Sudan University of Science and Technology

College of Graduate Studies

M.Sc Program In Mechatronics Engineering

Designing an Air Pollution Monitoring System in Cement Plants

تصميم نظام مراقبة التلوث الجوي في مصانع الاسمنت

A Thesis Submitted for Partial Fulfillment for the Requirements of the Degree of M.sc. in Mechatronics Engineering

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الآيـــة

قال تعالى :

{ ومَا يَعلمُ تَأويلَهُ إلا اللهُ وَ الراسخُونَ في العلْم يَقُولونَ آمَنا به كُلٌ منْ عنْد رَبنا }

صدق الله العظيم

(سورة ال عمران الاية 7)

Dedication

To my strong and gentle soul my parents who taught me to trust in allah believe in hard work.

To my sisters and brothers who made my life sweet.

To my best friends who lived every single moment together.

Acknowledgement

I would like to express my appreciation to my supervisor Ust. Abdullah Salih Ali for his guidance during the term of my research. Without his valuable assistance this work would not have been completed .

I also thanks my parents, friends and colleague for supporting and encouraging.

Abstract

Air pollution is one of the major cause of cancer diseases, Crisis diseases and Pneumonia. One of the main reason of the pollution is the cement industry which is widespread according to the increased requirement in the world, so a monitoring system wirelessly in cement plant was created to observe the concentration of gases like Oxides of Nitrogen (NOx), Oxides of Sulfur (SOx), Carbon Monoxide (CO), humidity, particles and temperature.

Many elements and software are used to design the system such as sensors, microcontroller, PROTEUS and MATLAB programs for interfacing and saving data.The simulation results showed good performance.

المستخلص

التلوث الجوي من الاسباب الرئيسية لامراض السرطان والازمة والامراض الرئوية. ومن الاسباب الرئيسيه لتلوث الهواء هو مصانع الاسمنت التي اصبحت منتشرة بصورة واسعه نتيجة الطلب المتزايد عليها ولذلك تم تصميم نظام مراقبة لاسلكي لمراقبة نسبة الغازات لكل من اكسيد النيتروجين و اكسيد الكبريت واكسيد الكربون والغبار والرطوبة ودرجة الحرارة.

عدة عناصر تم استخدامها لتصميم النظام مثل الحساسات لكل نوع من الغازات التي تقاس بصورة لاسلكية والمتحكم الدقيق الذي يربطهم عن طريق برنامج البروتوس وعرض الواجهات و حفظها عن طريق برنامج الماتلاب. نتائج المحاكاة اوضحت الاداء الجيد للنظام.

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GHG	Green House Gases
Co_2	Carbon Dioxide
CH_4	Methane
N_2O	Nitrous Oxide
HFC_s	Hydrofluorocarbons
PFC_s	Perfluorocarbons
SF_s	Sulfer hexafluoride
BC	Black Carbon
So_2	Sulfur dioxide
No_x	Nitrogen Oxide
WHO	World Health Organization
GUI	Graphical User Interface
GSM	Global System for Mobile Communications
AQI	Air Quality Index
NCAP	Network Capable Application Processor
RTC	Real Time O'clock
LCD	Liquid Crystal Display
PM	Particulate Matter
PPM	Parts Per Million
PPB	Parts Per Billion

CHAPTER ONE

INTRODUCTION

Chapter One

Introduction

1.1General Concept

Pollution is the effect of undesirable changes in our surroundings that have harmful effects on plants, animals and human beings. This is occurs when only short-term economic gains are made at the cost of the long-term ecological benefits for humanity. No natural phenomenon has led to greater ecological changes than have been made by mankind. During the last few decades we have contaminated our air, water and land on which life itself depends with a variety of waste products. Pollution can be in soil, air and water. The air pollution also damages our environment especially the atmosphere layer , This layer is normally composed of 79 percent nitrogen, 20 percent oxygen and one percent as a mixture of carbon dioxide, water vapor and trace amounts of several other gases such as neon, helium, methane, krypton, hydrogen and xenon.

The pollution occurs because of the increasing of the gas percentage in the atmosphere which is like Green House Gases (GHG) which is a gas that traps heat in the atmosphere. The principal greenhouse gases affected by human activities are: carbon dioxide(CO_2), methane (CH_4), nitrous oxide (N_2O), ozone, and fluorinated gases sub as (HydroFluoroCarbons [HFCs], PerFluoroCarbons [PFCs], and Sulfur HexaFluoride [SF_6]). Also the Black Carbon (BC) which is a component of particle pollution, directly absorbs incoming and reflected solar radiation and reduces reflection of sunlightoff of snow and ice. Air pollution can affect the health in many ways. Numerous scientific studies have linked air pollution to a variety of health problems including:

1- Aggravation of respiratory and cardiovascular disease.

2- Decreased lung function.
3- Increased frequency and severity of respiratory symptoms such as difficulty breathing and coughing .
4- Increased susceptibility to respiratory infections.
5- Effects on the nervous system, including the brain, such as IQ loss and impacts on learning, memory, and behavior .
6- Cancer.
7- premature death. Also it affects the Ozone layer.

Ozone can damage vegetation, adversely impacting the growthof plants and trees. These impacts can reduce the abilityof plants to uptake CO_2fromthe atmosphere andindirectly affect entire ecosystems. Visibility is reducedby particles in the air that scatter and absorb light and heat from the sun radiation which is affect obviously the snow mountain in the poles and change the climate in the earth. Acid rain one of the bad result of pollution acid-forming compounds (such as sulfur dioxide [SO_2] and nitrogen oxides [NO_x]) can deposit from the atmosphere to the Earth's surface. One of the major sources of air pollution are automobiles and industries, as per estimates vehicular pollution is the primary cause of air pollution in urban areas (60%), followed by industries (20-30%)[1]. In specific way It is found that one of the main causes of the pollution is the cement manufacturing , it increase rapidly because of the demand of the world for civilization and development that happen nowadays in an awful way which concentrate gases and small particuals that damage the atmosphere because of fuels that used and concrete .

The energy used by cement industry is estimated at about2% of the global energy consumption; 5% of global manmadecarbon dioxide emissions originate from cementproduction [2]. The aerial discharge of cement factories consist of

Particulate matter, Sulphur dioxide and Nitrogen oxides producing continuous visible clouds which ultimately settle on the vegetation, soil and effects whole biotic life around, as a result the whole ecosystem around the cement factory is subjected to extraordinary stress and abuse.

1.2 Problem Statement

Generally air pollution is increasing and the risk factors are greater than expected. The World Health Organization (WHO) reported that air pollution killed 7 million people in 2012 which is increased daily in scary way. So the world must focus on this issue to manage or limit the amount of pollution and protect the whole living life. The concentration of pollutants from cement plants are increased and they do not notice this rapiding of development that need cement plants which increase the percentage of emission of gases . The air pollution parameters are monitored by specified organization or association that care about the environment and the instruments that are used in monitoring. These equipment are expensive and not offered everywhere, therefore, it is neither widely used normonitor through.

1.3 Ojectives

The main objectives of this research are :

(1) To major the amount of pollution in the air in several locations in the plant.

(2) To send the reading data of sensors via zigbee module.

(3) To major the Oxides of Nitrogen, Oxides of Sulfur, Carbon monoxide, Particles, Humidity and Temperature.

1.4 Methodology

The method of this portable device is to be continuous online monitoring uses sensors to monitor the parameters, and then send to control center or PC wirelessly. Then these data will be display in a GUI by using MATLAB and it can be saved as a database to be a history to the user.

1.5 Thesis Outline

In chapter two a literature review of pollution monitoring system in cement plant is given in details. Experimental methodology is discussed in chapter three . Chapter four presents the result and discussion. Conclusion and recommendation are presented in chapter five .

CHAPTER TWO

LITERATURE REVIEW

Chapter Two

Literature Review

2.1 Previous Works

A number of researches had been studied by a researchers in the field of air pollution and air quality in general and some of them specified it in cement plants . one of these research is Swagarya, ShubiKaijage, Ramadhani S.Sinde study who measure and monitor the CO , SO and dust in a cement factories, particularly for those in Sub-Saharan countries where there is a lack of technologies in environmental monitoring because most of industries are using wired and traditional systems. which interfaced theses three sensors with PIC microcontroller , these data can be send wirelessly by zigbee module from different location to the main station which is apersonal computer that collecting data in a database . If the emission of gases exceed a limit the micro send data through GSM to the responsible person and Authorities . [3]

Kama Azura Othman, Norha Yati Hamzah, Norernina Sharudin study implement a circuit that detect carbon monoxide by using TGS2600 CO sensor and using a mobile network to send data after initialization and send it to the microcontroller to transfer it wirelessly to the station using XBee transceiver and having a database unit including the pc station as shown in figure(2.1). The sensor act as a potenimeter which the resistance changed according to the concentration of the gas then it affect on the output voltage. These data will displayed in the pc as a PPM value [4].

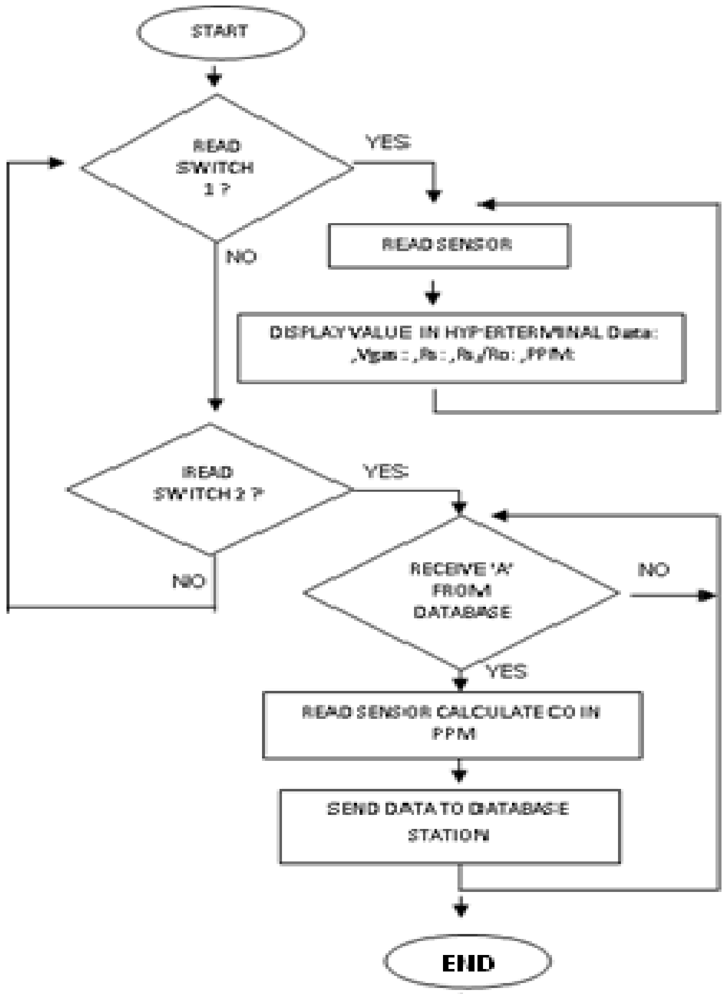

Figure 2.1: Detection circuit using mobile network

Parithielamvazhuthi R study collect samples from one of the cement plants in india. These Samples are collected for 8hrs at each site for every month at the time from 9AM to 5PM. Six sampling sites for ambient air monitoring were selected. They are near main gate, power plant, coal mill and dispensary. Monitored parameters were PM2.5,PM10, and gaseous pollutants such as SO_2 and NO_2 as in Table (2.1). Respirable Dust Sampler Envirotech APM 460(NL) was used for air sampling and analyzed as per standard methods. Air Quality Index (AQI) was calculated. Table 2.1 and Table 2.2 contain a result of a study[5].

