Remote Monitoring of Air & Noise Pollution through Android Application

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***Abstract*: Major factors of environmental pollution as air and noise pollution have long been a genuine issue of every nation whether it is developed or developing like Pakistan. As Pakistan is far-off updated analyzing and monitoring air and noise pollution equipment's. Modern urbanization and industrial societies are vastly growing and causing harmful impacts on human health. In order to tackle off this bad situation the advanced, portable, cheap and real time monitoring system for Remote Monitoring of Air & Noise pollution through Android Application is proposed here. The system consist of 8 sensors (MICS-4514, MQ-135 136, 9, 5, 4, DHT-11, LM-393 and Dust) which monitors SO_2, NO_2, CO, CO_2, CH_4, $PM_{2.5}$, temperature, noise, combustible and leak gases present in surrounding and transfer this data towards the microprocessor which analyze and transmit the data over server through the WIFI connectivity for 24-hours/day. But when there is the unavailability of WFI the GSM module transfers the data towards the end user in the form of SMS and Email. If the value of contamination increases from guideline values then the buzzer beeps and email or SMS is sent towards the end user. That will enable the User to get live readings in any weather at any time anywhere in the world.**

***Keywords*: Internet of things, Air and Noise pollution, Water quality, Remote monitoring system, Sensors Based, Raspberry pi.**

I. BACKGROUND

Quality of air is depleted as the humans are getting civilized. Depletion of air quality is not from today but it's from the last two centuries, but it gets worsened from the Industrial Revolution when industries, factories, different coal power plants were installed that contribute to the depletion of air quality. No doubt that industrialization did great damage to the environment during the second half of the 19th century. On the other hand, in this 21st Century things are not much different. Deteriorated air quality has caused Global warming, Climate change, Ozone depletion, Health problems and many other adverse impacts on environment. That are directly or indirectly relating to air pollution [1]. All leaders of the world agreeing on cutting down the emissions and other anthropogenic harmful actions they result in air pollution. Massive and serious actions are being taken to tackle this emergency situation. Different innovative, efficient and cost-effective mitigation measures are taken by implementing best technologies. However, these actions are taken when the situation gets worse. For instance, in US many coal power plants were emitting million tons of emissions every year which affects badly the people's health and the environment. After that, in 2013 US government takes measures for mitigation. This happens because there was no serious monitoring of Air quality. Though many air pollution monitoring systems and equipment's introduced for this purpose. That let you know the air quality of any area by just holding equips in the air, similarly for the noise. Along with monitoring systems are also existing that monitors the air quality without visiting the site by remote monitoring sensors based through IOT [2].

II. INTRODUCTION

Today, many advanced systems, techniques are present to monitor Air quality and Noise levels but, everywhere in the world it is not likely that these systems are available. In remote and urban areas where there is the unavailability of modern analyzing equipment's. This system is the alternate, provides Fastest and accurate monitoring. This paper presents such an air and noise monitoring system that is more effective, advanced, efficient, cost-effective, fastest and accurate. The idea is that, Sensor detects the pollution level in surrounding and transmit the data to microprocessor through ADC. Data collected by microprocessor is uploaded to server through WIFI module. If pollution level increases from NEQS the end user is informed by SMS, email and notification on the application. In the case when there is no availability of WIFI the data is transferred to the end user through GSM module. In the case when both the WIFI and cellular network are not available the data is stored in Memory card and when they get available the data is uploaded on the server [3].

- The ultimate goal and objective of this study is to develop and fabricate a fully functional IOT based monitoring of air & noise pollution through android system.
- To monitor the Air quality and Noise level of a remote areas by sensors through IOT environment.
- To obtain the real time air and noise pollution results in the respected areas over the cloud server also on android application

The system tends to be effective way for air and noise quality monitoring in many of the Sites such as Industries, National highway authority (NHA), Brick factories, and Coal mines power plants, commercial and residential areas. Also, it is necessary requirement of common people because it enables them to check whether they are living and breathing in a good and healthy air in the surroundings or not.

