

# INVESTIGATIONS ON AUTOMATED MONITORING SYSTEMS IN INDUSTRIES

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## ABSTRACT:

This paper presents investigations on automated monitoring systems used for safety purpose in industries. It includes gas leakage and water level monitoring, fire accident detection and air pollution monitoring in industries. This system is used to monitor air pollution in industries through the use of wireless sensors deployed in huge numbers around the industries. The fire accident causes a major disaster not only for humans but also for industrial properties. This system detects the fire and turns the water pumping motor on. To maintain the air pollution, water leakage, gas leakage and fire monitoring individually, it will cost millions of dollars a year and also requires more labour work. To overcome this problem, the single automatic monitoring system is used. It provides early detection and early warning of defects.

**Keywords:** Automated system, wireless sensor, monitoring

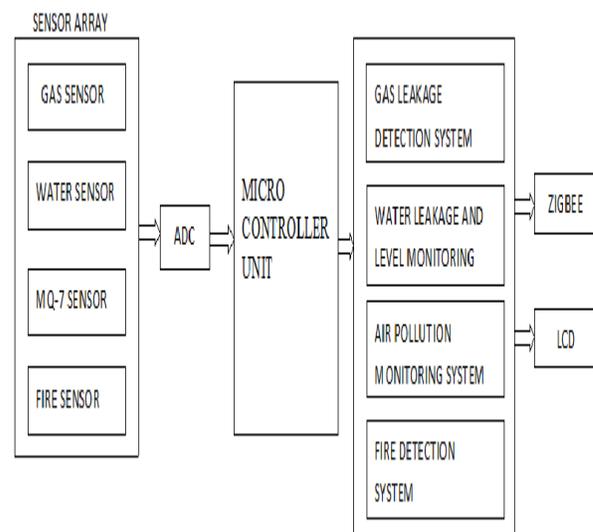
## INTRODUCTION:

Automated system operations are a combination of both hardware and software which allows machines, computer systems or computer devices to function without any manual work. It allows computer systems to work without a human operator physically located at the site where the system is installed. It is used in a wide range of applications like industrial automation system, control and monitoring system, data security applications and so on. The automated system operation saves labour work, time and cost.

The main reason for using the single automated system is used to maintain all the systems in a simple manner. If any small problems occur in industries, it will cause major financial losses and possible environmental damages [1]. The common issues occur in industries are leakage of gas, water, air pollution and fire accident. Due to the leakage of gas such as methane and hydrocarbon gas causes adverse effects on the ecosystem such as global warming, acid rain and air pollution. The sensors are capable of measuring the changes in pressure due to

leaks. To overcome the problem of water dispersion in water distribution networks, it is necessary to measure water level in tank and control the water leakage in the pipeline network [2]. With the fast growing industrial activities, the air pollution becomes a major problem and it affects the health of the population. If a pipeline is not properly maintained in industries, it can begin to slowly corrode, particularly at joints or locations which causes deformation in the pipe. In the olden days, the people control the fire by manual methods. But nowadays wireless sensor technology is used to monitor and control the fire. By using separate system, it requires more time and maintenance. This paper provides the whole system ideas, procedure, benefits, devices and apparatus used to accomplish the system with high efficiency.

## BLOCK DIAGRAM:



**Fig.1 Block diagram of automated monitoring systems**

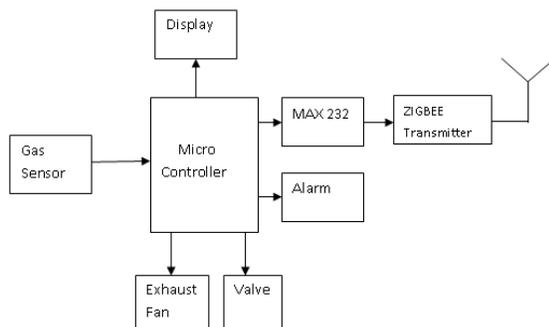
In this system, individual sensors in the sensor array detects the corresponding parameters like gas, water, air and fire. The sensed signal from the respective sensors are converted into digital signals by using ADC converter. The converted

digital signal is transmitted to the multifunctional microcontroller. This control unit identifies the risk and sends the signal to the respective system.