Table 2.1: National ambient air quality standards (NAAQS)

Pollutant	Time Weighted Average	Concentration in Ambient Air		Method of Measurement
		Industrial and Residental Area	Sensitive area	
Sulpher Dioxide(SO_2)	Annual Average	50μg/m^3	20μg/m^3	Improved west and Greake Method
	24H Average	80μg/m^3	80μg/m^3	
Nitrogen Dioxide (NO_2)	Annual Average	40μg/m^3	30μg/m^3	Jacob and Hoochheiser Modified (NaOH-Na Aso2)Method
	24H Average	80μg/m^3	80μg/m^3	
Particulate Matter (PM2.5)	Annual Average	40μg/m^3	40μg/m^3	High Volume Sampling Method
	24H Average	60μg/m^3	60μg/m^3	
Particulate Matter (PM10)	Annual Average	60μg/m^3	60μg/m^3	Respirable Particulate Matter Sampler
	24H Average	100μg/m^3	100μg/m^3	

NihalKularatna, and B. H. Sudantha, study talks about monitoring with low cost requirement using a semiconductor gas sensor which classified into two n-type and p-type as shown in Table 2.3 .Semiconductor sensor consists of one or more metal oxides such as tin oxide, aluminum oxide, etc. When heated to a high temperature, an n-type semiconductor material decreases its resistance, while p-type increases the resistance in the presence of a reducing gas .

Table 2.2: Average ambient air pollution level In cement Industries around ariyalur district

No	Cement Industries Name	Pollutants in µg/m^3			
		$PM_{2.5}$	PM_{10}	SO_2	No_2
1	Arasu Cement Industry	25.8	77	45	48
2	Ramco Cement Industry (1)	12.8	68	15.5	16.4
3	Ramco Cement Industry (2)	15	67	13.70	12.9
4	Dalmia Cement Industry	-	-	-	-
5	Chettinad Cement Industry	-	-	-	-
6	Ultra Tech Cement Industry	-	-	-	-
7	India Cement Industry	12.3	69	17.4	13.8

Table2.3: Classification of sensor materials

Material Type	Materials	Oxidizing Environment	Reducing Environment
n-type	Sno_2	Resistance-Rise	Resistance-Fall
p-type	Cr_2TiO_3	Resistance-Fall	Resistance-Rise

The conductivity of the sensing element, which is formed by metal-oxide semiconductor material, changes according to gas concentration.

In the presence of a reducing gas, the surface density of thenegative oxygen ions decreases. Consequently, the height of thepotential barrier decreases and as a result, the resistivity of thematerial falls according to a logarithmic function. The correlation of the sensor resistance (Rs) and the concentrationof a reducing gas(C) can be expressed in the following general function .

$R_s = R_o(1 + k\sqrt{C}$ ……………………………………………………………..(2.1)

Where:

R_s= Electrical resistance of the sensor.

R_o= Electrical resistance of sensor at zero PPM.

K=A constant for particular.

C= Gas concentration in PPM.

So these sensors used as array connected to the Smart Transducer Interface Module(STIM). In addition to that a warning generation buzzer is also connected. The STIM islinked to an Network Capable Application Processor (NCAP)PC through transducer independent interface as shown in figure (2.2).

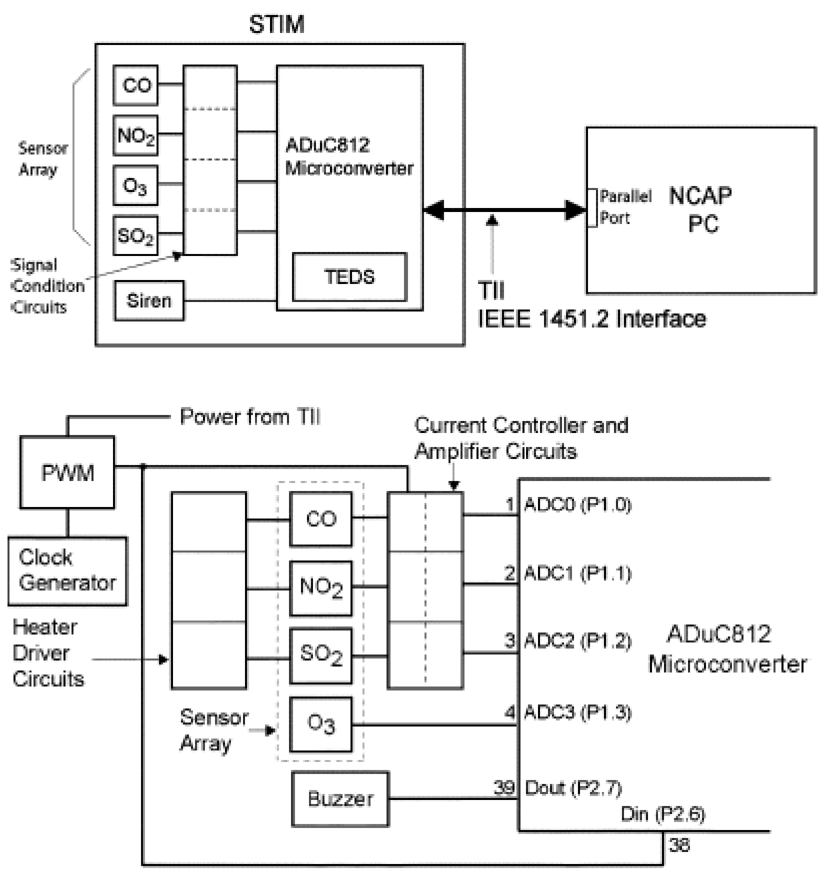

Figure 2.2: The block diagram of the EAPMS.

And the data transfer functions have been implemented using the protocols described in the IEEE 1451.2. The triggering and data transport functions and controlling of the data rate are handled by the NCAP which providing the GUI(graphical user interface).

Alka Dubey ,Mohd Shamshad and Kamlesh Patel displayed the air pollutionrate when the traffic light signal glows red and vehicle stop for an allotted time and this is happened in all four sides of the square. theses device fabricated to aware the people about the dangerous of air pollution. The data will be recorded in external memory with real date and time which is very important for monitoring .

In the present system an embedded system is designed which have multi channel gas sensor MQ2 and MQ6 having capability to senseNO_2, SO_2, Methane, LPG, CO and other toxic gases. For measurement of temperature there is temperature sensor LM35, humidity there is sensor w generate voltage signals in proportions to the percentage amount of the detectable gas, temperature, humidity in the square area with real time. Voltage data from appropriate channel is converted into digital form using 8 channels ADC 0808 this ADC is attached with port 1 of microcontroller 89C52.

There microcontroller is a signal processing unit, where signal is manipulated and transfer to the port 3 where LCD is interfaced. One external memory having capability of 1MB and Real Time Clock (RTC) is also attached with the microcontroller for recording and display data with real date and time. This data send as sms in user mobile or send it to pc or laptop or pc using hyperterminal [6].

2.2 Air Pollution

Air pollution define as a contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere. This atmosphere has be changed now a days after the industrial revolution that occurs in the last centuries and it affects on environment which include air , water and soil .Also it defined in other way as an increase in the global concentrations of greenhouse gases CO_2, CH_4, and N_2O.

2.3 Classification of Air Pollution

In the following the classification of air pollution will be described.

2.3.1 According to the manner of reaching the atmosphere

the substance that pollute the air classified into two categories according to the manner in which they reach the atmosphere which is primary and secondary pollutants . Primary pollutants are substances that are directly emitted into the atmosphere from sources. The main primary pollutants known to cause harm in high enough concentrations are the following:

1- Carbon compounds, such as CO, CO_2, CH_4, and VOCs.

2- Nitrogen compounds, such as NO, NO_2, and NH_3.

3- Sulfur compounds, such as H_2S and SO_2.

4- Halogen compounds, such as chlorides, fluorides, and bromides

5- Particulate Matter (PM or "aerosols"), either in solid or liquid form.

The secondary pollutant which is defined as a pollutant that are not directly emitted from sources, but instead form in the atmosphere from primary pollutants (also called "precursors"). The mainsecondary pollutants known to cause harm in high enough concentrations are the
following:

1- $NO_2$and HNO_3formed from NO.

2- Ozone (O_3) formed from photochemical reactions of nitrogen oxides and VOCs.

3- Sulfuric acid droplets formed from $SO_2$and nitric acid droplets formed from NO_2.

4- Sulfates and nitrates aerosols (e.g., ammonium (bi) sulfate and ammonium nitrate) formed from reactions of sulfuric acid droplets and nitric acid droplets with NH3, respectively.

5- Organic aerosols formed from VOCs in gas-to-particle reactions .

2.3.2 According to chemical composition

1. Sulfur-containing compounds.
2. Nitrogen-containing compounds.
3. Carbon-containing compounds.
4. Halogen-containing compounds.
5. Toxic substances (any of about).
6. Radiative compounds.

2.3.3 According to physical state

1. Gaseous.
2. Liquid (aqueous).
3. Solid.

2.3.4 According to the space scales of their effects

1. Local (or indoor).
2. Regional.

2.4 Causes of Air Pollution

One of the major causes of air pollution is a cement plants which is one of the main causes of pollution, ship emissions ,industrial factories , transportations . It is kill approximately 50,000 people a year in Europe, at an annual cost to society of more than €58 billion, according to a recent scientific study.

2.5 Affects of Air Pollution

It is affect on human being, animals, plans and environment around them include materials due to indoor air pollutants, air toxics, radioactivity, urban photochemical smog, acid rain, visibility reduction, greenhouse warming, depletion of the ozone layer, climate forcing due to anthropogenic atmospheric aerosols. Here will explain the affect of each gas :

1- Sulfer dioxide

i. At relatively high concentrations SO_2causes severe respiratory problems.

ii. Sulfur dioxide is an acid precursor, which is a source of acid rain produced when SO_2combines with water droplets to form sulfuric acid, H_2SO_4.

iii. Sulfur dioxide is an precursor of sulfate particulates (sulfates) which affect the radiation balance of the atmosphere and can cause global cooling.

2- Nitrogen oxides

i. causes the reddish-brown haze in city air, which contributes to heart and lung problems and may be carcinogenic.

ii. $NO_x$is an acid precursor, which is a source of acid rain produced when nitrogen oxides combines with water to produce nitric acid, HNO_3, and other acids.

iii. Nitrogen oxides are the precursors of nitrate particulates (nitrates) which affect the radiation balance of the atmosphere and can contribute to global cooling.

iv. Nitrogen oxides are major contributors to the formation of ground level 'bad' ozone.

3- Carbon monoxoide

CO is highly poisonous to humans and most animals: when inhaled, CO reduces the ability of blood hemoglobin to attach oxygen.

4- Particulate matters (aerosols)

i. Diverse health effects (e.g., harmful to human respiratory system)
ii. Contribute to urban haze, cause visibility reduction.
iii. Play a key role in the Earth's radiative budget and global change.