TABLE. 01

SOUND LEVEL METER	FLUE GAS ANALYZER (TESTO 350)	COMBUSTIBLE GAS DETECTOR	Drager Pac III (ANALYZER)	DI MONITRING SYSTEM (PROPOSED)
Requires human interaction to obtain the readings and it's an expensive device.	Requires human interaction to obtain the readings and it's an expensive device.	Requires human interaction to obtain the readings and it's an expensive device.	Requires human interaction to obtain the readings and it's an expensive device.	Doesn't require any human interaction to obtain the readings and it's a Relatively inexpensive device.
Manually operated works for **4-6 hours** and reading are displayed on the device screen.	Manually operated works for **6-8 hours** and reading are displayed on the device screen.	Manually operated works for **4-6 hours** and reading are displayed on the device screen.	Manually operated works for **4-6 hours** and reading are displayed on the device screen.	Automatically **24 hours** operated & reading are displayed on the device screen also on the web page & application.
Battery operated, cannot store data and upload it to server	Battery operated, can store data but can't upload it to server	Battery operated, cannot store data and upload it to server	Battery operated, cannot store data and upload it to server	Solar + battery operated, can store data as well upload it to server and notify the end user.
Only monitors sound quality and per sample cost is **1000 PKR.**	Monitors six air quality parameters (CO, CO2, NO, SO2, NO2) at a time and per sample cost is **2500 PKR.**	Monitors Combustible gasses at a time and per sample cost is **2000 PKR.**	Monitors single air quality parameter at a time (CO, NO2, SO2) and per sample cost is **2000 PKR.**	Monitors both sound and air quality at a time. (CO, CO2, NO, SO2, Smoke, Dust, CH4, Noise, Temp, Humidity and etc.) only installation cost to be considered.

A. Hardware Requirements

1) Raspberry pi 3B
2) ADC
3) PCB
4) MQ-135
5) MQ-9
6) MQ-5
7) MQ-4
8) MQ 136
9) LM-393
10) DHT-11
11) DUST Senor
12) MICS-4514
11) GSM SIM-800A
12) GSM POWER SUPPLY
12) SOLAR POWER BANK
13) BUZZER
15) JUMPER WIRES

B. Software Requirements

1) RASPBIAN
2) GEANY
3) PYTHON LANGUAGE

III. ADVANTAGES OF PROPOSED SYSTEM OVER EXISTING CONVENTIONAL SYSTEMS SS

VI. HARDWARE COMPONENTS OF SYSTEM

1) Raspberry Pi 3B

Raspberry Pi Foundation is world's largest UK based charity organization whose moto is to teach and instruct people in programing and to establish and make on step access to computing knowledge. Raspberry pi is the name given to series of microprocessor developed by Raspberry Pi Foundation. It is a small credit card size computer. IF add keyboard, mouse, micro SD card, power supply with linux distribution the small computer is ready that can run the applications from word processors and spreadsheets to games. It also gives the set of GPIO that can allow the electronic components for physical computing like sensors and also provide internet cable [4]. Fig: 1 shows Diagram of Raspberry pi