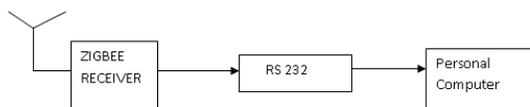
### GAS PIPELINE LEAKAGE:

Gas pipeline plays an important role in transmission and distribution of gases in industries. Gas pipeline leakage is the one of major problems in industries. The pipeline system used for the transportation process [5]. The pipeline network is easily affected by corrosion, cracks etc. This will lead to emission of hazardous gases like carbon monoxide, methane, ethane, propane, nitrogen, etc which causes major destruction in industries. If these gases leak from the pipeline, it will change the percentage of gas in the atmospheric air [4]. It also affects the human health and nature of environment. So the maintenance of pipeline network is important process. The main aim of leakage detection system is used to identify the leakage or hole which occurs in a system. It early detects the leakage and locate the problem. After detecting the problem it will send the alert message by using wireless sensor node.

### BLOCK DIAGRAM:



**Fig.2(a) Block diagram of Transmitter side of gas leakage pipeline system**



**Fig.2(b) Block diagram of Receiver side of gas leakage pipeline system**

The gas detection system is used to detect toxic gas by using microcontroller. To detect the presence of gases in industries, gas detector is used which is safest equipment. This equipment detects the leakage of gases or other emissions and it will automatically shut down the entire process [6]. The

gas leakage detector is a device which identifies the hazardous gas leaks by using sensors. The gas sensor is able to monitor the certain parameters such as amount of oxygen content present in air, CO2 concentration, temperature, pressure and relative humidity [8]. If the gas leaks in the pipeline network, the gas sensor will sense the hazardous gas. Normally the sensor is interfaced with microcontroller unit.

In this system, low power microcontroller is used for transmission of data. This sensor will sense the gas and it will transmit the data to the microcontroller unit. The sensed signal is very small, so the transmission of the signal is not possible. In order to amplify the signal, the gain amplifier is used [11]. The sensed impulse is an analog signal which is given to Analog to Digital Converter(ADC) because the microcontroller works with digital signal. The output voltage of the sensor is insufficient, to avoid this analog to digital converter is interpreted. The Analog to Digital Converter converts the analog signal into digital signal. The converted digital signal will be given to the microcontroller unit. This unit is interfaced with wireless sensor node and it sends the alert message through zigbee or GSM or Bluetooth. Here MRF24J40 ZIGBEE module is used so the wireless connectivity is established. MRF24J40 RF Transceiver ZIGBEE module is based on the standard of 2.4GHz IEEE 802.15.4.

By establishing wireless connectivity, the transmission of data is possible. The zigbee and microcontroller unit is interfaced by the support of Serial Parallel Interface(SPI) communication [14]. To power up the entire system, rechargeable battery is used. In future, solar battery will be used. Power is needed to activate all the modules. Each module requires input voltage supply, so voltage regulation is needed [10]. The output voltage is affected by some noise signals. To avoid the noise, filter circuit is implemented.

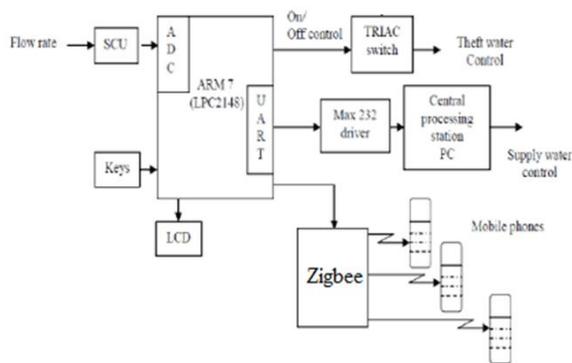
In the gas leakage system, adaptive filter algorithm is used. All adaptive filters are digital filters. Adaptive filter has the transfer function with linear filter which is controlled by some parameters. Adaptive filter is used for the noise cancellation, signal prediction, adaptive feedback cancellation and echo cancellation. The filter circuit along with the gain amplifier reduces the noise level of the output voltage [15]. By using the automated gas leakage detection system, the critical solution can be solved because it provides quick response time and exact detection of gas leakage.