5- particels

One of the most critical impacts of cement manufacturing is the dust generated during transport, storage, milling, packing,… etc. Atmospheric dust is an important source of air pollution particularly in dry climates. Mineral dust contains high concentrations of many metals known to have toxic effects not only on plants and animals but also on humans .It has been reported that 1kg of cement manufactured in Egypt generates about 0.07kg of dust in the atmosphere.

2.6 Criteria of air pollution

The clean air act, which was last amended in 1990, requires EPA to set National Ambient Air Quality Standards (40 CFR part 50) for pollutants considered harmful to public health and the environment. The clean air act identifies two types of national ambient air quality standards. Primary standards provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. The EPA has set National Ambient Air Quality Standards for six principal pollutants, which are called "criteria" air pollutants. Periodically, the standards are reviewed and may be revised. The current standards are listed in Table 2.4. Units of measure for the standards are parts per million (PPM) by volume, parts per billion (ppb) by volume, and micrograms per cubic meter of air (μg/m3).

Table 2.4: EPA National Ambient Air Quality Standards

Pollutant [links to historical tables of NAAQS reviews]	Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO)	primary	8 hours	9 PPM	Not to be exceeded more than once per year
		1 hour	35 PPM	
Lead (Pb)	primary and secondary	Rolling 3 month average	0.15 µg/m3 (1)	Not to be exceeded
Nitrogen Dioxide (NO2)	primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	primary and secondary	1 year	53 ppb (2)	Annual Mean
Ozone (O3)	primary and secondary	8 hours	0.070 PPM (3)	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle PM2.5	primary	1 year	12.0 µg/m3	annual mean,

Pollution (PM)					averaged over 3 years
		secondary	1 year	15.0 µg/m3	annual mean, averaged over 3 years
		primary and secondary	24 hours	35 µg/m3	98th percentile, averaged over 3 years
	PM10	primary and secondary	24 hours	150 µg/m3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO2)		primary	1 hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3 hours	0.5 PPM	Not to be exceeded more than once per year

(1) In areas designated nonattainment for the Pb standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5µg/m_3 as a calendar quarter average) also remain in effect.

(2) The level of the annual NO_2 standard is 0.053PPM. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour or year standard level.

(3) Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O_3 standards additionally remain in effect in some areas. Revocation of the previous (2008) O_3 standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.

(4) The previous SO_2 standards (0.14PPM 24-hour and 0.03PPM annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet one year since the effective date of designation under the current (2010) standards, and (2) any area for which implementation plans providing for attainment of the current (2010) standard have not been submitted and approved and which is designated nonattainment under the previous SO_2 standards or is not meeting the requirements of a SIP call under the previous SO_2 standards (40 CFR 50.4(3)), A SIP call is an EPA action requiring a state to resubmit all or part of its State Implementation Plan to demonstrate attainment of the require NAAQS.

2.7 Cement Plants Stages

Cement plants are usually located closely either to hot spots in the market or to areas with sufficient quantities of raw materials. The aim is to keep transportation costs low. Basic constituents for cement (limestone and clay) are taken from quarries in these areas. Al stages are explained below as in Figure 2.3.

2.7.1 Process

Basically, cement is produced in two steps: first, clinker is produced from raw materials. In the second step cement is produced from cement clinker. The first step can be a dry, wet, semi-dry or semi-wet process according to the state of the raw material.

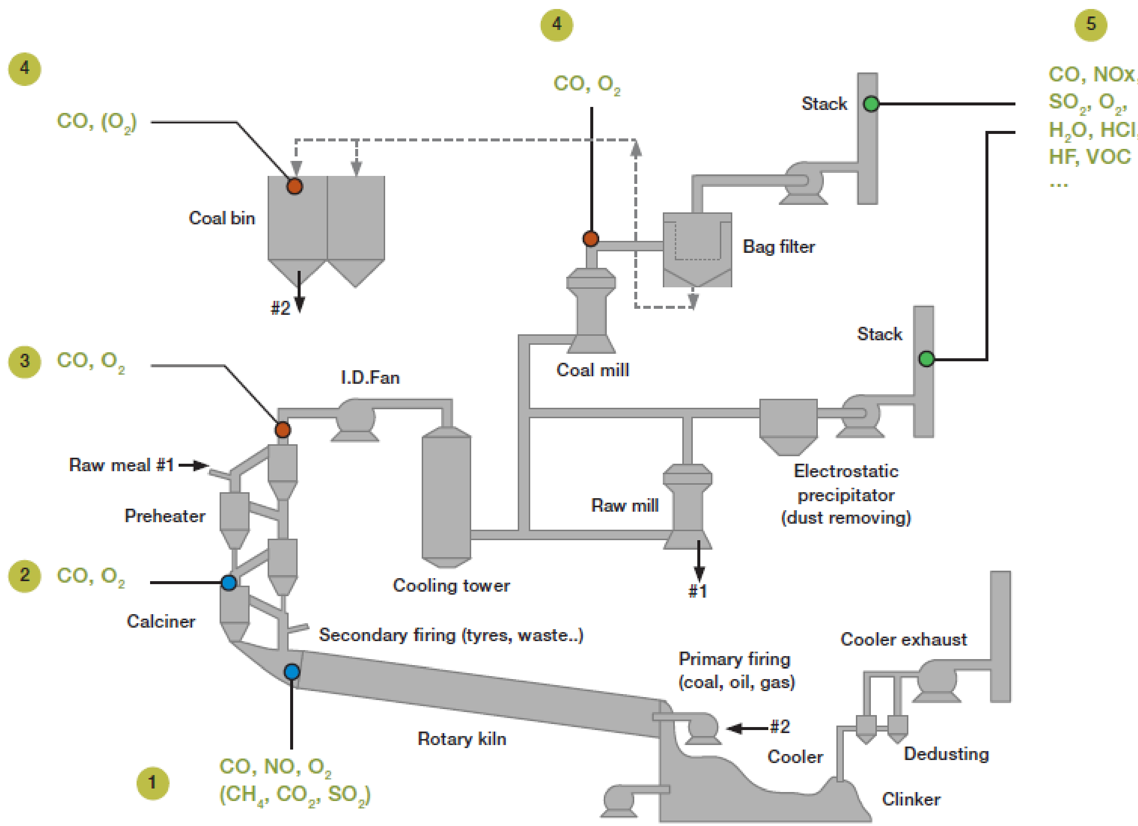

Figure2.3: Cement plant stages

2.7.2 Making clinker

The raw materials are delivered in bulk, crushed and homogenised into a mixture which is fed into a rotary kiln. This is an enormous rotating pipe of 60 to 90m long and up to 6m in diameter. This huge kiln is heated by a 2000°C flame inside of it. The kiln is slightly inclined to allow for the materials to slowly reach the other end, where it is quickly cooled to 100-200°C. Four basic oxides in the correct proportions make cement clinker: calcium oxide (65%), silicon oxide (20%), alumina oxide (10%) and iron oxide (5%). These elements mixed homogeneously (called "raw meal" or slurry) will combine when heated by the flame at a temperature of approximately 1450°C. New compounds are formed: silicates, aluminates and ferrites of calcium. Hydraulic hardening of cement is due to the hydration of these compounds.

The final product of this phase is called “clinker”. These solid grains are then stored in huge silos. End of phase one.

2.7.3 From clinker to cement

The second phase is handled in a cement grinding mill, which may be located in a different place to the clinker plant. Gypsum (calcium sulphates) and possibly additional cementitious (such as blastfurnace slag, coal fly ash, natural pozzolanas, etc.) or inert materials (limestone) are added to the clinker. All constituents are ground leading to a fine and homogenous powder. End of phase two. The cement is then stored in silos before being dispatched either in bulk or bagged.

2.8 Emission From Cement Plant

In Cement factory, the systems which are used to monitor the amount of wastes emitted into air mostly are OPSIS, Uras26, Magnos27 and CODEL which are all wired systems and theymonitors the emissions passing through the chimney only. So the emissions from other areas are not monitored. Also these systems are more expensive, so most factories fails to install these systems. This situation makes difficult for the environment management authorities to know exactly the amount of pollution emitted to our environment. The Figure 2.3 shows the areas where gas analysers are fixed[7].

CHAPTER THREE
SYSTEM DESIGN and METHODOLOGY

Chapter Three

System design and Methodology

3.1 Gas concentration and standards

The Sudanese standards and Metrology Organizationis specified the limitation to be as standard to avoid the emissions that happen in the cement plant to protect the environment from pollution. These standards are the same as the United Arab Emirates standard that the cement plants work with its standard and criteria . It will be as follow shown in Table 3.1.

Table3.1 United Arab Emirates Gas standards in Cement Plant

No	Gas name	Sample	Limit (mg/m^3)
1	Particulate	SPM	50
2	Sulfur dioxide	SO_2	400
3	Nitrogen oxides	NO_x	600
4	hydrogen chloride	HCL	10
5	Formaldehyde	CH_2o	20
6	Carbon	C	10
7	*Hydrogen fluoride*	HF	1.0
8	*Copper*	Cu	0.5
9	Lead	pb	0.05
10	*Cadmium*	Cd	0.05
11	Mercury	Hg	0.05
12	Arsenic	As	0.1
13	*Zinc*	Zn	1.0

World Health Organization (WHO) standards are published in mg/m^3.For those who want to do the conversion, 1ppm = 1.145mg/$m^3$and 1mg/m^3= 0.87ppm.

3.2 Gas Analyzier

The analyzer consists of three basic components: the sensing unit (transmitter), the control unit (receiver) and apower supply. The sensing unit receives a continuous flow of the multi-component gas mixture, measures the concentration of the sample gas and transmits an electrical signal to the control unit.

3.3 The Sensing Unit

It consist of multi gas sensors to measure the concentration of gasess emitted from cement plant .those sensors are : So sensor, Co sensor, No sensor, particle sensor, humidity sensor and temperature sensor.

3.3.1 Co Sensor

The main feature of CO sensor are :

(1) Concentration range is10-10000ppm CO.

(2) Vc: 5.0V ± 0.1V.

(3) Sensing Resistance (Rs) 2KΩ - 20KΩ (in 100ppm CO).

Figure 3.1 shows the typical sensitivity characteristics of the MQ-7, ordinate means resistance ratio of the sensor (Rs/Ro), abscissa is concentration of gases. Rs means resistance in different gases, Ro means resistance of sensor in 1000ppm Hydrogen. All test are under standard test condition .

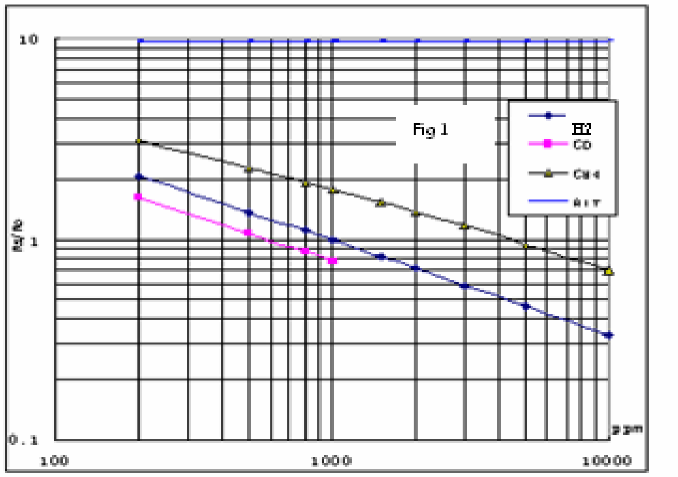

Figure3.1: MQ-7 characteristics

3.3.2 So Gas Sensor

The main features of SO gas sensor are :

(1) Concentration range is 1-200ppm (SO_2).

