Automated Gas Leakage Detection System with Visual Data Monitoring using Wireless Visual Sensor

M. S. Tadpatrikar and J. G. Rana

***Abstract*-- Low-cost, low-power multifunctional camera devices can be used as visual sensors to take the real time images. These visual sensor devices are used to make up ad-hoc sensor nodes spread around the physical environments.**

Usually, these sensor devices communicate with each other to establish a sensing network. This network can provide access to information anytime and anywhere, by collecting, processing, analyzing data, and creates a smart environment.

This paper represents a wireless visual sensor comprising of camera as the visual sensor and RF transceiver module as the transmission hardware. We can insert this visual sensor as a node in the wireless network.

In this proposed project wireless visual sensor is used with gas leakage sensor. These two sensors can be used in industrial application like at bio –gas plant or at sugar factory or at gas filling plant where detection of gas leakage is very much essential with wireless transmission of picture information of that physical environment.

***Index Terms*-- ARM processor, camera, gas leakage sensor , RF transceiver, Visual Sensor, Wireless sensors network.**

I. Introduction

THIS paper represents how wireless visual sensor is used with gas leakage sensor & used to transmit visual information with gas leakage data . Such system forms a node in wireless sensor network. Here we are just developing one node.

Wireless sensor network (WSN) is a novel technology in acquiring and processing information and has been an active research area in recent years. There are no. of applications of WSN outlined in many areas such as military, environmental, health, home, commercial, and the industrial. Particularly, the WSN solutions for real time monitoring of nuclear power plant. [2]

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Sensor networks are commonly comprised of lightweight distributed sensor nodes such as low-cost video cameras. Most sensor networks will also be based on employing content-rich vision-based sensors. The volume of data collected as well as the sophistication of the necessary in-network stream content processing provides a diverse set of challenges in comparison with generic scalar sensor network research. Applications that will be facilitated through the development of visual sensor networking technology include automatic tracking, monitoring and signaling of intruders within a physical area, assisted living for the elderly or physically disabled, environmental monitoring, and command and control of unmanned vehicle.

These wireless visual sensor with gas leakage sensor can also be use in used in industrial application like at bio –gas plant or at sugar factory or at gas filling plant where detection of gas leakage is very much essential with wireless transmission of picture information of that physical environment.

Figure1 shows general idea of Wireless Sensor Network.

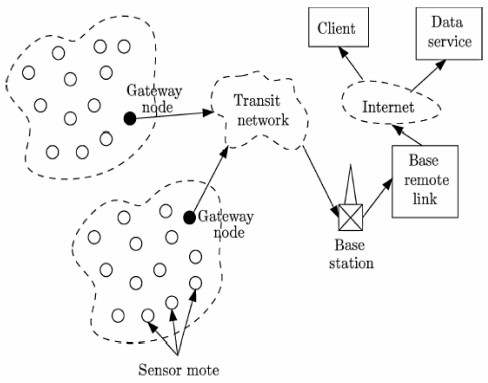

Fig. 1 Wireless Sensor Network

Due to wireless architecture we can access sensor data remotely by using sink nodes that connect them to other networks using wide area wireless links. In sensor networks Energy is typically more limited because of nature of sensing devices & because it is difficult to recharge their batteries. Therefore, power consumption is an important parameter for the development & the construction of these sensors.

In the main class of sensor networks, there are significant cases that require the use of image- based (i.e. visual) sensors. An image based sensor could be successfully used in many

areas where particular production or high quality requirements create appropriate conditions for introducing visual measurements.

A wireless image based sensor is useful for handling various tasks, such as environmental measurements, shape recognition, sensor could be placed in mobile robot & visual quality tests after assembly. In addition, a wireless image based sensor may be used to make remote measurement with old analog measurement instruments, or to acquire the output of sensors with visible analog interfaces.