### WATER LEAKAGE DETECTION AND WATER LEVEL MONITORING:

Water is one of the important natural resource and it should be used in a proper manner. Due to water scarcity, it should be properly maintained for future generation. In order to utilize the water in an adequate manner, a proper water leakage prevention and identification of leakage is needed. To overcome this problem, wireless sensor node based water monitoring system is employed. By using this monitoring system, not only the water leakage can be prevented but also water level should be maintained in a certain level [7]. Based on microcontroller, water leakage is controlled and by using wireless sensor node the data is transmitted. The essential parameter in the water pipeline monitoring is the internal pressure of the pipe.

Leakages will change the normal pressure in the pipe and so the pressure monitoring is done. Initially the manufacturer fixes the maximum pressure rate of the water flow in the pipeline network. If the pressure of the water flow in the pipeline exceeds the maximum pressure rate, it will cause the deformation of the pipes [9]. It results the pipes to explode and the water deviates from the main track which results in water leakage. The pipeline leakage is caused by the following parameters pipe's over-age, natural disaster and improper installation. This situation causes a major losses to industries. The underground water pipeline systems are difficult to maintain. When there is any small problem like leakage happens, it will affect the whole process.

**BLOCK DIAGRAM:**



**Fig.3 Block diagram of water pipeline leakage detection system**

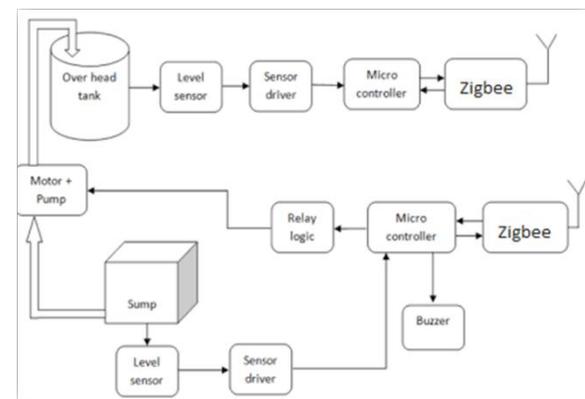
To avoid this problem the location of the leakage is determined by using the system. The water leakage and water level monitoring is done with the help of sensor. Whenever either the water leakage or water level is decreases or overflows, the sensor will automatically collect the information [12]. The collected information is sent to the microcontroller

unit .The microcontroller unit gets the information from the sensor and decides the risk. It sends the message to the owner through wireless communication .

In early days to indicate the leakage alarm is used. But due to the growth of advanced technologies wireless communication is used. Wireless communication plays a vital role and makes a revolution in developing industries. It helps the people to easily share the information and prevents from further damages. If any leakage in the pipeline occur, the flow sensor will detect. The observed signal is sent to the microcontroller and transmitted using zigbee or GSM or Bluetooth module [13]. By detecting the leakage using water leakage system time, cost and energy are saved.

Some industries requires continuous flow of the water is essential. For example like brewage industry, the water level in the tank reaches the critical level the whole process will stop [17]. In earlier days, in order to monitor the water level in the tank, more manual work is required. So, the employee are needed to check the water level continuously. If manual work is more , it results in the delay of industrial process leads to financial loses. This problem is overcome by using the automatic water level monitoring system is employed.