(2) Vc: 5.0V ± 0.1V.

(3) Sensing resistance 2KΩ - 20KΩ (in 50ppm SO_2).

Figure 3.2 shows the typical sensitivity characteristics of the MQ136, ordinate means resistance ratio of the sensor (Rs/Ro), abscissa is concentration of gases. Rs means resistance in different gases, Ro means resistance of Rs means sensor in 50ppm SO_2. All test are under standard test conditions.

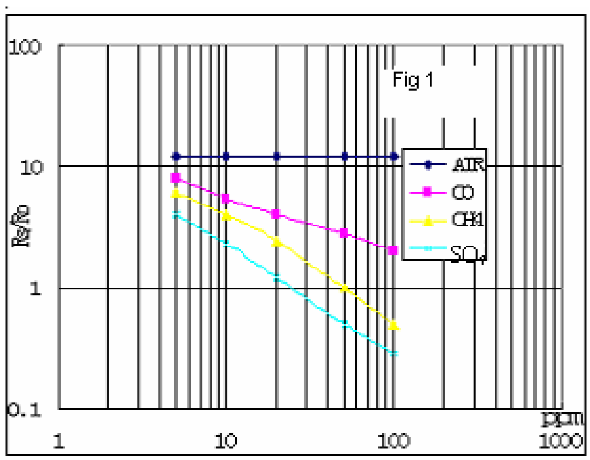

Figure 3.2: MQ136 characteristics

3.3.3 No gas sensor

Detection range from 0 to 30ppm and the Maximum Overload Range is 150ppm. Figure 3.3 shows the NO gas sensor characteristic.

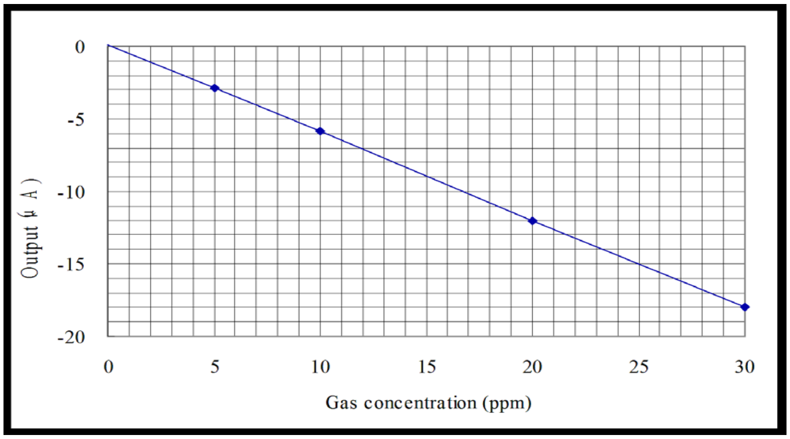

Figure 3.3: No gas sensor characteristic

3.3.4 Particles Sensor

The main features of particles are :

(1) Operating Supply voltage (Vc) is 5 ± 0.5V.

(2) Sensitivity between 0.35 to 0.6V/(0.1 mg/m^3).

Figure 3.4 shows the dust sensor characteristic .

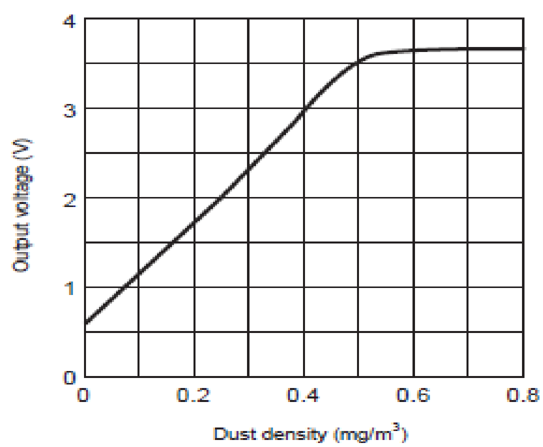

Figure 3.4: Dust sensor characteristic

3.3.5 Humidity sensor

It operate with rated 5V DC, operating temperature between 0 to 60 Celsius and humidity between 30-90% RH. Figure 3.5 shows the humidity sensor characteristic.

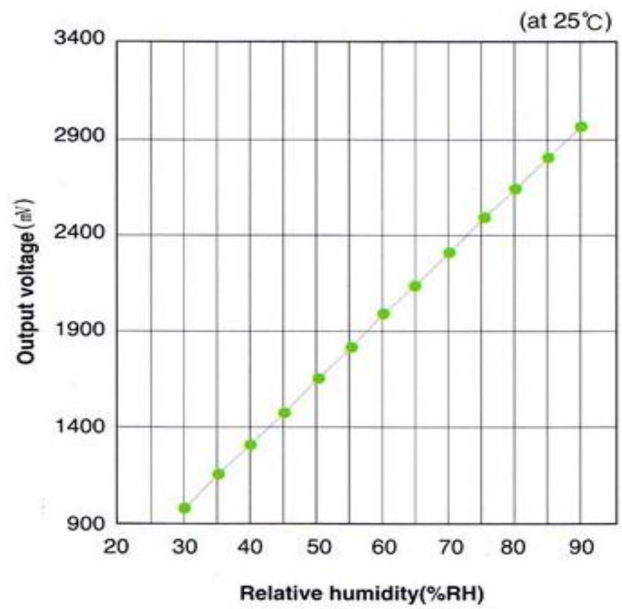

Figure 3.5: Humidity sensor characteristic

3.3.6 Temperature Sensor

It operates from 4 to 30V. It has an output voltage that is proportional to the Celsius temperature. The scale factor is .01V/^{o}C. It does not require any external calibration or trimming and maintains an accuracy of +/-0.4 ^{o}C at room temperature and +/- 0.8 ^{o}C over a range of 0 ^{o}C to +100 ^{o}C.also it is low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air. Figure 3.6 shows the LM35 sensor.

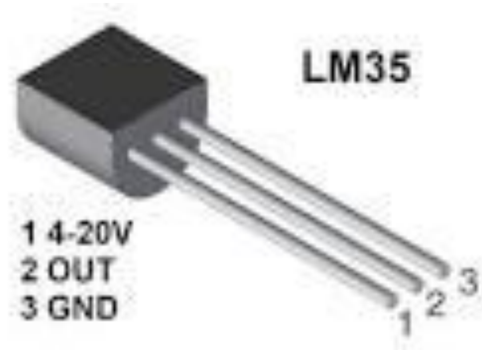

Figure 3.6: LM35 sensor

3.4 Control Unit

It contain the microcontrollers that receive and transmit the signals to the interface for monitoring wirelessly using zigbee technology.

3.4.1 Microcontroller

It is a small computer chip that called embedded controllers. Atmega 32 bit microcontroller one of the types which has a self-programmable flash program memory (32kbytes) in system, 1024 bytes EEPROM , 2Kbyte internal SRAM, CPU 8 bits AVR and speed 16MHZ. It has 40 pins with 32 programmable I/O lines. It is operate with 4.5V-5.5V for ATmega32 in 25c.

It has 4 ports A,C and D with an analog to digital convertor ports for analog inputs . Figure 3.7 explains AVR controller the pins clearly.

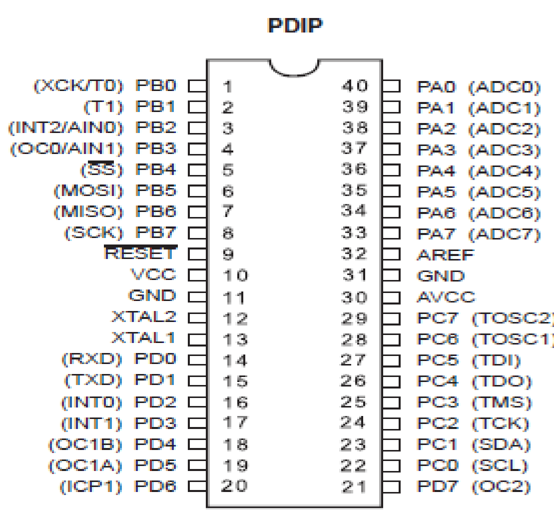

Figure 3.7 :AVR Microcontroller

3.4.2 Zigbee module

It is an IEEE 802.15.4-based specification for a suite of high-level communication protocols used to create personal area networks with small, low-power digital radios, such as for home automation, medical device data collection, and other low-power low-bandwidth needs, designed for small scale projects which need wireless connection.the frequency bands is 2.4GHz, 868MHz and 915MHz. The transmission distance is between 10 to 100 meters of sight depending on power output and environmental characteristics. The low cost allows the technology to be widely deployed in wireless control and monitoring applications, the low power-usage allows longer life with smaller batteries, and the mesh networking which promises high reliability and larger range. ZigBee has-been developed to meet the growing demand for capable wireless networking between numerous low power devices.

3.5 Methodology

The system contain two parts one which is in the site that we specified it to make measurement and the other is in the station that collect the data which is emitted from these location. The first part contain multi gas sensors that interfaced with microcontrollers to process the analog signal to be send to the microcontroller in the station . The data will be send in serial way wirelessly using zigbee module that transfer it to the another microcontroller in a station. The second micro connected to the personal computer to be displayed in the graphical user interface (GUI) to let the observer monitoring the level of emission gases. Figure 3.8 show the system design and the components .

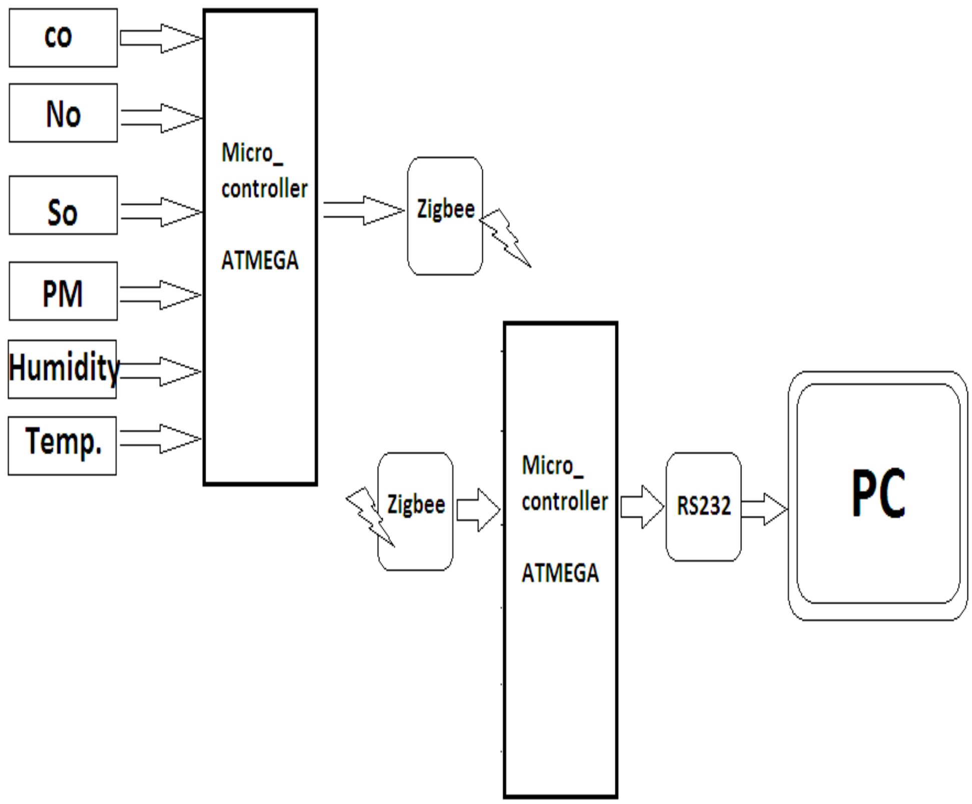

Figure 3.8: Schematic diagram for the monitoring system

The microcontroller connected to the personal computer using serial module RS232 standard. RS232 sends a one bit in a line a long a time. It has two lines one to transmit and the other to receive and allows a bit rate of 19600bps for a maximum distance of 20 meters. The electrical characteristics define the minimum and maximum voltages of logic ‘1’ and ‘0’ and it ranges from -3V to -25V but will be typically around -12V . Zero logic range from 3V to 25Vand one logic will range from -3V to -25V but if there is no pulse present in the line the voltage level is equivalent to a high level that is -12V as shown in figure 3.9.

