A Novel Method to Detect the Amount of Silica Levels in Mines

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Abstract*: The main objective of the Silica Tracking System is to detect the amount of silica levels workers in mining areas are being exposed to. The System should have Sharp GP2Y1010AU0Foptical dust detector as a sensor for silica dust and ESP8266 - 12E as a processing module.MFRC522. RFID card reader is used for maintaining detailed track of each worker. Readingsfrom the sensor has been uploaded to the local database and can be accessed through a webpage.The amount of the silica exposure by workers in time spent per day is compared with thethreshold value of "50µg/mg3" for an 8 hours shift, set by Occupational Safety and HealthAdministration. MQ-4 Gas sensor is also integrated to this system in order to determine thecombustible Methane gas leakage in the mining areas as a safety measure. By installing theSilica Tracking System in the workplace, each worker silica dust exposure can be calculatedeasily and detailed track can also be maintained.

***Index Terms*: Silica Tracking System, RFID Card Reader, Gas sensor, Mining areas.**

I. INTRODUCTION

Internet of Things is a technology with computing systems which are accompanied with different identities. It has the efficiency to send any information over a network without spending need for communication. Internet of Thing could be a person to monitor implant. An animal with a biochip transponder, an automobile with built-in sensors that can alert the driver when the system fails, artificial system that will be allotted with an IP address given the skill to transfer data on any network comes under IOT. Internet of Thing has evolved from different Wireless technologies, micro-electromechanical systems microservices and the internet. This technology has helped to bring down the gap between Operational Technology (OT) and Information Technology (IT), which allowed unstructured information to be studied for further improvements.

II. ARCHITECTURE

The system is an example of the architecture; bottom-up made and can take into account any secondary levels. Therefore, model derived and practicalslants will coexist with new methods to be able to giveomissions and unusual evolution of different tasks.

In an Internet of Things, the sense of an event is not based on a deterministic or systematic model .It is based on the context of the event itself. Accordingly, it will not require common usualthatwill not be able to address every framework.

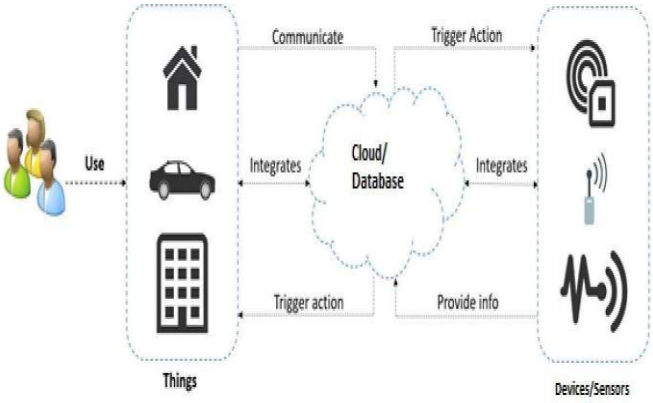

Fig 1 : IoT Architecture

III. SILICA TRACKING SYSTEM

India being a vast country has a surface area of about 3.3 million square kms , and according to 2001 census the population was around 1.025 billion where 72% of its residentssurvive in the rural area. Accompanied by the existing public health problems, evolving professional health problems are also likely to be attempted. In the past few years, Globalization and rapid industrial growth are added further to complex health issues.

A. Occupational injuries and diseases:

The annual frequency of work-related disease is expected to be between 924,700 and 1,902,300 and 121,000 occupational disease caused deaths in India.

According to the study by NIOH [1999], registers more than 3 million people working in various type of mines, ceramics, potteries, foundries, metal grinding, stone crushing, agate grinding, slate pencil industry etc are being effected . These workers are open to free silica dust and are at latenthazard of mounting **silicosis.**

B. SILICOSIS

Silicosis is a liberal interstitial lung disease, branded by tininess of breath, cough, fever and bluish skin. It can be in three customs: acute, accelerated and chronic. It is because of lung tissue reaction to the inhalation of silica and occurs mostly in people working in the construction . Since silica is odorless, non-irritant and will not cause any instant health effects experience to huge amounts of free silica can go overlooked. Silicosis is irrepressible, eliminating the worker from the industry and giving suggestive treatment is the only solution.

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Public health objectives are to detect early cases by proper nursing of exposed workers, to establish investigation platforms, to slow down the development and to reduce ill health .

