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Smart Gas Monitoring System for Home and Industries

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Abstract. Nowadays, gas industries or gas cylinders in a home will experience gas leakages because of human negligence or other external conditions and lack of patience. Due to disaster to be raised by such cases, the demolition happened is unpredictable. To predict the disaster in advance, then alternatives could be taken to avoid such cases. In this paper, an IoT device is designed that will detect gas leakages and the status of the gas to be known whenever cut off is specified by the user. The proposed IoT methodology for knowing the status of the gas summary is demonstrated using the specific use cases. The proposed IoT to be installed through a manual approach or virtual approach is depending on the consumer interest. There were many instances experiencing the many people to become victims of this and also the environment to be also spoiled and it takes more time to purify the infected environment or to bring the affected environment to a normal level. It is demanded nowadays to predict future disasters using G-IoT. In G-IoT, the components whenever meet less than the cut off values, will notify the report to the main center and authorized user. The V-IoT is also used to monitor outer environments like gas pipeline and its conditions. If the resources are supplied at the time of installation of setup and detected whenever a specific component becomes shortage, the automatic approach takes place and will start filling that specific component with required according to manual recording.

1. Introduction

In our daily lives, we are encountering many situations such as gas cylinder burns with negligence of the user in the kitchen, also many gas industries pipeline to be leaked and emitting toxic gas that harms the people living in the society, and many other situations depicting the consequences when the gas to be leaked outside. When you take normal case such as a gas cylinder, the user is more negligent about it, although the user is cautious about the usage of gas in the kitchen, because the user frequently needs to on the stove whenever relatives or friends came to the home at unpredicted times. The user who is in the kitchen loses patience and will not care about the usage of the stove and requires using the stove

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frequently. At many instances in India, we are observing a few cases about someone who is injured or died because of exposure to gas in the kitchen. In this scenario, suppose one IoT sensor to be designed in such a way that will alert the user through voice and text alert to the registered mobile. If any resource is sorted, that resource to be automatically filled to the setup of the gas stove. It is an automatic system that takes care of monitoring of the gas and controls it. There is another scenario where many gas industries are developing and generating the toxic gases that are to be used in many other products and are generating revenue because of those gases. Such gas companies are facing problems such as sudden leakage of the gas from their installed pipelines, this situation is not only harming the people and also causing the company to be ceased or company license to be suspended for a period of duration. The company also must bear the compensation for the lost lives because of this odd incidence. To avoid such situations, an IoT sensor to be developed and that is to be installed throughout the pipeline might make the gas company be safe in the system but affording such activities and products may damage the economic status of the company. Hence, in this scenario, virtual sensors are to be installed to predict the shortage or loss in advance and set right the environment from the resources that are in the buffer. If the situation is not set right, it will alert through the voice and text to the concerned authority to solve such issue suing the experts. The need for IoT sensors in these applications is highly required and the result should be user friendly, and to be accurate in functioning. There were few inventions and studies that are there in these applications but how much they provide security and perfection is considered. After analyzing the studies, which study is good and which study to be extended in our study are noted and that work to be elaborated. All these studies to be described in the related work chapter and are also considered as a literature survey. Then, the proposed work is to be discussed along with the features and methodology of it.

2. Related Work

In this, various studies are listed and discussed. In [1], there is a solution that when sprayed will bubbles remain for 15-30 minutes. It is one of traditional ways of detecting gas leakage. In study [2], various techniques are discussed to detect gas leakage. In [3], a detector is so sensitive and locates the leaks as bubbles using liquid. In [4], a pipeline is analyzed using a leak simulator software that estimates the state of the gas. In [5], gas detection is done using WIFI and minimum and maximum levels set using Arduino and IoT concept. The following is the architecture resembling the working of the model. It uses MQ5 gas sensor to detect LPG gas in the air. In [6], the LPG gas detection is done and alerts through SMS and sounds. In [7], the issue raised by leakage of gas that harmed many innocent people and few were dead and impacts and consequences are noted, and compensation is filed against victims. In [8], atmospheric gases dispersion from two major plants from Our state Andhra Pradesh and its effects and consequences are discussed. In [9], an approach is discussed on leakage before break from flawed vessels. Architecture of gas leakage detector is shown in figure 1.