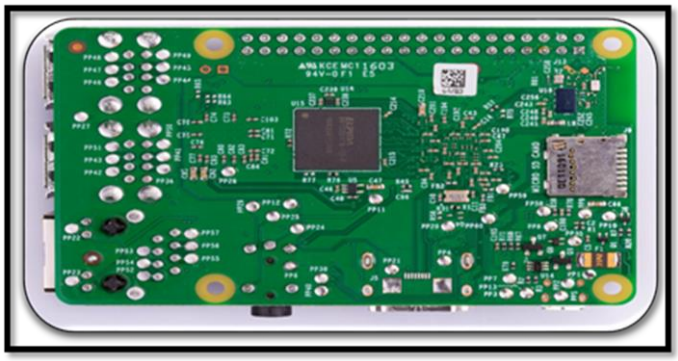

Fig 1: RASPBERRY PI 3B

2) *GSM SIM900A MODULE*

GSM stands for Global system for Mobile Communication. It is a mode of communication. It is a chip or circuit that is used to create communication between a mobile device and a computing machine. Bell Laboratories first introduces this idea in the late 19870's. This mobile communication system is innovative and widely used in the world. It is an open digital technology provides a mode of communication between system and operator. It enables the system to Send and receive calls and SMS [5]. Fig: 2 shows Diagram of GSM MODULE.

Fig 2: GSM SIM900A MODULE

3) *SENSORS*

i. MQ-4 SENSOR

It is used to sense the natural gas in the atmosphere with sensing limit of 300 to 10000 ppm. It consists of 4 pins for VCC, GND, DO and AO. This sensor requires minimum 5 volts for stable working. It is also known as semiconductor sensor. It is used to sense the natural gas in the atmosphere with sensing limit of 300 to 10000 ppm. It consists of 4 pins for VCC, GND, DO and AO. This sensor requires minimum 5 volts for stable working. It is also known as semiconductor sensor [6]. As shown in Fig: 3(i).

ii. MQ-5 SENSOR

This sensor is most commonly known as leak gas detecting sensor. This sensor is used to detect the leak gasses in the atmosphere. When it is exposed to atmosphere it detects methane, coal gas and LPG. This sensor is semiconductor type sensor with a preheat time of over 48 hours with a loop and heating voltage of less than 24 and 5 volts respectively [7]. As shown in Fig: 3(ii).

iii. MQ-9 SENSOR

This sensor is most commonly known as leak gas detecting sensor. This sensor is used to detect the leak gasses in the atmosphere. When it is exposed to atmosphere it detects methane, coal gas and LPG. This sensor is semiconductor type sensor with a preheat time of over 48 hours with a loop and heating voltage of less than 24 and 5 volts respectively [8]. As shown in Fig: 3(iii).

iv. MQ-135 SENSOR

This sensor is known as alcohol sensor with an operational voltage between 2.5 to 5. This sensor is also called multi gas analyzing sensor which is utilized to monitor the various atmospheric and point source pollutants. Since it is an analog sensor it provides the pollution level in voltage level which is converted to numerical value by using corresponding programing. Its accuracy can be increased or decreased by using the on-board potentiometer [9]. As shown in Fig 3(iv).

Figure 3(i) MQ-4 Sensor

Figure 3(ii) MQ-5 Sensor

Figure 3(iii) MQ-9 Sensor

Figure 3(iv) MQ-135 Sensor

v. MQ-136 Sensor

The MQ-136 sensor comes under the category of gas sensor which is most often used to detect and measure ambient air SO_2 level when SO_2 limit exceeds its threshold limit. There is a particular range to which this sensor measures the SO_2 intensity. Once the SO_2 intensity level exceeds the range it continuously beeps and informs the end user through text via Wi-Fi connectivity that SO_2 level has exceeded [10]. As shown in Fig: 3(v).

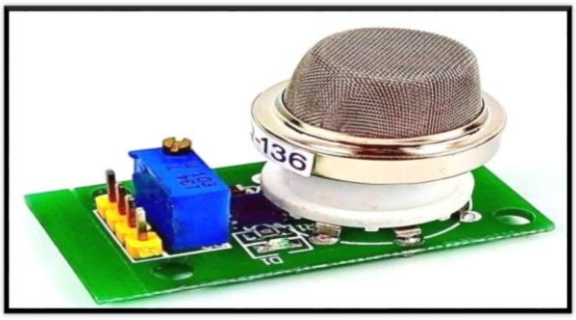

Fig: 3(v) MQ-136 Sensor

vi. LM393 SOUND SENSOR

The LM-393 sensor comes under the category of sound sensor which is most often used to detect and measure ambient noise level when sound exceeds its threshold limit. There is a particular range to which this sensor measures the noise intensity [11]. As shown in Fig: 3(vi).