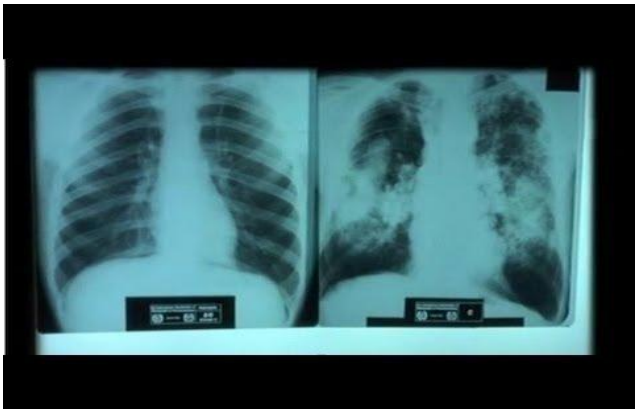

Fig 2: Silicosis affected lungs

C. AVAILABILITY OF SILICADUST:

Workers in mines, stone drilling areas, cement factories etc. are exposed to dust which contain various types of harmful particulates. Silica is one such particle whichcausesgreat harm to the person inhaling it. Silica dust gets accumulated in lungs and leads to various problems when it exceeds certain amount. When silica exceeds a threshold, the body needs time to degrade it.

D. TRACKINGSILICOSIS

Silicosis is a potentially disabling and sometimes fatal lung disease caused by breathing dust containing extremely fine particles of Silica ion crystal form. It is almost always related to work with prolonged exposure to silica in crystals, found in materials like sand, rock, granite. Breathing dust generated from these materials for prolonged periods can scar the lungs. There is usually a lag time of 20 years or more between exposure and onset of the disease. If exposure is intense, onset can occur in just a few years.

Silica tracking system helps to estimate the amount of silica workers are being exposed to. Silica exposure leads to various lung diseases and other health problems. Thiscan be avoided by installing a **Silica tracking system** in the workplace. This estimates the total silica exposure and helps to warn the worker not to work in those conditions anymore.

IV. BLOCKDIAGRAM

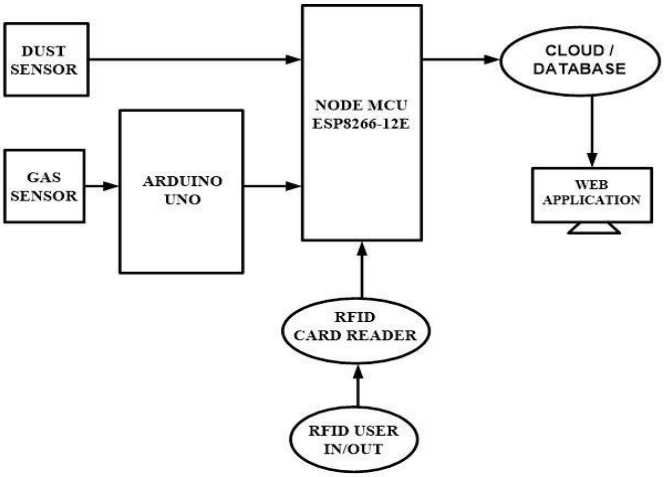

Fig 3: Block diagram of Silica Tracking System

AUTHENTICATIONPURPOSE: RFID CARD READER

SENSING MODULES: DUST SENSOR, GAS SENSOR

PROCESSING MODULES: ESP8266-12E,ARDUINOUNO

A. Internal Architecture:

An RFID arrangementcomprises of two coremodules, a transponder or a tag which is placed on the object that has to be identified, and a transmitter/repeater or a reader. The RFID reader has a RF module, a control unit and an antenna coil which generates HF electromagnetic field. The tag is generally a passive component, which has an antenna and an electronic microchip. As itmoves near the electromagnetic field region of the module , due to induction, a voltage is produced in its antenna coil and this voltage aids as power for themicrochip.

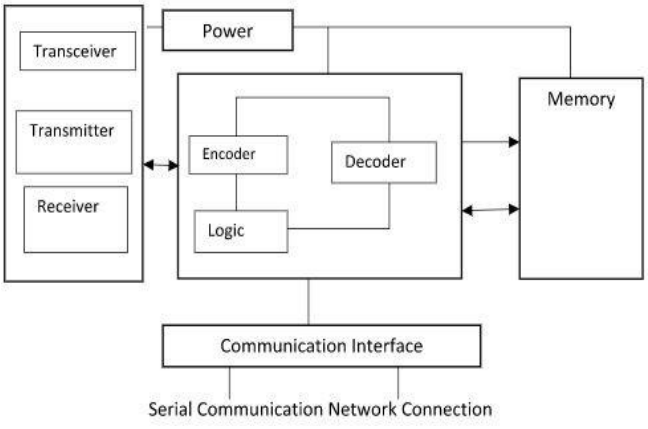

Fig 4: RFID reader structure

A. Interfacing:

To interface with the sensor connection to its 6-pin, 1.5mm pitch connector is needed called ‘mating connector’

