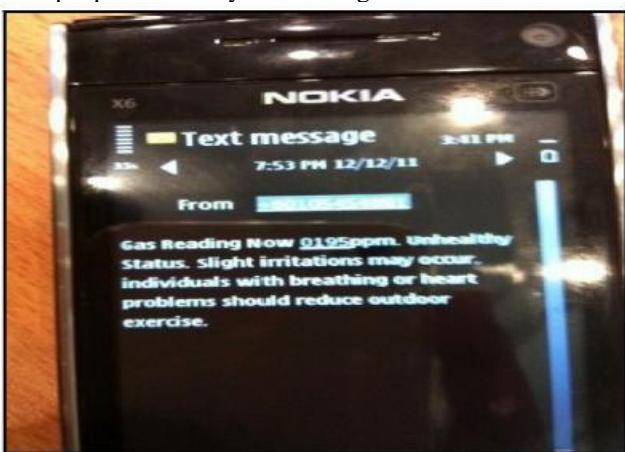
Fig.12. SMS alert for Unhealthy level

Fig.12 shows the sample of SMS alert notification received through mobile phone generated by the developed system. The alert message received depends on the level of readings measured at that instance. Table II shows the category of readings to define the quality of air.

V. CONCLUSION

This project presents a high sensitive sensor based SMS alert. Experimental work has been carried out carefully. The proposed method is verified to be highly beneficial for haze monitoring.

Table III. Air quality classification

API scale	Air quality
$0 - 50$	Good
$51 - 100$	Moderate
$101 - 200$	Unhealthy
$201 - 300$	Very unhealthy
301 and above	Hazardous

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