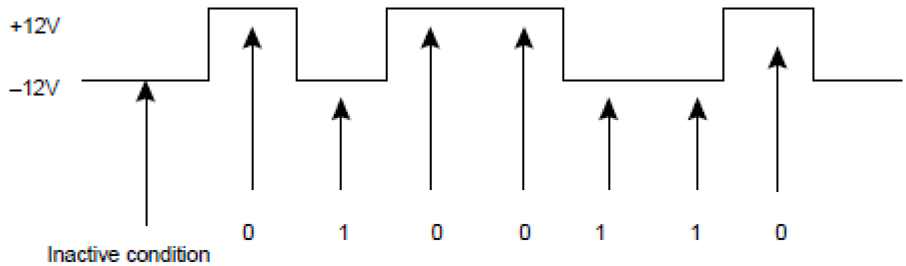

Figure 3.9: RS-232 voltage level

The RS232 in Figure 3.10 has a various connector but the smallest one has 9 pins D type connector which has a male outer casing with female connection pins. The DTE (the computer) has the female outer casing with female connecting pins. The PC has a communication port to connect in a serial way. The Table 3.2 show the abbreviation and functionality of RS232 bins.

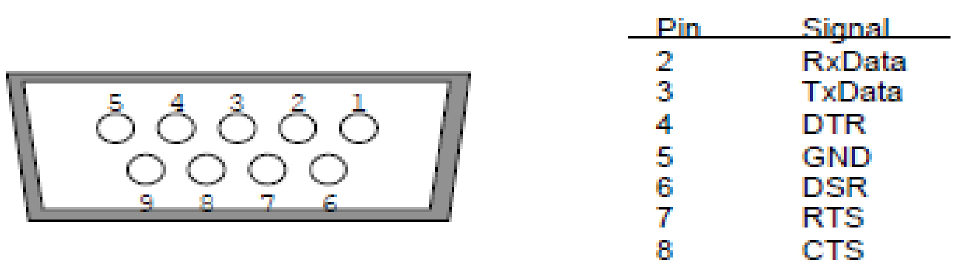

Figure 3.10 RS-232 pins

Table 3.2 RS-232 abbreviation and Functionality

Number	Name	Abbreviation	Functionality
1	Frame Ground	FG	This ground normally connects the outer sheath of the cable and to earth ground .
2	Transmit Data	TD	Data is sent from the DTE(computer or terminal) to a DCE via TD .

3	Receive Data	RD	Data is sent from the DCE(computer or terminal) to a DTE via RD .
4	Request To Send	RTS	DTE sets this active wen it is ready to transmit data .
5	Clear To Send	CTS	DCE sets this active to inform the DTE that is ready to receive data .
6	Data Set Ready	DSR	Similar functionality to CTS but activated by the DTE when it is ready to receive data .
7	Signal Ground	SG	All signals are referenced to the signal ground (GND) .
8	Data Terminal Ready	DTR	Similar functionality to RTS but activated by the DCE when it wishes to transmit data .

CHAPTER FOUR

SIMULATION and RESULT

Chapter four

Simulation and result

4.1 Case study

In these chapters all the characteristics of the gases sensors will be simulated and appear its behavior according to the increase and decrease the amount of gases . One of the simulation programs is proteus which is provide the user the ability to observe the levels of gasses in the plant that you study it and it is fast, accurate and flexible in using . This program simulate using a microcontroller that programmed using Bascom program to make the microcontroller ready for simulation .The Protues also connected with the graphical user interface GUI in MATLAB program to show the results and the readings of multi sensors .

4.2 System Identification

An Atmega 32 AVR microcontroller for carrying out the required data. It has built with an analog to digtal Convertor to carry the analog data from the sensors to itself to process it. Also it has a send and receive serial pins that connected with zigbee module to transmit data wirelessly to the station from the plant that you put the detection system and other in the output of the gas filter to notice the amount of filtering the particles and dust that it result. The receiver of the zigbee module connected in a serial way to the personal computer using RS232 protocol to show the result in the GUI.

The readings of gases that get from the sensor will be compared in the MATLAB with a set point which is the limit that you have not to exceed according to the standard. The reading must be within the a specified limit otherwise the MATLAB will alarm the user to make an action to change the filter of the system. In the same time that the GUI appear the readings as a numbers the GUI show the reading in an axes as a graph in different color to observed easily. Figure 4.1shows the simulation using Proteus.

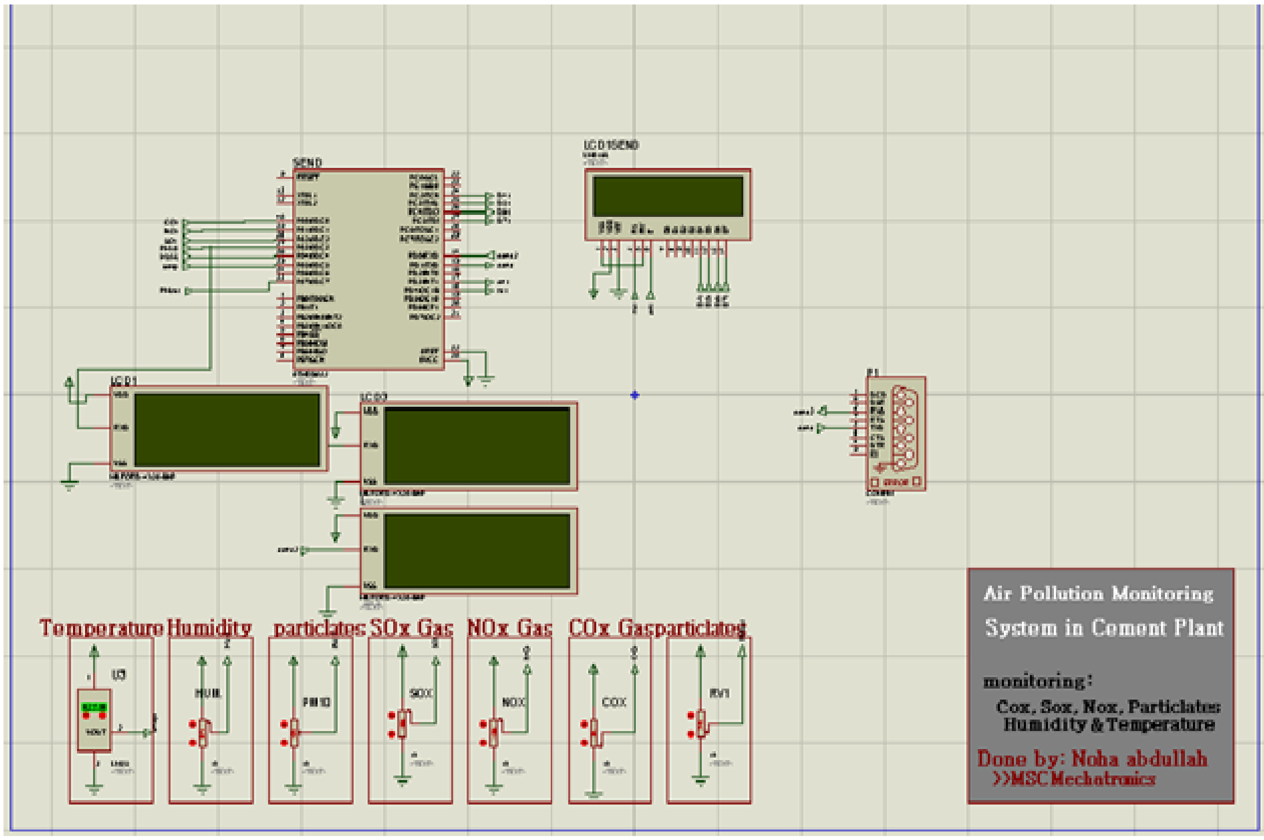

Figure 4.1: Protues Simulink

An AVR microcontroller shown in the Figure 4.1 connected to a temperature sensor, humidity sensor ,particles sensor ,sulfer dioxide sensor, nitrogen sensor, carbon dioxide sensor and the particles sensor in the output of dust filter all of it appear in the 16*2 LCD. The graphical user interface shown in the figure 4.2 explains the result in text and graphical way when the user run the program .