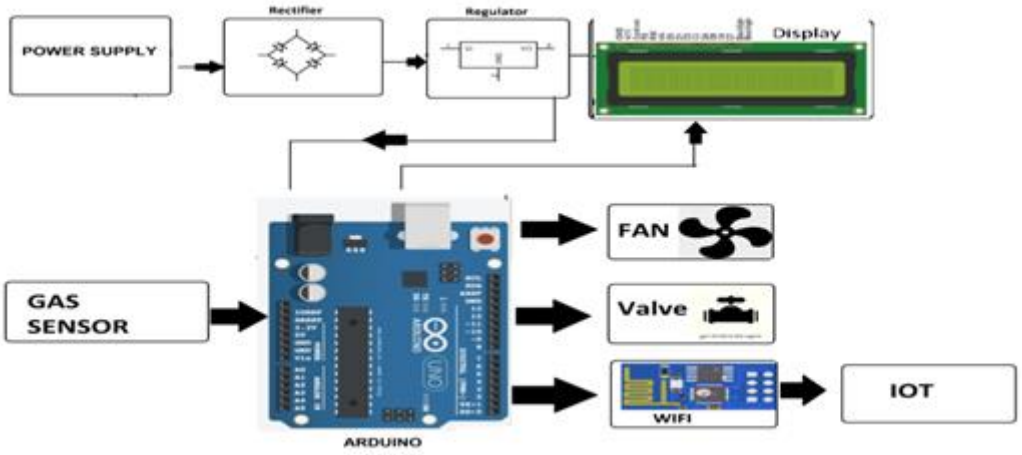


Fig.1: Architecture of gas leakage detector using Arduino

In [10], an approach is discussed on algal biomass concentration under flue gas atmosphere. here, its influence and consequences are also discussed. In [11], an approach for optimization of biogas upgrading and a prospective on design and microalgae selection and its consequences on the society is discussed. In [12], synthesis of few gases combinations and their reactions are discussed, and their consequences are demonstrated. In [13] and [14], the studies in which one state that designing of a specific system using thing speak and Internet of Things, and other state that securing free certificate less aggregate signature scheme for healthcare medical sensor networks and its consequences are discussed. In [15], the study happened on routing for Internet of Things using multi context clustering and its consequences are demonstrated. In [16], Designing a formulae-based type-II super lattices using specific delineation and its applications and consequences are demonstrated. In [17], a study on Quantization of two samples in specific type base pallets of modified release capsules by using headspace gas and its applications and consequences are demonstrated. In [18], the cloud internet of things requires a new scheme for securing data and its working methodology and its features are demonstrated. In [19], a specific user event detection is captured and are monitored using spatio-temporal model and its working ideology and its implications are demonstrated. In [20] and [21], the studies represent about Hybrid context aware for pervasive smart environment and its consequences is discussed is as one, other is about on smart emergency responsive environment for fire hazards using IoT and its consequences are discussed. In [22] and [23] states that one is on THAM index for agriculture decision making using IoT and other is on specific nano-tube arrays for sensing acetone room temperature and their implications. These are although different w.r.to application, the terminology IoT is useful in our proposed application. In all the mentioned studies, somehow, they are related and partly they are useful but not fully related to the proposed methodology. The main objective of proposed work is automatic connecting and filling when resources are added in buffer and are alerting when reading level falls than cut off.

3. Proposed Work

In this, the designing of IoT sensor for small application to large application is discussed through the features and architecture. Pre-alerting conditions are shown in figure 2.

3.1 Small gas Applications:

In this, IoT sensor has features such as reading the gas level, also releasing the gas in the control level, alert when abnormality is found, auto replace the gas cylinder when it is about to have no gas and many other features. In this, when more than one cylinder is connected using this smart gas sensor, in addition to send details of the gas when it is about to over, which helps to the user to

book for new gas cylinder but also another cylinder which is connected comes to use when first cylinder's gas is completed and is not removed after alerting also.