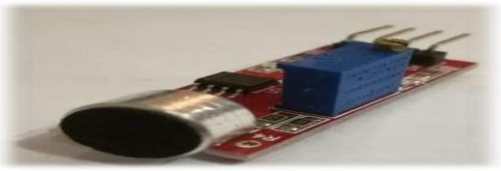

Fig: 3(vi) LM393 SOUND SENSOR

vii. DHT-11Sensor

It is a multipurpose and digital sensor which is utilized to record and determine the ambient air temperature and humidity. It consists of two basic components one is humidity sensing component and other is NTC temperature thermistor. It has solder pad, moisture holding substrate and two electrodes. This sensor has its own library (DHT11.h) by which it directly converts the digital data into analog data [12]. As shown in Fig: 3(vii).

Fig: 3(vii) DHT-11 SENSOR

viii. MICS-4514 SENSOR

The MICS-4514 is an electronic and multi gas detector sensor which is used to measure the concentration of CO, NO_2 and NOx. When the concentration of CO, NO_2 and NO level exceeds its threshold limit the sensor blinks light that air quality is worse. There is a particular range to which this sensor measures the CO, NO_2 and NOx intensity [13]. As shown in Fig: 3(viii).

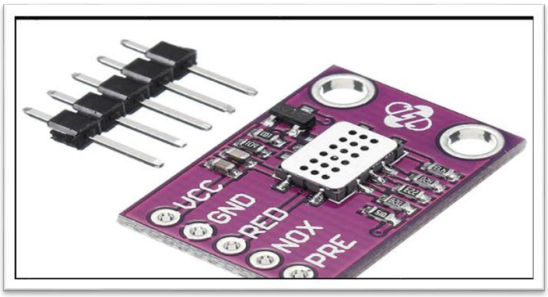

Fig: 3(viii) MICS-4514 SENSOR

ix. DUST SENSOR MODULE (GP2Y1010AU0F)

Dust Smoke Particle Sensor an infrared emitting diode (IRED) and a phototransistor are diagonally arranged into this device. It detects the reflected light of dust in the air. Especially, it is effective to detect very fine particle like the cigarette smoke. In addition, it can distinguish smoke from house dust by the pulse pattern of the output voltage [14]. As shown in Fig: 3(ix).

Fig: 3(ix) Dust Sensor

4) PRINTED CIRCUIT BOARD (PCB)

The main purpose of printed circuit board is to provide support to all electrical parts. There are mainly two effective ways to attach the components either by surface mount method or through-hole method. It is fabricated by incorporating many sheets of non-conductive material [15]. As shown in Fig:4

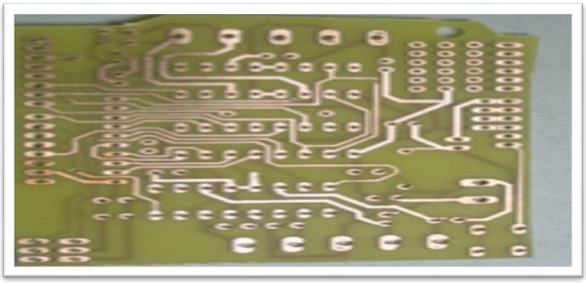

Fig: 4Diagram of PCB

5) ANALOG TO DIGITAL CONVERTED (ADC)

An ADC is a type of data translator which is used to convert analog value to digital value. This converter converts the input analog energy, power or value to a digital value which only represents the extent of energy or power that either they are available or not. The digital value is mostly in the forum of zero or one [16]. As shown in Fig:5