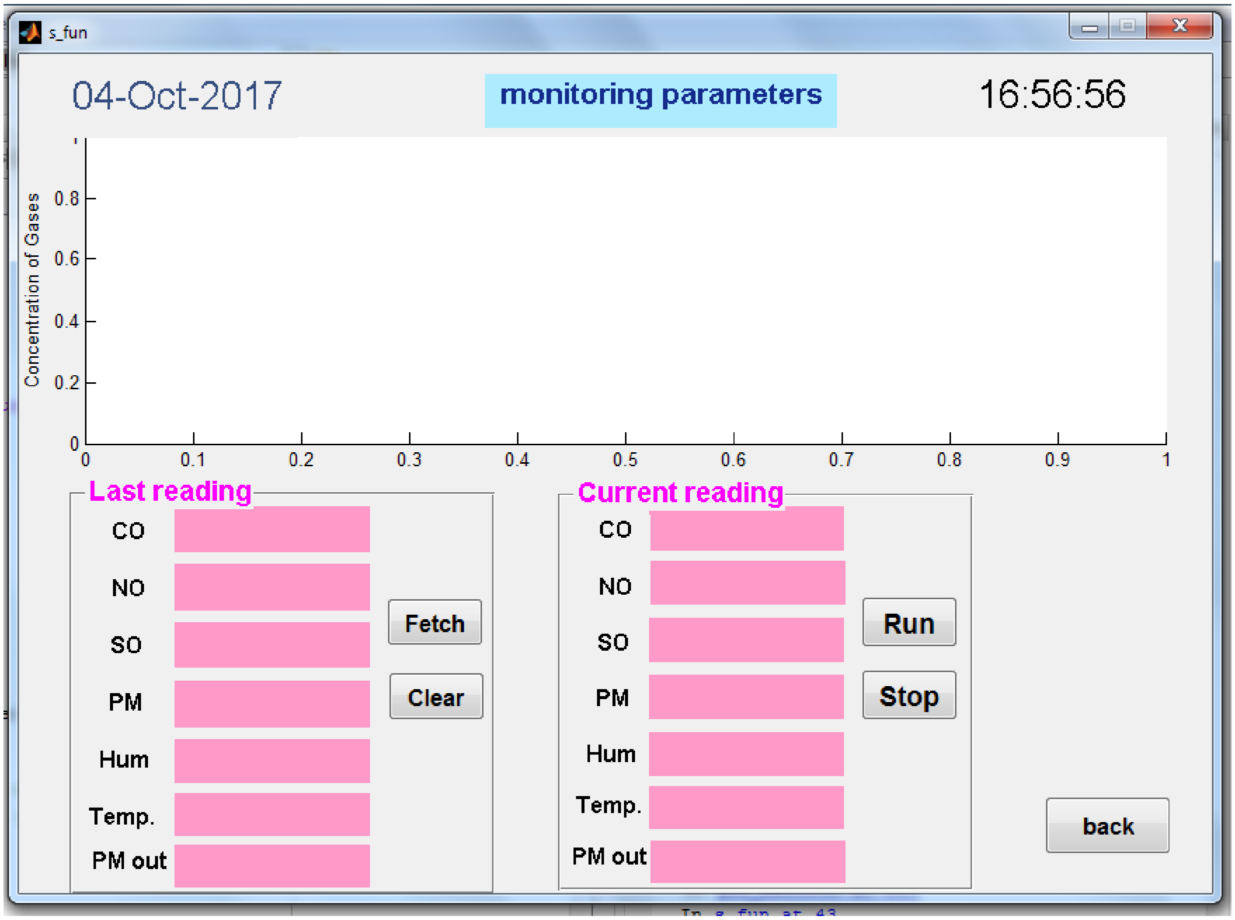

Figure4.2: The monitoring interface

The interface in Figure 4.2 will help the user to monitor the gases intensity in PPM in the plan. Also it save the last results in a history and it can fetched when you need which help the user to compare between the two result . Each gas has a color to be clear in observing .

In the main interface accessing as shown in Figure 4.3 and Figure 4.4 below you can enter the program by entering the name and password the you save it before and you can get some information and other thing .

Figure 4.3: Main interface

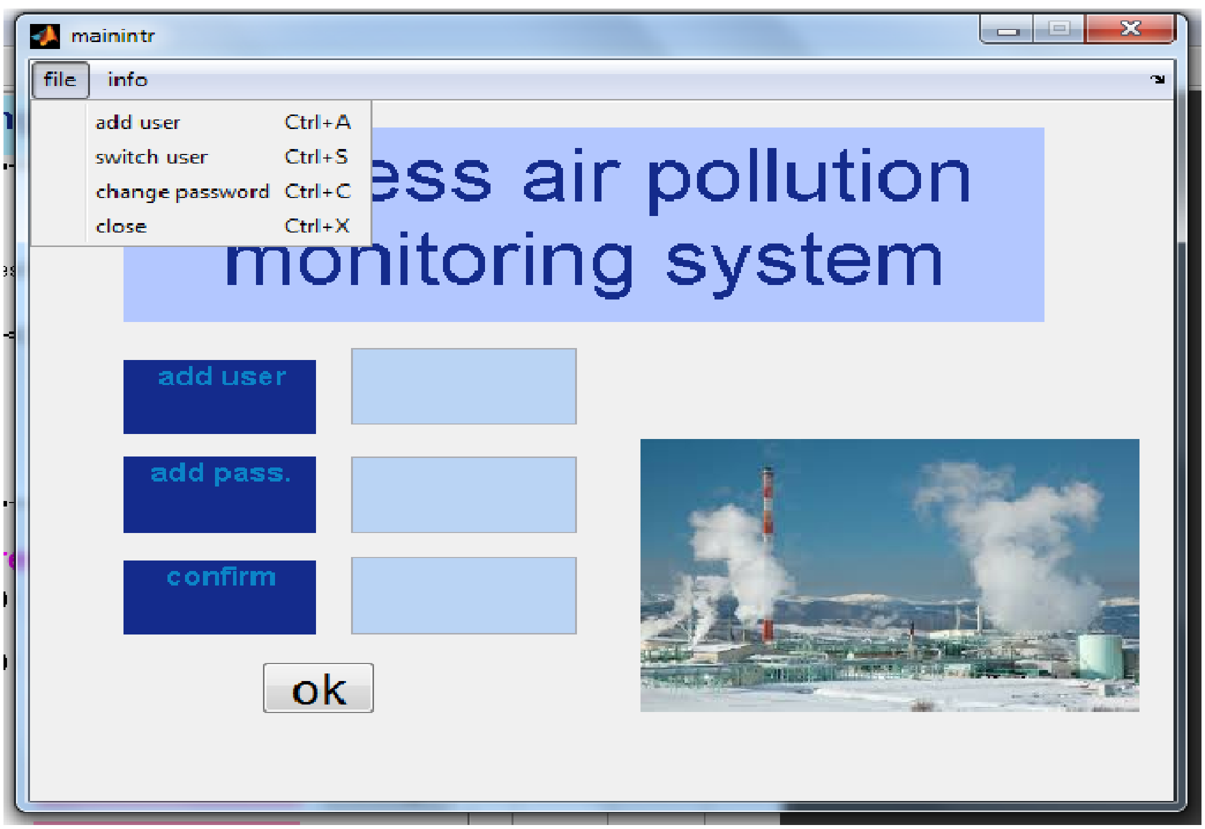

Figure 4.4: Main interface show the user entering

4.3 System analysis

The simulation will simulate the real sensor characteristic behavior in the cement plant to observe the increase and decrease of the gases concentration. When the potentiometer will be increase that mean the amount of gas increase in the other hand the program will show it until will reach the limit that must not exceed as in the standard shown in chapter three Table 3.1.

There is two sensor of particles one in the plant and the other in the exit of dust filter. This will compare between the input and the output to see the efficiency of the filter. If the output not differ from the input that mean the filter must be changed or cleaned from the dust and it is not affective to be used. Figure 4.5 shows the flow chart of proposed system.

4.4 Operation

The system can be classified into two stages, firstly the stage of clear air and small concentration and the secondly the stage of saturation.

4.4.1 in the clear air

The gases are in the normal and less than normal amount that mean good and will not make any pollution in the air . In the simulation the sensors will work with less voltage . The Table 4.1 shows the PPM in the less voltage.

Table 4.1: Gases in clear air

Num.	Gas	Concentration
1	CO	61.8 PPM
2	NO	6.75 PPM
3	SO	825.8 PPM

4	PM in	0 PPM
5	HUM.	93.9 %
6	Temp.	47
7	PM out	0 PPM

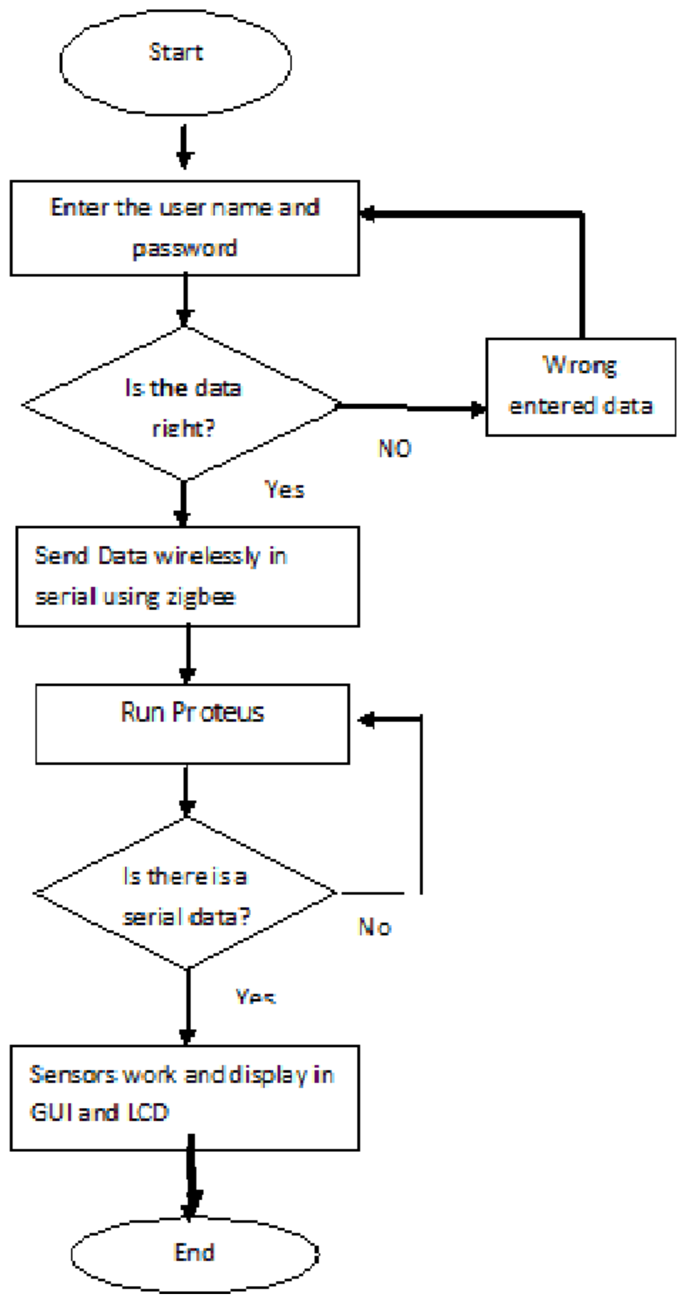

Figure 4.5: Flow chart of proposed system

4.4.2 In the polluted air

The gases in the cement plant under the working will be polluted with gases and will saturated and exceed the limit. The numbers below in Table 4.2 are greater than the standard that specified for the cement plants in Sudan and appear in the GUI MATLAB as shown in Figure 4.6.