**BLOCK DIAGRAM:**



**Fig.4 Block diagram of water level monitoring system**

To measure the water level in a tank in industries, the ultrasonic sensor is used. Ultrasonic sensors are fixed within the tank. First ultrasonic sensor exhibit the ultrasonic wave through the air medium and it store the information of reflected wave [21]. Again ultrasonic waves are passed to the water medium, the sensor stores the echoed wave which is reflected from the other surface of the tank. If the water level in the tank decreases, it compares

the echoed wave from the water with echoed wave from the air. After the comparison, the sensor identifies that the water level is low because the reflected ultrasonic wave from the air is high due to low density. Water level monitoring is used to avoid the overflowing and underflowing of the water in the tank [24]. Whenever the water level of the tank reaches low or high level, the ultrasonic sensor will monitor the tank continuously. To ensure the tank levels are maintained, a pump controller is used .

The overflow of the water is prevented by providing an early warning message. If the water level in the tank is low, the ultrasonic sensor will automatically send a sensed signal to the microcontroller unit .The signal from the sensor is received by the microcontroller. It will turn the water pipe on with the help of Serial Parallel Interface and it will alert the alarm and send the message through the wireless network. If the level of the water reaches to the maximum level of the tank, the sensor transmits the signal to the microcontroller and it will turn off the water pipe and send an alert message through GSM or Bluetooth [25]. By using the system, it is very easy to monitor both leakage and water level in industries. It helps to save the time and avoid delay. This system helps the owner to save money by identifying the leakage earlier and helps them to take necessary steps to prevent this problem.

#### AIR POLLUTION MONITORING SYSTEM:

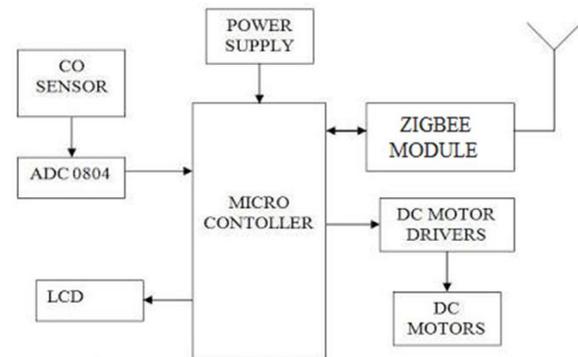
Nowadays air pollution is a growing threat to human health and natural environment. For the last few decades ,air pollution has become a major threat. Due to the increasing the number of industries, the contamination in air increases [18]. In industries, some of the sources emit the hazardous gases such as nitrogen oxide, carbon monoxide, carbondioxide, sulphur dioxide from chimney, diesel generator and boiler. Humans are severely affected by the inhaling this contaminated air [19]. It causes several health problems such as respiratory problem and lung alignments. Because of the effects of air pollution among the people causes diseases like lung cancer, chronic obstructive pulmonary disease, asthma, heart disease and cerebrovascular diseases. To avoid this kind of problem, the automatic air pollution monitoring and control system is used.

Based on the development of the communication technologies, nowadays wireless sensor node is used to monitor the air pollution. For monitoring the air pollution, GSM and GPRS are the wireless sensor node devices to be used. But the cost of the installation and maintenance of these devices are high [20]. So the wireless sensor networks have been developed and installed in industries. Traditionally the air pollution monitoring system

used bulky instruments. The flexibility of the system gets reduced and it becomes difficult to ensure proper monitoring and controlling. To enhance this situation, wireless air pollution monitoring system is used which gives more flexibility and accurate data [21]. The atmosphere is contaminated by gaseous, liquid or by-products of industries that can cause damage to human life. Industries release a huge amount of hydrocarbons, chemicals, organic compounds and carbon monoxide into the air. The combustion of fossil fuels like coal and petroleum emit sulphur dioxide to the air [22]. It will affect the quality of air. Due to the pollution of air, the ozone layer gets depleted and contributes to global.

In this system, a single microcontroller chip which includes an array of sensors and zigbee module are used. To detect the gas, the sensor is placed in chimney. There are different sensors used to detect the different gases present in the air. MQ-7 sensor is used to monitor the level of carbon monoxide in the atmosphere ranging from 20-2000ppm [23]. GMS-10 is an oxygen sensor, it accurately monitor the oxygen content present in the air. It is especially used in the boilers.