After developing this node to reduce the power consumption to minimum & having the necessary bandwidth to support image transfer, the sensor node can be easily inserted in wireless network. This sensor may become optimum solution for wireless applications that prefer low power consumption & high coverage area. [1]

WSNs are a collection of a large number of miniature autonomous devices known as sensor nodes to form the network without the aid of any established infrastructure. The individual nodes are capable of sensing their environments, processing the information locally, or sending it to one or more collection points through a wireless link.

Some of the attributes of WSNs are:-

1 Minimum power consumption.
2 Low RF transmit power.
3 Short range communication.
4 Operating frequency.

The advantages of wireless connection in sensor networks are ---

They allow making measurements of moving objects.

They provide higher flexibility in sensor placement.

They can minimize human intervention.

They avoid use of wires & hence save the cost.[1]

Two of the great advantages of these sensor networks are that they do not require particular infrastructures or human control. They sense compute, and actuate in the physical environments & therefore can be used in several applications.

The objective of this project is to design a low cost, low power consuming visual sensor node which can be inserted in a wireless network for remote monitoring.

A. Brief History

In older systems wires were used to carry raw electricity to our gadgets and wires to link gadgets together. Wires are not so bad when you use the device infrequently or don't move around too much. Today's society is becoming more and more mobile, both at home and at work. Business all over the world are redefining the work environment, once confined to the office, to include the activities in airplane, in automobiles, home, offices, hotels and customer sites

There are many wireless technologies on the market like GSM, GPRS, and DECT which are characterized by a high-range coverage area, high costs, & high power consumption. Others are characterized by low coverage area, low costs, & low power consumption such as Bluetooth (BT), IEEE 802.11 & Wireless Fidelity (WiFi). From an economical point of view, wireless systems are promising for use in sensor network configuration & for different industrial applications.

Considering importance of mobile computing leaders across the telecommunication and computing industries are working together to develop on the wireless technologies like Bluetooth, Wi-Fi, Home RF and many more for global voice and data communication to replace cables that connect devices. Technologies are being developed for faster data communication and for long ranges. [1]

Wireless visual sensor can be used with gas leak sensor at bio gas plant.

Fig. 2 Photograph showing man checking a gas meter for leaks with a hand-carried detection unit.

In industries like bio –gas plant or sugar factory or gas filling plant number of gas leakage sensors are placed at various places. To check the meter readings the controlling person has to go to each & every unit. Hence, a too time consuming job.

B. Recent Trends & Developments

Many current video-based systems have centralized architectures that collect all visual data at a central location for storage or real-time interpretation by a human operator. The use of distributed processing for automated event detection would significantly alleviate mundane or time-critical activities. These were previously performed by human operators and provide a better network scalability. Thus, it is expected that video surveillance solutions of the future will successfully utilize visual sensor networking technologies. [1]

Placing number of such nodes for detecting gas leakage & to sense visual information forms a Wireless network.

Here, it is not necessary to go to each & every place where gas leakage sensors are connected. Instead of this, controlling person get detailed information of gas data & picture information of that place at the control room. At the same time wherever there is detection of gas leakage, the system gives audio indication. The controlling person can go to only that place from where he gets audio & picture information. Hence saves the time of controlling person. [3]

II. TECHNICAL WORK PREPARATION

SOFTWARE

A. Algorithm for Image Transfer & Gas Leakage Detection

1. Initialize all ports Registers, ADC, RF module and camera.
2. Store set point value of gas using keypad in the memory of processor.
3. Continuously read ADC output.
4. For image transfer check for the keypad input.
5. If current value of a gas is greater than the maximum set value, give alarm indication.
6. At the same time take images from camera and store it into the memory.
7. Send this data to RF module.
8. At receiver initialize RF module using PC.
9. Receive data at RF module.
10. Read Receiver output using software written at PC side.
11. Display and store images on PC.