Table 4.2: Concentration of gases in the cement plant

Num.	Gas	Concentration
1	CO	61.8 ppm
2	NO	749.4 ppm
3	SO	406.6 ppm
4	PM in	41.6 ppm
5	HUM.	99.95%
6	Temp.	-
7	PM out	31.87 ppm

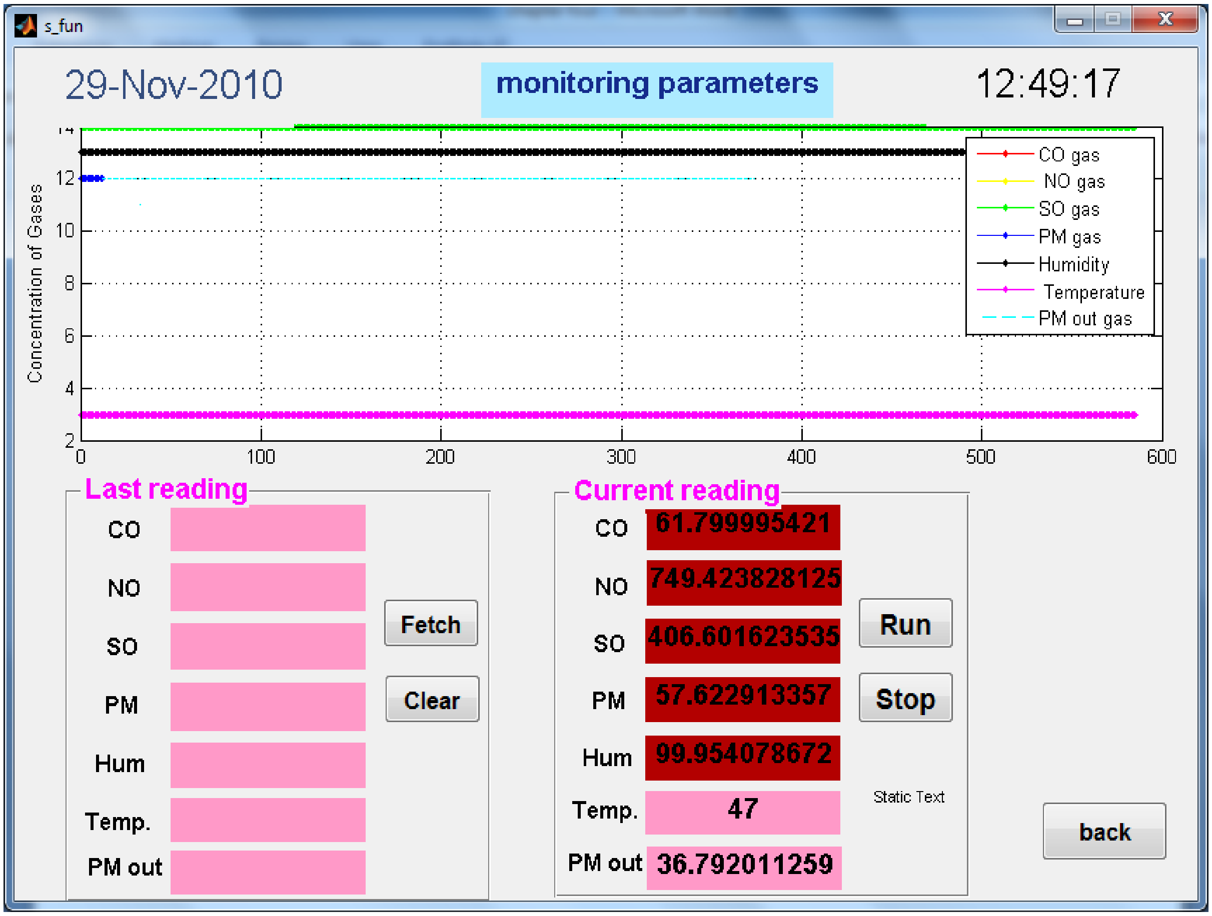

Figure 4.6: GUI data

CHAPTER FIVE
CONCLUSION and RECOMMENDATION

Chapter five

Conclusion and Recommendation

5.1 Conclusion

Measuring air pollution in cement plant has been discussed in this thesis to monitor and observe the pollution in the cement plants. The design include multi sensors like particulate sensor one in the plant and one in the output of filter, Co sensor, SO sensor, NO sensor, humidity sensor and temperature sensor which connecter to AVR Microcontroller .The system modeled using Proteus ISIS and GUI MATLAB to show the result of simulation . The simulation work in the range of sensor according to the concentration in the air.

5-2 Recommendation

- The system need buzzer to warn the user in high level of gases .
- Design a potable device to monitor the gases in the plant .

References

(1) Syed Sana Mehraj Balkhi , Cement Factories,Air Pollution and Consequences ,2013.

(2) xHendriks et al., “Assessment of Air Pollutants Emissions from a Cement Plant” , 1998.

(3) GodblessSwagarya1, Shubi Kaijage, Ramadhani S. Sinde, Air Pollution Monitoring System based on Wireless Networks –Simulation, 2014.

(4) Kamazura Othman, Norhayati Hamza, Norernina, Monitoring Carbon Monoxide Using Wireless Application, 2015.

(5) Parithielamvazhuthi R , Analysis of Air Pollutant Emission and Control System in Cement Industries around Ariyalur District,2013.

(6) AlkaDubey, Mohd Shamshad and Kamlesh Patel , Design and Implementation of Pollution Monitoring and Recording System Using Microcontroller,2013.

(7) GodblessSwagarya ,ShubiKaijage , Ramadhani S. Sinde , A Survey on wireless sensor networks application for air pollution monitoring” , 2014 .

(8) Eurepean Environmental Agency ,Air quality in Europe Report , 2016 .

Appendix

programs

A.1 Bascom code

```
'Bascom program for the project of Air pollution monitoring system in cement plant"
'Requirement of the degree of M.sc in Mechatronics Engineering done by Noha Abdullah
$regfile = "m32def.dat"
$crystal = 2000000
$baud = 9600
$hwstack = 32
$swstack = 10
$framesize = 40
'************************config lcd and ADC
Config Lcdpin = Pin , Db4 = Portc.2 , Db5 = Portc.3 , Db6 = Portc.4 , Db7 = Portc.5 , E = Portd.3 , Rs = Portd.4
Config Lcd = 16 * 2
Config Adc = Single , Prescaler = Auto , Reference = Avcc
Config Portd.1 = Output
'Enable Adc
Start Adc
'************************ dimension of variables
Dim W As Integer , A As Single , Lm As Integer , O As Word
Dim X As Integer , B As Single , Z As Integer , D As Single
```

```
Dim Y As Integer , C As Single , H As Integer , E As Single
Dim Ee As Single , Eee As Single , Z1 As Integer , D1 As Single
Dim Aa As Single , Bb As Single , Cc As Single , Aaa As Single
Dim Dd As Single , Bbb As Single , Ccc As Single , Ddd As Single
Dim Dd1 As Single , Dd21 As Single
Config Portd.1 = Output
'*************************serial port and get analog data
Wait 2
 Open "comd.1:9600,8,n,1" For Output As #1

Again:
O = Waitkey()
If O = 1 Then
'*******co concetrtion
W = Getadc(0)
A = W * 5
A = A / 1024
Aa = A * 0.4
Aa = Aa + 4
Aaa = Aa * -2196
Aaa = Aaa + 14964
Aaa = Aaa / 100
Lcd "CO=" ; Aaa
Print Aaa
Cls
'*******no concetrtion
 X = Getadc(1)
B = X * 5
```

```
B = B / 1024
Bb = B * -3.6
Bbb = Bb * -1.652
Bbb = Bbb + 0.270
Bbb = Bbb * 25
Lcd "NO=" ; Bbb
Print Bbb
Cls
'*******so concetrtion
 Y = Getadc(2)
C = Y * 5
C = C / 1024
Cc = C * 7.6
Ccc = Cc * -10.95
Ccc = Ccc + 825.8
Ccc = Ccc / 2
Lcd "SO=" ; Ccc
Print Ccc
Cls
'*******pm10 concetrtion
 Z = Getadc(3)
D = Z * 5
D = D / 1024
Dd = D * 0.62
Dd = Dd + 0.6
Dd = Dd ^ 1.834
Ddd = Dd * 5.238
Lcd "pm10=" ; Ddd
```

```
Print Ddd
Cls
'*******humidity concetrtion
 H = Getadc(4)
E = H * 5
E = E / 1024
Ee = E * 0.01212
Eee = Ee + 0.939
Eee = Eee * 100
Lcd "humidity=" ; Eee
Print Eee
Cls
'*******temperature concetrtion
Lm = Getadc(5)
Lm = Lm / 2

Lcd "temp.=" ; Lm
Print Lm
Cls

'*******pm10 concetrtion in the output of filter
 Z1 = Getadc(7)
D1 = Z1 * 5
D1 = D1 / 1024
Dd1 = D1 * 0.62
Dd1 = Dd1 + 0.6
Dd1 = Dd1 ^ 1.834
Dd21 = Dd1 * 5.238
```

```
Lcd "pm10=" ; Dd21
Print Dd21
Cls
Goto Again
Else
Cls
  If O = 1 Then
  Goto Again
          End If
End If
```

A.2 Matlab Code

mainintr.m

```
% --- Executes just before mainintr is made visible.
function mainintr_OpeningFcn(hObject, eventdata, handles, varargin)
% This function has no output args, see OutputFcn.
% hObject    handle to figure
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
% varargin   command line arguments to mainintr (see VARARGIN)

% Choose default command line output for mainintr
handles.output = hObject;

handles.figure1=s_fun;
h1=guidata(handles.figure1);
h1.backpbs2=hObject;
```

```
guidata(handles.figure1,h1);
set(handles.figure1,'visible','off');

% Update handles structure
guidata(hObject, handles);
[x,map]= imread('plant.jpg');
      axes(handles.axes2);
   set(handles.axes2,imshow(x,map));
% UIWAIT makes mainintr wait for user response (see UIRESUME)
% uiwait(handles.figure1);



% --- Outputs from this function are returned to the command line.
function varargout = mainintr_OutputFcn(hObject, eventdata, handles)
% varargout  cell array for returning output args (see VARARGOUT);
% hObject    handle to figure
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Get default command line output from handles structure
varargout{1} = handles.output;

% --------------------------------------------------------------------
function adduser_callback_Callback(hObject, eventdata, handles)
% hObject    handle to adduser_callback (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
set(handles.text14,'visible','on');
```

```
set(handles.text13,'visible','on');
set(handles.text15,'visible','on');
set(handles.edit3,'visible','on');
set(handles.text3,'visible','off');
set(handles.text6,'visible','off');
set(handles.pushbutton1,'visible','off');
set(handles.pushbutton7,'visible','on');



% --------------------------------------------------------------------
function close_callback_Callback(hObject, eventdata, handles)
% hObject    handle to close_callback (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
%delete(handles.figure1);
delete(handles.output);
% --- Executes during object creation, after setting all properties.
function text1_CreateFcn(hObject, eventdata, handles)
% hObject    handle to text1 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called
set(hObject,'string','wireless air pollution monitoring system');



% --- Executes during object creation, after setting all properties.
function text6_CreateFcn(hObject, eventdata, handles)
% hObject    handle to text6 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
```

```
% handles    empty - handles not created until after all CreateFcns called

set(hObject,'string','user name');

function edit1_Callback(hObject, eventdata, handles)
% hObject    handle to edit1 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Hints: get(hObject,'String') returns contents of edit1 as text
%        str2double(get(hObject,'String')) returns contents of edit1 as a double

name=get(hObject,'string');
% --- Executes during object creation, after setting all properties.
function edit1_CreateFcn(hObject, eventdata, handles)
% hObject    handle to edit1 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end
```

```
function edit2_Callback(hObject, eventdata, handles)
% hObject    handle to edit2 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Hints: get(hObject,'String') returns contents of edit2 as text
%        str2double(get(hObject,'String')) returns contents of edit2 as a double
pass=get(hObject,'string');



% --- Executes during object creation, after setting all properties.
function edit2_CreateFcn(hObject, eventdata, handles)
% hObject    handle to edit2 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end



% --- Executes on button press in pushbutton1.
function pushbutton1_Callback(hObject, eventdata, handles)
% hObject    handle to pushbutton1 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
```

```
% handles    structure with handles and user data (see GUIDATA)

name=get(handles.edit1,'string');
pass=get(handles.edit2,'string');
a=str2double(name);
b=str2double(pass);
n=xlsread('user.xls','user1','A1:A1');
o=xlsread('user.xls','user1','B1:B1');

if a==n && b==o

    set(handles.figure1,'visible','on');
    set(handles.output,'visible','off');
set(handles.edit1,'string',' ');
set(handles.edit2,'string',' ');
else

    msgbox('wrong password ,,try again');
end
guidata(hObject,handles);
% --------------------------------------------------------------------
function info_callback_Callback(hObject, eventdata, handles)
% hObject    handle to info_callback (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
%out = dialog('WindowStyle', 'normal', 'Name', 'information');
myicon = imread('pollution.jpg');
```

```
out = msgbox('Its an application to monitor the concentration of gases in a cement plant,so this will measure the CO,NO,SO,particulars, humidity and temperature all of that to Facilitate the way of monitoring... ','information','custom',myicon);
% --- Executes during object creation, after setting all properties.
function text3_CreateFcn(hObject, eventdata, handles);
% hObject    handle to text3 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called
set(hObject,'string','password');


% --- Executes when user attempts to close figure1.
function figure1_CloseRequestFcn(hObject, eventdata, handles)
% hObject    handle to figure1 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
% Hint: delete(hObject) closes the figure
pos_size=get(handles.figure1,'position');
user_response=questdlg('do you want to close this program','cofirm close');
switch user_response
    case {'Yes'}
        delete(hObject);

    case 'No'
        %nothing will happen
end
```

```
% --- Executes on button press in pushbutton2.
function pushbutton7_Callback(hObject, eventdata, handles)
% hObject    handle to pushbutton2 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
a=get(handles.edit1,'string');
b=get(handles.edit2,'string');
c=get(handles.edit3,'string');
x={a b c}
xlswrite('user.xls',x,'user1');
if b==c
set(handles.text14,'visible','off');
set(handles.text15,'visible','off');
set(handles.edit3,'visible','off');
set(handles.text13,'visible','off');
set(handles.text3,'visible','on');
set(handles.text6,'visible','on');
set(handles.pushbutton1,'visible','on');
set(handles.pushbutton7,'visible','off');
set(handles.edit1,'string',' ');
set(handles.edit2,'string',' ');
set(handles.edit3,'string',' ');
else
  msgbox('the password and the confirmation not the same');


end
```