Table 1: Interface with ESP8266-12E

Dust sensor	ESP8266-12E
Vcc	3.3V
GND	GND
LED	D0
GND	GND
V_O	A0
V_{CC}	3.3V

B. Dust density characteristics:

Test condition: According to "Electro-optical characteristics" of the specification of GP2Y1010AU0F.

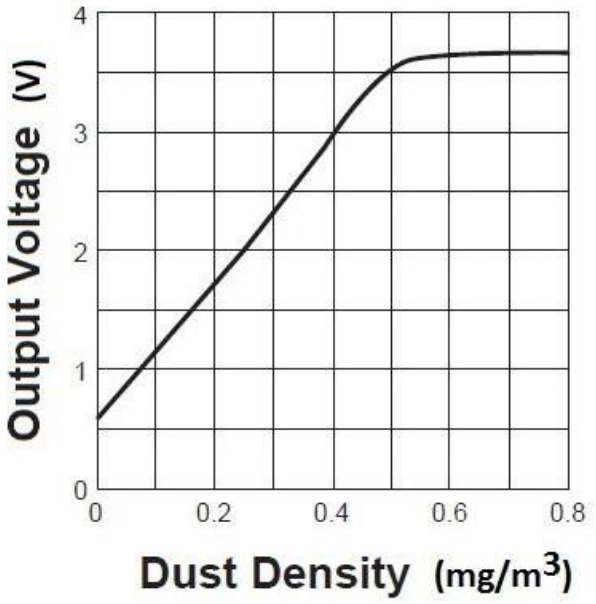

Fig 5: Dust sensor characteristics

V. IMPLEMENTATION OF SILICA TRACKINGSYSTEM

The **Silica tracking system** involves estimation of silica dust in a site by installing a dust sensor. Each worker has a unique RFID number. When the worker enters the workplace by swiping the card, the corresponding IN time is noted. The dust sensor estimates the amount of silica in that working environment from time to time. The dust values sensed are linked to individual workers' RFID card.

When the person leaves the place by swiping the card, the OUT time is noted. Using this IN and OUT time, the time spent by worker in the silica dust environment can be found and is given as an input to the processing module. The total silica exposure throughout the day is given by dust sensor. The output of sensor is an analog voltage and is given as another input to the PWM pin of ESP8266. The processor ESP8266 links dust sensor and RFID.

The Occupational Safety and Health Act of 1970 (OSHAct) was approved to prevent workers from being wounded at work. The law requires that employees are provided with working conditions that are free of known risks. According to OSHA, initially the maximum PEL (Permissible Exposure Level) of silica dust is "100µg/mg^3" for a person worked 8 hours in silica dust environment.

Table 2: Silica exposure levels

Hours of exposure	Exposure levels			
	50µg/mg3	100µg/mg3	200µg/mg3	400µg/mg3
1	105	210	420	840
2	210	420	840	1680
3	315	630	1260	2520
4	420	840	1680	3360
5	525	1050	2100	4200
6	630	1260	2520	5040
7	735	1470	2940	5880
8	840	1680	3360	6750

Exceeding OSHA PEL

Web Page is created to access the data stored in database. By logging into this webpage by using individual unique card numbers Contractors and Workers under the same network can obtain the data of the accessed card.

VI. RESULTS & OBSERVATIONS

To see the result of the module three possible ways arethere

(i) Database tables - treated as backend
(ii) Web page - which can be accessed by using the unique id
(iii) Serial Monitor – the output window of the Arduino IDE

VII. EMPLOYEEDETAILS

All the details of the workers like their name, in which mine they are working and their unique id(Emo_id) are made as a table in the database.