3.2. Pseudo Procedure:

Small_gas_application (Cylinder, IoT_Sensor):

Step1: Read the gas level in the cylinder and fix the cut off level

Step2: Install IoT_Sensor with features such as alerting when cut off is reached, auto fill from the buffer when it gas is over, and duration of the cylinder is served.

2.1 if gas_level<=cut_off:

alert "gas is about to over in n days" where n is determined based on past daily usage of the gas. It also alerts to the user to book for new cylinder if there is no cylinder in buffer.

2.2 if gas_level==empty:

auto connects to second cylinder which is connected as a buffer.

else:

alert "gas is over"

Step3: Information of alerting is stored, and history is maintained in the server.

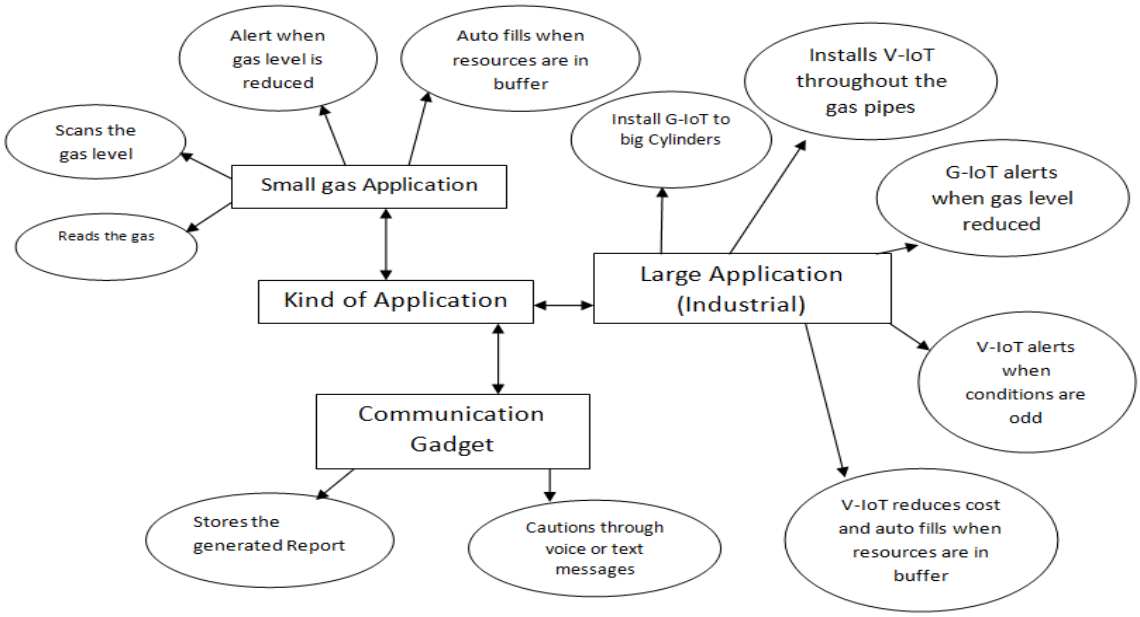


Fig.2: Architecture of pre-alerting about conditions and gas status

3.3 Large gas application

In this, a specific IoT sensor to be designed that consists of multiple sensors where each sensor is dedicated for specific activity. In this, big gas containers are fixed with few G-IoT sensors to read the level of gas, and alert its status whenever gas drops, auto fills cylinders with connected resources in the buffer. there were other V-IoT sensors are designed and are fixed at gas pipes to know conditions of the pipe. The alert message and conditions are to be communicated to the communication center. The distance between one V-IoT and other V-IoT is customized based of range of V-IoT device. In this way, the industrial gas company to be set righted.