Fig: 5 Diagram of ADC

VII. FLOW CHART AND WORKING PRINCIPLE

- *WORKING PRINCIPLE:*

The project consists of multiple air quality sensor which are connected to a 12v power bank and use the Wireless sensing network to detect the presences of harmful pollutants in the surrounding. The presence of harmful pollutants like SOx, NOx, CO, CO2, CH4, Benzene, NH3, H2S, Smoke, PM 2.5, combustible and leak gasses, moisture content, temperature and noise pollution in the surrounding will be sensed by the respective sensors MQ-(135, 9, 5, 4), ME-3, DHT-11 and LM-393 and the corresponding values will be recorded. The recorded values of MQ series sensor and LM-393 will be transmitted to the microprocessor (Raspberry Pi 3B) through the ADC (Analog to digital converter) which is integrated on the PCB board. Whereas the data recorded by the DHT-11 don't require any ADC because it has the capability of directly transferring analog data by means of using its librarie name as: DHT11.h so this sensor is directly connected to the digital pins of Raspberry Pi 3B. After receiving the digitized data from particular sensors, we applied the digital to analog processing by using the ADC library i.e. ADSX1115.h. After that we have initialized infinite loop in order to continuously read data on every clock cycle (SCL). In order to send the data over the internet we required some sort of protocol, therefore we have used MQTT communication protocol/library to send the data over portal (cayenne). Then we initialized the MQTT library with our API (application program interface) IDs. Over the portal we created separate channel for each sensor so that the specified data can be communicated to the specified channel. After the completion of transferring the sensed data over the portal we provided a delay of 500 ms (milli seconds). In the case of absence of network, sensed values will be stored on SD card and when the network gets available the stored data will be sent to the portal. When there is the unavailability of Wi-Fi and the cellular network is available then the communication gateway will be switched to GPRS via GSM module. If the pollution level increases from NEQS values then automatically the buzzer beeps, and the email and SMS is sent towards the end-user about the condition along with the treatment and mitigation measure [17].

- *FLOW CHART*

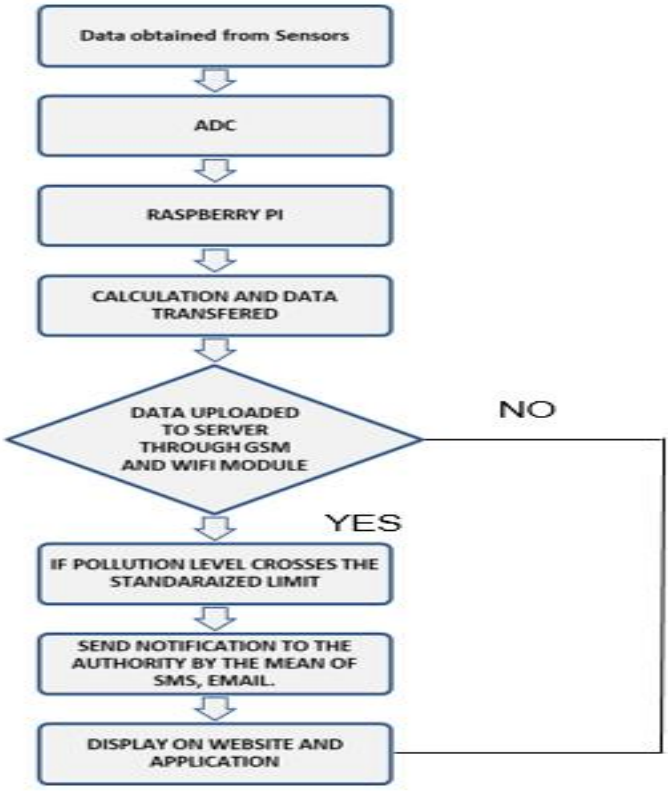

FIG: 6 FLOW CHART SHOWING WORKING MECHANISM

VIII. RESULTS

The site selected for the results is Qasim Chock the busy road route way in Hyderabad. The composition of vehicles are