#### BLOCK DIAGRAM:



**Fig.5 Block diagram of air pollution monitoring system**

Parallax-60500008 gas sensor is used to detect methane, isobutene, propane and liquefied petroleum gas. It is especially used for smoke detection process. This sensor senses the gases which are emitted in the industries. The sensor output is detected by the microcontroller. The microcontroller is an important platform is interfaced with the sensor. The processed data from the microcontroller is sent wirelessly through the Zigbee module. If the sensor senses continuously, it will detect the amount of gas molecule present in air. Whenever the gas molecule is high, the sensor outputs the maximum voltage in analog form which is beyond the threshold voltage. This analog values

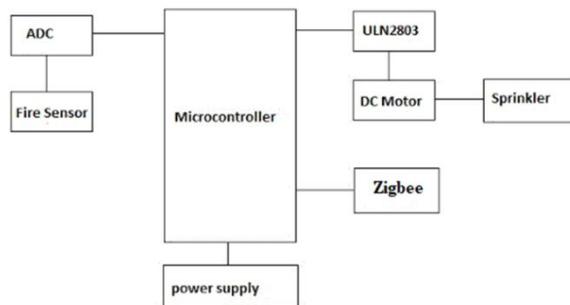
are converted into digital values by Analog to Digital Converter(ADC) and send an alert message. In industries, to minimize the level of pollution in the air proper precautions should be taken to sustain the human life.

### FIRE DETECTION SYSTEM:

The fire is the most dangerous for human life and industries. The fire detection system is used to minimize the loss of life, resources and properties [3]. The industrial security plays a major role for the life of the industrial people. One of the main reasons for the occurrence of the fire is ignite due to electrical short circuit in industries. If proper precautions are not taken, it will lead to severe fire risks along with thermal radiation burns. Even though the fire accidents are very small, the proper actions for protecting the people and industrial properties are needed. If not, it can spread to the entire industries and cause damages. The accurate and early detection is needed in order to prevent the fire from spreading and minimizing their impact.

The fire accident causes many damage to the industrial properties. It will lead to financial losses. So the fire detection system is used to detect the fires and warn the industrial people to evacuate to a safe location. Preventing and avoiding the fire in industrial environment can be easily achieved by the technological improvements.

### BLOCK DIAGRAM:



**Fig.6 Block diagram of fire detection and control system**

In order to take an appropriate action against the fire accident, this automatic fire detecting system is used. Whenever the fire accident occurs, this automated system gives the better response. The power system of lift and machineries are shut down and the lifts are closed. The automatic alarms systems and water sprayers will activate and smoke sensing sensors will monitor the environment to prevent from fire and alert the employees of industries [16]. There are different alarm devices for fire detection and control such as sprinklers, alarm

system, fire doors, stairwells, manual pull alarm and smoke detector.

To identify the location of a fire, there are different alarm signals for different fire zones in the fire alarm system. If the fire accident occurs, an alarm initiating device will trigger. A signal is transmitted through the alarm circuit in the central control unit. The fire indicating devices are activated by the microcontroller. The microcontroller sends an alarm message depending on the system. One of the important safety device is water sprinkler which is placed on the ceiling. When the fire heats the sprinkler, it will shower the water. This system activates the fire alarm and simultaneously sprinklers are activated by exposure to heat. It prevents the fire from spreading to other places by shutting down the electrical, air handling equipments or special process operations. This system is used to protect the building and its properties especially the life of the people.

### CONCLUSION:

This paper provides a detailed summary of systems which detects the gas and water leakage, water level, air pollution and fire accident. The detected information is reported by using zigbee technology. These systems helps to point out unique advantage of safety in a single system. Wireless sensor networks are applied in the field of monitoring and safety. Labour work takes more time for monitoring and maintenance. To avoid delays, this system notifies and informs the condition through wireless medium. The methodologies used here are for safety purpose in industries. The safety of human is given high priority. To reduce the risk level to the human, an automated single system is implemented. If proper maintenance is not taken, it will causes severe damage and causes financial losses. By using these systems, monitoring and preventing the damages can be done effectively.

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