The G-IoT and V-IoT sensors are designed in such a way that those could fit in large scale gas industrial applications. The gas sensor in the small application could be designed in such a way that it could satisfy the features such as reading the gas, alerting when cut off is reached, auto filling from second cylinder when it is in buffer, and the duration of the cylinder service.

Here, G-IoT and V-IoT are titled as Giant sensor over huge gas containers and Virtual Sensor over huge length gas pipes. The G-IoT and V-IoT sensors are customized type and are installed with many parameters at the time of fixing. The parameters are fall in to height in centimeters to cover, when to alert could be initiated (when cut off to be mentioned), and when auto fill option to be activated, and also gives duration of that cylinder to be used. All these factors are helpful to do further analysis.
The pseudo procedure of small gas application is as follows:

3.4 Pseudo Procedure
Large_gas_application (Environment, G-IoT, V-IoT):
Step1:Environment consist of number of big cylinders, the kind of gas they hold, height of each cylinder.
Step2:The number G-IoTs are determined from step1, and the features of G-IoT are loading cylinder details (height, kind of gas) to it depending on the cylinder.
2.1 if gas_level<=cut_off:
alert "gas is about to over in n days" where n is determined based on past daily usage of the gas. It also alerts to the user to book for new cylinder if there is no cylinder in buffer.
2.2 ifgas_level==empty:
Auto connects to extra cylinders which are connected as a buffer.
else:
alert "gas is over"
Step3: When it comes to outer environment, the gas pipelines are arranged in several kilometres to provide necessity for the people. In this category, V-IoT is used a lot. The characteristics of V-IoT are measuring and monitoring the lengths of a pipe depending on its capacity loaded at the time of fixing. These virtual IoTs will reduce the infrastructure cost for the managements and are highly reliable and efficient in monitoring the gas based on the internet.
3.1 Read the length of the pipe, asking the number of points to be installed, load the distance to cover by each Virtual sensor.
The management has to decide the number of virtual sensors to be used. It determines the capacity of each virtual sensor to cover the range.
3.1.1 if gas_level_ith_point<= cut_off:
alert "gas level and ith point location"
else:
Continuously monitor the gas level
3.1.2 if the gas_pipe is broken because of many external factors:
Alert "location of broken point and reason for broken"
else:
Continuously monitor the gas level
3.2 At every day, the report to be generated and propagated to the communication canter for analysis.
Step4: The periodical reports are stored in the cloud for further reference and analysis.
The G-IoT and V-IoT plays a vital role in the successful monitoring of the industrial gas companies. This ideology reduces the huge manpower to monitor the gas pipeline and changing of huge gas cylinders. This traditional approach pitfalls are overcame using automating the gas industry using Internet of Things (IoT).

In this, the modules identified are kind of application and Communication device. The small gas application in which Gas Sensor to be fixed for the gas Cylinder and that voice report or alerting could be sent to registered communication device. In this, if the user fixes automatic booking of cylinder when it is about to over, it alerts the nearest gas booking office to deliver the cylinder on a specific date before. Home-based and Industrial based pre-alerting applications are shown in figure 3 and figure 4.

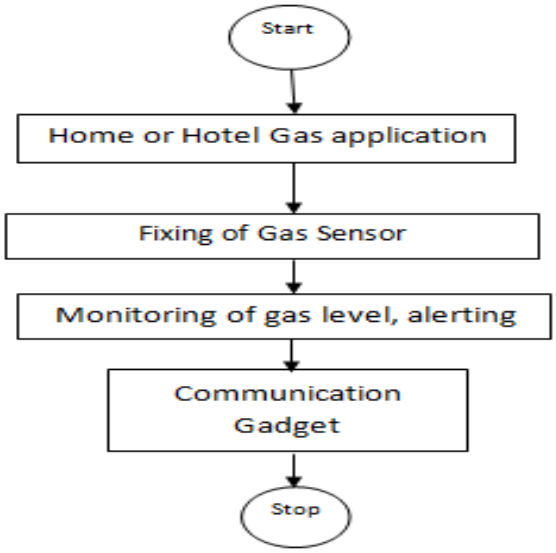


Fig.3: Pre-alerting in Home based application

In above flow chart, activities involved are mentioned one after another in the small gas application.