S-fun.m

```
% --- Executes just before s_fun is made visible.
function s_fun_OpeningFcn(hObject, eventdata, handles, varargin)
% This function has no output args, see OutputFcn.
% hObject    handle to figure
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
% varargin   command line arguments to s_fun (see VARARGIN)
global s
% Choose default command line output for s_fun
handles.output = hObject;
handles.backpbs2=1;

% Update handles structure
guidata(hObject, handles);
 set(handles.text4,'string',datestr(now,'HH:MM:SS'));
set(handles.text5,'string',date);
xlabel('Time');
ylabel('Concentration of Gases');
legend('CO gas',' NO gas', 'SO gas', 'PM gas', 'Humidity',' Temperature')

%x=upd_datestr(now,'HH:MM:SS');

guidata(hObject, handles);
```

```
% --- Outputs from this function are returned to the command line.
function varargout = s_fun_OutputFcn(hObject, eventdata, handles)
% varargout  cell array for returning output args (see VARARGOUT);
% hObject    handle to figure
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Get default command line output from handles structure
varargout{1} = handles.output;



% --- Executes on button press in mainpbs1.
function mainpbs1_Callback(hObject, eventdata, handles)
% hObject    handle to mainpbs1 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)



% --- Executes on button press in backpbs2.
function backpbs2_Callback(hObject, eventdata, handles)
% hObject    handle to backpbs2 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
global s
set(handles.backpbs2,'visible','on');
set(handles.output,'visible','off');
%           fclose(s);
```

```
        delete(instrfindall);

% --- Executes on selection change in popupmenu1.
function popupmenu1_Callback(hObject, eventdata, handles)
% hObject    handle to popupmenu1 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Hints: contents = cellstr(get(hObject,'String')) returns popupmenu1 contents as
cell array
%        contents{get(hObject,'Value')} returns selected item from popupmenu1



% --- Executes during object creation, after setting all properties.
function popupmenu1_CreateFcn(hObject, eventdata, handles)
% hObject    handle to popupmenu1 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

% Hint: popupmenu controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'),
get(0,'defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end
```

```
function edits1_Callback(hObject, eventdata, handles)
% hObject    handle to edits1 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Hints: get(hObject,'String') returns contents of edits1 as text
%        str2double(get(hObject,'String')) returns contents of edits1 as a double



% --- Executes during object creation, after setting all properties.
function edits1_CreateFcn(hObject, eventdata, handles)
% hObject    handle to edits1 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end



% --- Executes when user attempts to close figure4.
function figure4_CloseRequestFcn(hObject, eventdata, handles)
% hObject    handle to figure4 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
```

```
% handles    structure with handles and user data (see GUIDATA)

% Hint: delete(hObject) closes the figure
global s
%fclose(s);
            delete(instrfindall);
delete(hObject);
close all

% --- Executes during object deletion, before destroying properties.
function mainpbs1_DeleteFcn(hObject, eventdata, handles)
% hObject    handle to mainpbs1 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)




% --- Executes during object creation, after setting all properties.
function text4_CreateFcn(hObject, eventdata, handles)
% hObject    handle to text4 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called


% --- Executes during object creation, after setting all properties.
function text5_CreateFcn(hObject, eventdata, handles)
```

```
% hObject    handle to text5 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called


% --- Executes during object creation, after setting all properties.
function co_CreateFcn(hObject, eventdata, handles)
% hObject    handle to co (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called



% --- Executes during object creation, after setting all properties.
function no_CreateFcn(hObject, eventdata, handles)
% hObject    handle to no (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called


% --- Executes during object creation, after setting all properties.
function so_CreateFcn(hObject, eventdata, handles)
% hObject    handle to so (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called


% --- Executes during object creation, after setting all properties.
```

```
function pm_CreateFcn(hObject, eventdata, handles)
% hObject    handle to pm (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called


% --- Executes during object creation, after setting all properties.
function temp_CreateFcn(hObject, eventdata, handles)
% hObject    handle to temp (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called


% --- Executes during object creation, after setting all properties.
function hum_CreateFcn(hObject, eventdata, handles)
% hObject    handle to hum (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called



% --- Executes during object creation, after setting all properties.
function axes1_CreateFcn(hObject, eventdata, handles)
% hObject    handle to axes1 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

% Hint: place code in OpeningFcn to populate axes1
```

```
% --- Executes on button press in fetch.
function fetch_Callback(hObject, eventdata, handles)
% hObject    handle to fetch (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
global o p q r t u v
 [ndata, headertext] = xlsread('yoyo.xls','z1','A1:B1:C1:D1:E1:F1:G1')
%co
[n,y] = xlsread('yoyo.xls','z1','A1:A1');
set(handles.txt12,'string',y);
%no
[n,y1] = xlsread('yoyo.xls','z1','B1:B1')
set(handles.txt13,'string',y1);
%so
[n,y2] = xlsread('yoyo.xls','z1','C1:C1')
set(handles.text14,'string',y2);
%pm
[n,y3] = xlsread('yoyo.xls','z1','D1:D1')
set(handles.text15,'string',y3);
%humidity
[n,y4] = xlsread('yoyo.xls','z1','E1:E1')
set(handles.text17,'string',y4);
%temp
[n,y5] = xlsread('yoyo.xls','z1','F1:F1')
set(handles.text16,'string',y5);
%pmout
[n,y6] = xlsread('yoyo.xls','z1','G1:G1')
```

```
set(handles.text34,'string',y6);
% --- Executes on button press in clear.
function clear_Callback(hObject, eventdata, handles)
% hObject    handle to clear (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
set(handles.txt12,'string',' ');
set(handles.txt13,'string',' ');
set(handles.text14,'string',' ');
set(handles.text15,'string',' ');
set(handles.text17,'string',' ');
set(handles.text16,'string',' ');
set(handles.text34,'string',' ');

% --- Executes on button press in run.
function run_Callback(hObject, eventdata, handles)
% hObject    handle to run (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
global s
global stop
 i=0;
  for i=0:inf

 set(handles.text4,'string',datestr(now,'HH:MM:SS'));
set(handles.text5,'string',date);
delete(instrfindall);
s=serial('com2','baudrate',9600);
```

```
fopen(s);
%fscanf(s,'99')
fprintf(s,1);
o=fgetl(s);
set(handles.co,'string',o);
 o0=str2num(get(handles.co,'string'));
if o0>= 43.65
    set(handles.co,'BackgroundColor',[.7 0 0]);
else
    set(handles.co,'string',o);
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
p=fgetl(s);
set(handles.no,'string',p);
pp=str2num(get(handles.no,'string'));
if pp>= 523.8
    set(handles.no,'BackgroundColor',[.7 0 0]);
else
    set(handles.no,'string',p);
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
q=fgetl(s);
 set(handles.so,'string',q);
qq=str2num(get(handles.so,'string'));
if qq>= 349.2
    set(handles.so,'BackgroundColor',[.7 0 0]);
else
   set(handles.so,'string',q);
```

```
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
r=fgetl(s);
set(handles.pm,'string',r);
rr=str2num(get(handles.pm,'string'));
if rr>=50
    set(handles.pm,'BackgroundColor',[.7 0 0]);
else
   set(handles.pm,'string',r);
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
t=fgetl(s);
set(handles.hum,'string',t);
tt=str2num(get(handles.hum,'string'));
if tt>=60
    set(handles.hum,'BackgroundColor',[.7 0 0]);
else
   set(handles.hum,'string',t);
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
u=fgetl(s);
set(handles.temp,'string',u);
v=fgetl(s);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
set(handles.pmout,'string',v);
o0=str2num(get(handles.pmout,'string'));
if o0>=523.8
    set(handles.pmout,'BackgroundColor',[.7 0 0]);
```

```
else
   set(handles.pmout,'string',v);
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%save data
nn={o p q r t u v};
xlswrite('yoyo.xls', nn,'z1');
  fclose(s);
  pause(0.01)

% plot data
        global o,p,q,r,t,u,v

plot(i,length(o),'r.-','linewidth',0.5)
hold on
plot(i,length(p),'y.-','linewidth',0.5)
hold on
plot(i,length(q),'g.-','linewidth',0.5)
hold on
plot(i,length(r),'b.-','linewidth',0.5)
hold on
plot(i,length(t),'k.-','linewidth',0.5)
hold on
plot(i,length(u),'m.-','linewidth',0.5)
hold on
plot(i,length(v),'c--','linewidth',0.5)
   xlabel('Time');
ylabel('Concentration of Gases');
```

```
legend('CO gas',' NO gas', 'SO gas', 'PM gas', 'Humidity',' Temperature','PM out gas')

    grid on

hold on

  end

% --- Executes on button press in stop.
function stop_Callback(hObject, eventdata, handles)

global stop
% hObject    handle to stop (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
global s y
set(handles.text38,'string',1)

         stopp=get(handles.text38,'value')
        % pause(0.01)
if stopp==1
    set(handles.run,'value',0)
   set(handles.run,'',[.6 0 0]);

else
end
y=get(handles.stop,'value')
```

```
s=serial('com2','baudrate',9600);
fopen(s);
fprintf(s,2);
 fclose(s);
delete(instrfindall);
set(handles.co,'string',' ');
set(handles.no,'string',' ');
set(handles.so,'string',' ');
set(handles.pm,'string',' ');
set(handles.hum,'string',' ');
set(handles.temp,'string',' ');
set(handles.pmout,'string',' ');

% --- Executes during object deletion, before destroying properties.
```