←T→	s_no	Emp_id	Emp_name	Workplace
	1	67,244,164,213,198	Meghana	Gannavaram
	2	225,98,9,25,147	Ujjwala	Thadigadapa
	3	65,49,12,25,101	Mercy	Enikepadu
	4	17,58,8,25,58	Divya	Kanuru

Fig 6: Employee details

Employeehistory:

This table gives the "IN" and "OUT" time of the workers. Using these "IN" and "OUT" times, the amount of dust to which a particular worker is exposed to, can be calculated

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Id	Emp_id	InTime	OutTime	Date
1	225,98,9,25,147	01:50:07	01:50:29	2018-03-07
2	17,58,8,25,58	01:51:34	01:51:39	2018-03-07
3	61	01:57:17	01:57:30	2018-03-07
4	17,58,8,25,58	02:06:21	02:07:04	2018-03-07
5	65,49,12,25,101	02:06:34	02:06:50	2018-03-07
6	225,98,9,25,147	02:06:43	02:06:57	2018-03-07
7	17,58,8,25,58	02:08:39	02:10:06	2018-03-07
8	225,98,9,25,147	02:45:23	02:46:04	2018-03-07
11	17,58,8,25,58	01:03:56	01:04:41	2018-03-28
12	65,49,12,25,101	01:05:31	01:06:13	2018-03-28
13	225,98,9,25,147	01:05:40	01:06:08	2018-03-28
14	67,244,164,213,198	01:07:11	01:07:18	2018-03-28
15	67,244,164,213,198	01:07:29	01:08:40	2018-03-28
16	67,244,164,213,198	01:09:05	6	2018-03-28
17	67,244,164,213,198	01:14:59	6	2018-03-28
18	17,58,8,25,58	01:18:32	01:18:40	2018-03-31
19	65,49,12,25,101	01:24:02	01:24:45	2018-03-31
20	67,244,164,213,198	05:28:05	6	2018-03-31
21	67,244,164,213,198	05:34:34	6	2018-03-31

Fig 7: Employee history

Dusthistory:

From the Dust sensing module, the dust value is updated to this page of the database.

d_id	date	time	dust_value
84	2018-03-31	05:29:01	0.02
81	2018-03-31	05:28:20	0.51
76	2018-03-31	01:24:40	0.43
75	2018-03-31	01:24:26	0.14
74	2018-03-31	01:24:12	0.39
73	2018-03-31	01:23:58	0.07
72	2018-03-31	01:19:55	0.11
71	2018-03-31	01:19:41	0.09
70	2018-03-31	01:19:27	0.07
69	2018-03-31	01:19:14	0.09
68	2018-03-31	01:19:00	0.12
67	2018-03-31	01:18:46	0.1
66	2018-03-31	01:17:34	0.11
65	2018-03-31	01:17:20	0.07
64	2018-03-31	01:17:06	0.06
63	2018-03-31	01:16:53	0.06
62	2018-03-31	01:16:39	0.04
61	2018-03-31	01:16:25	0.04
60	2018-03-31	01:16:11	0.05
59	2018-03-31	01:15:57	0.05
58	2018-03-31	01:15:43	0.05
57	2018-03-31	01:15:29	0.04
56	2018-03-31	01:15:16	0.04
55	2018-03-31	01:15:02	0.05
54	2018-03-31	01:14:23	0.05
53	2018-03-31	01:14:09	0.06
51	2018-03-28	01:10:01	0.07
50	2018-03-28	01:09:47	0
47	2018-03-28	01:09:02	0.1
46	2018-03-28	01:08:31	0.11

Fig 8: Dust history

Webpageoutlook:

Fig 9: Worker details

Fig 10: Worker details

VIII. CONCLUSION

In many parts of the world, 'health' is identical with remedial services. Occupational health is a right of every worker.Majority of the working population are from unorganized sector and further, being largely illiterate are unaware of the hazards linked with their occupation. Workers in mining areas are affected with lung diseases because of inhaling crystalline silica dust. Silica Tracking System helps in determining the exposure level to silica dust and maintains database containing record of each individual's data. This results in avoiding overexposure to silica dust and thereby preventing silicosis. This system helps in acknowledging the workers about their health condition. Thereby, even the illiterate and unorganized sector of population will be able to avoid undesired health effects.

IX. FUTURE SCOPE ANDDEVELOPMENT

At present the dust sensor is being used in the prototype due to the unavailability of silica sensors. In the future, the abundant availability of silica sensors will help to track the exact amount of silica in the workplaces. Wearable silica sensors can also be developed such that, the exact amount (now calculating the aggregate amount of all the workers) of silicaeach worker is exposed to, can be calculated.

Further extension of this prototype can include some Safety measures. Sensors like Seismic sensor can be integrated. Seismic vibrations are measured by Seismic sensors by adapting ground motion into a quantifiable electronic signal.

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AUTHORS PROFILE

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