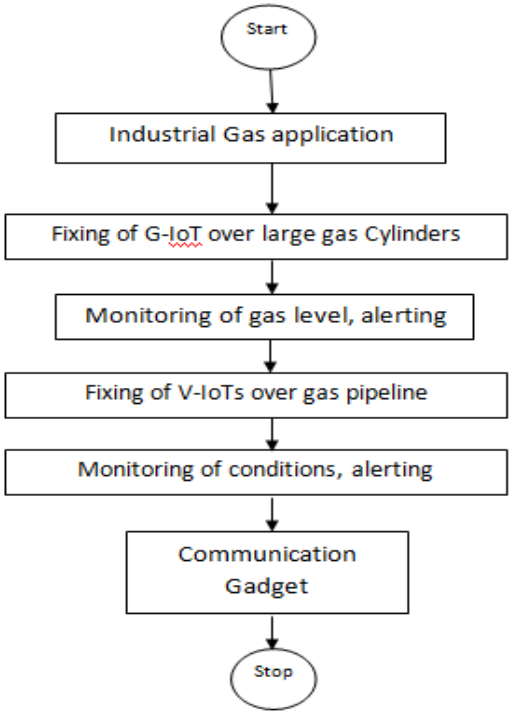


Fig.4: Pre-alerting in Industrial gas-based application

In above diagram, the activities to be performed in the large-scale gas-based application.

4. Results

The input and output of each module is mentioned in this study. The screen shots of proposed study are to be specified from figure 5 to figure 10.

4.1 For Small application: In this, gas sensor to be fixed at the regulator and is WI-FI connected. The details to the gas sensor are loaded at the time of installing it to the regulator.

Screen1: This sensor requires calibration and not much accurate.

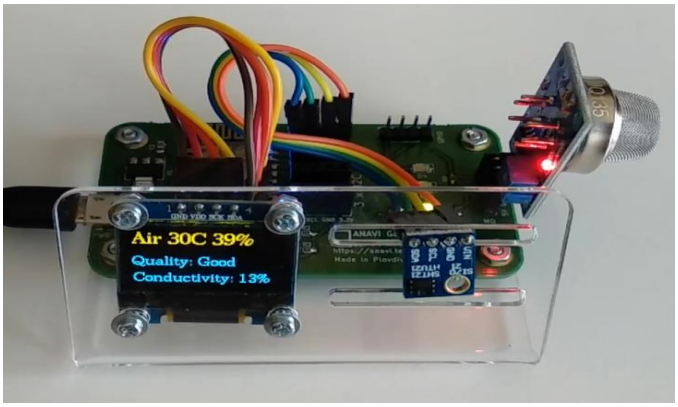


Fig.5: MQ-135 gas Sensor

Screen2: Various kinds of gas sensors in the market

		
MQ4 gas sensor	MOX gas sensor	Meta Optical Gas sensor
		
Grove – Gas sensor	Electro Chemical type gas sensor	

Fig.6: Various gas sensors

Among many gas sensors, calibrated gas sensors are more accurate in detecting.

Screen3:



Fig.7: Calibrated gas detector cum sensor

Screen4: Working of gas sensor and internal structure of gas sensor is as follows-