Rickshaws	Bikes	Cars	Buses
300	800	234	4

Fig: 7 Shows Location of site selected

Representative Sample of Results from Qasim Chock

S:NO	Date	Time	CO (PPM)	CO_2 (PPM)	NO_2 (PPM)	SO_2 (PPM)	Dust (ug/m^3)	Sound (db)	Temp (°C)
1	01/10/2019	6:40:00	0.607168	15.42554	3.837617	0.196167	14.45877	66	32
2	01/10/2019	6:41:00	0.446747	13.1024	3.825117	0.19008	27.95919	66	32
3	01/10/2019	6:42:00	0.319907	10.64335	3.95012	0.24891	16.08382	66	32
4	01/10/2019	6:43:00	0.115356	5.905824	3.93762	0.208479	32.6885	63	32
5	01/10/2019	6:46:00	0.100413	5.606709	3.92512	0.222873	30.6051	64	32
6	01/10/2019	6:47:00	0.090009	5.210225	3.93762	0.230842	26.85499	64	32
7	01/10/2019	6:49:00	0.041842	3.427012	4.025123	0.259473	26.79248	62	33
8	01/10/2019	6:50:00	0.042808	3.342964	4.037623	0.24338	36.50111	63	32
9	01/10/2019	6:51:00	0.037725	3.138082	4.075124	0.264584	25.58411	62	32
10	01/10/2019	6:52:00	0.031475	2.876225	4.112626	0.248735	25.56328	63	33
11	01/10/2019	6:53:00	0.027054	2.572959	4.100125	0.238801	25.25077	63	32
12	01/10/2019	6:54:00	0.035638	2.960688	4.125126	0.270526	26.45914	63	32
13	01/10/2019	6:55:00	0.032039	2.841635	4.137626	0.286777	27.75085	63	34
14	01/10/2019	6:56:00	0.032453	2.866818	4.175128	0.255077	37.2303	63	32
15	01/10/2019	6:57:00	0.026243	2.561488	4.150126	0.27363	36.18861	63	33
16	01/10/2019	6:58:00	0.01875	2.167715	4.150126	0.262385	26.22997	63	32
17	01/10/2019	6:59:00	0.015413	1.937543	4.175128	0.25242	25.1466	62	32
18	01/10/2019	7:01:00	0.016214	1.936851	4.150126	0.225421	25.06326	62	32
19	01/10/2019	7:02:00	0.021961	2.248776	4.200128	0.251626	41.12626	63	32
20	01/10/2019	7:03:00	0.020289	2.177967	4.175128	0.221612	36.68862	63	32
21	01/10/2019	7:04:00	0.017765	2.009824	4.26263	0.252331	36.39695	64	32
22	01/10/2019	7:05:00	0.018809	2.137921	4.100125	0.214689	25.91746	65	32
23	01/10/2019	7:06:00	0.008443	1.285114	4.100125	0.189526	36.14694	64	32
24	01/10/2019	7:07:00	0.023823	2.426388	4.112626	0.227918	25.89662	64	32
25	01/10/2019	7:08:00	0.01878	2.110541	4.162627	0.220903	32.31349	64	32
26	01/10/2019	7:09:00	0.013768	1.795446	4.000122	0.194331	30.29259	64	32
27	01/10/2019	7:10:00	0.016614	1.961022	4.100125	0.201622	25.79245	64	32

28	01/10/2019	7:11:00	0.014674	1.811412	4.150126	0.213847	30.12592	64	32
29	01/10/2019	7:12:00	0.009139	1.353224	4.175128	0.195106	24.06323	64	32
30	01/10/2019	7:13:00	0.008895	1.391862	4.187628	0.202935	24.12574	65	33
31	01/10/2019	7:14:00	0.007964	1.278664	4.212628	0.202568	41.3971	64	33
32	01/10/2019	7:15:00	0.008543	1.341457	4.26263	0.234626	31.5843	63	32

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