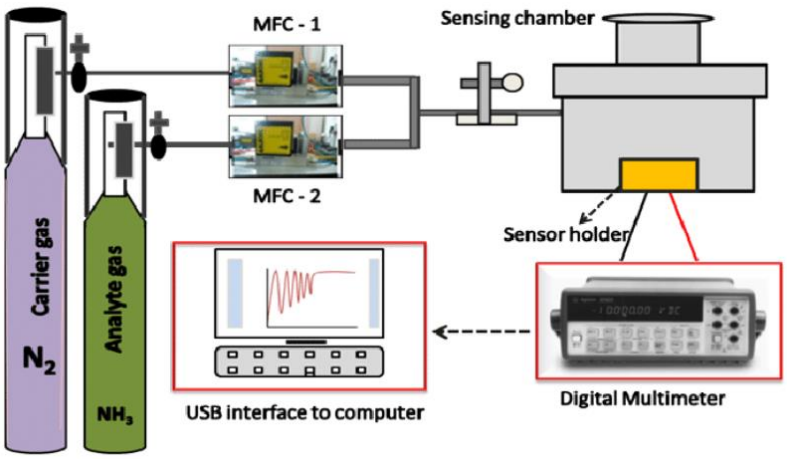


Fig.8: Performance analysis of gas sensor

When reading level falls below the cut off level, alerts to the communication device. Also, buffer cylinder will be used automatically whenever primary cylinder is completed.

4.2 For Large applications: In this, G-IoT sensor to be fixed to the large gas cylinders and additional cylinders are in buffer for auto filling option. V-IoT Sensor to be fixed at specific distances apart in the pipeline and are Internet enabled. The conditions of the pipeline are posted in a report and the same to be alerted.
Screen1: In industrial gas applications, various terminologies that were used. It is termed as G-IoT that could be fixed to each large gas cylinder.



Fig.9: Industrial gas detection devices

Screen2: Outer environment gas pipelines, requires Virtual Sensors that are internet enabled.

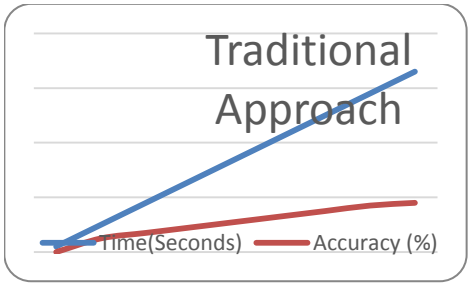


Fig.10: Pipelines that could be installed with V-IoT

Suppose the distance from one place to other place is 45 Kilo meters. The number of V-IoT s depending on distance to cover. Assume each V-IoT capacity is 1 Kilometre, 45 V-IoT's are installed with one Kilometre apart from each V-IoT sensor.
If the range to cover varies, the number of virtual sensors required also varies.

The following graphs (figure 10 and figure 11) shows the performance between traditional approach and automated approach:

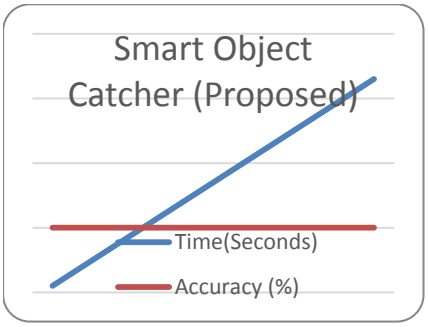
Y –Axis:
Time



X-Axis : Accuracy

Fig.11: Graph of Traditional Approach

Y –Axis:
Time



X-Axis: Accuracy

Fig.12: Graph of Proposed Approach

4.3: Comparison of Automatic and Standard Approaches based on time and accuracy

In above, automatic approach consumes more accuracy with respect to time whereas traditional or semi traditional approaches consume more time to get accuracy. The automated approach has more accuracy whether it is less time or more time for the activity to perform.

5. Conclusions

In this, based on application, the ideology is applied. In case of small home or hotel-based application, the gas sensor is fixed, and other cylinders are buffered. Whenever the present cylinder which is in use, will complete and the cylinder in buffer to be automatically connected. In this case, if reading level is falls below the cut off, alerting is done, and sound also alerted about the status in eco-friendly environment. In other case such as industrial gas applications, where G-IoT and V-IoT are used and are fixed at big cylinders and in pipeline. Any leakage could be identified and that will be brought into notice of the communication center. In this case, G-IoT will alert when reading level will fall below the cut off level and will automatically connect to the resources in the buffer. V-IoT will be fixed based specific distance apart and they will monitor the conditions of the pipeline and will alert if any odd factor is identified. In this paper, automatic connecting and filling could be done as resources are supplied in a buffer.

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