B. Flowchart for Image Transfer

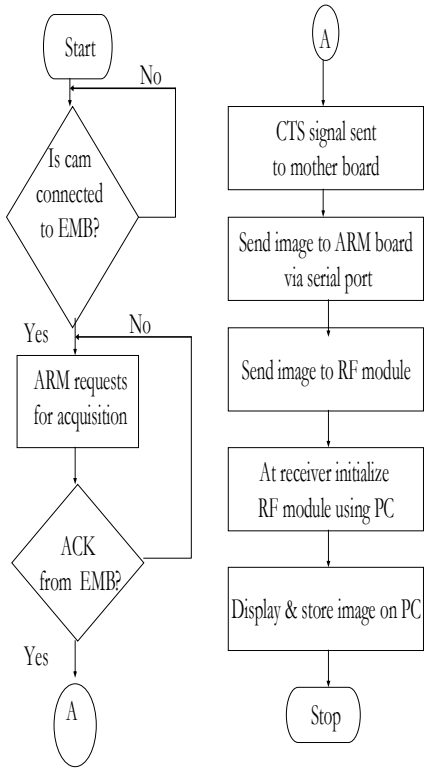

Fig. 3 Flowchart for image transfer

C. Flowchart for Gas Leakage Detection

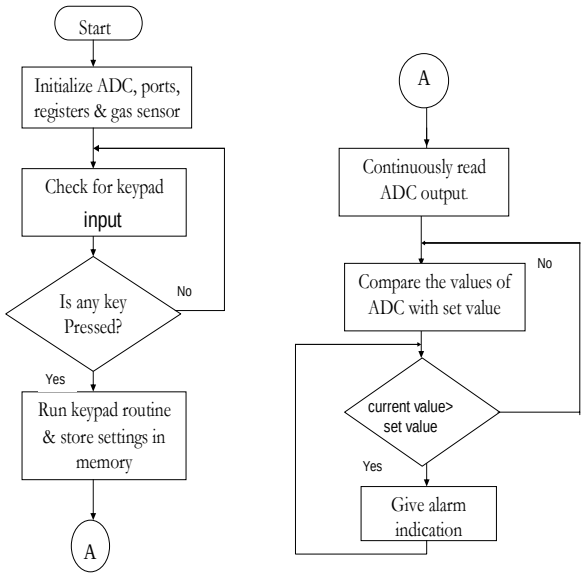

Fig. 4 Flowchart for gas leakage detection

HARDWARE

To detect the gas leakage no. of sensors are available. But gas leakage detection with picture transmission for security was not available. Hence simple gas detection with picture transmission is possible by this project. Figure 5 shows block diagram of this project.

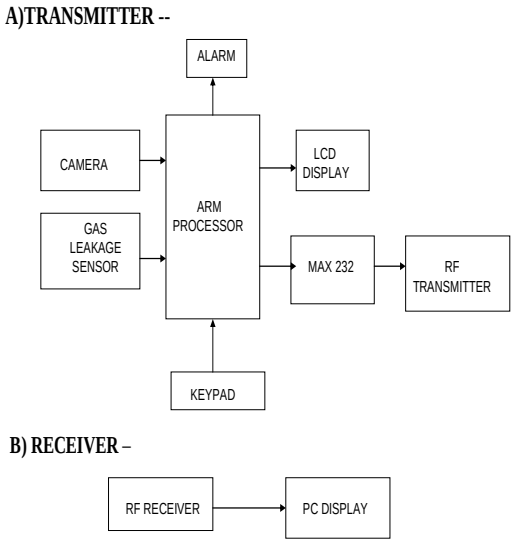

Fig. 5 Block Diagram of actual system

A. Audio/Video Camera: JMK – Jk301

TABLE I

SPECIFICATIONS:

Sr. No.	Parameters	For Black & White	For Colour
1	Resolution Ratio	320 line	420 line
2	Illumination	0.5 lux	0.2 lux
3	Lens focus & visual angle	3.6mm 90°	6.0mm 62°
4	Supply voltage, Current	8-12V,200mA	8-12V,200mA
5	Consumed power	90mW	120mW

B. RF module

Long Range-Low Power Data Radio Modem LR96 is a 433 MHZ long range (up to 1.5 km) transparent and easy to use RF Modem for wireless communication at speed of 9600 bps. LR96 can replace an existing RS 232 (9600 bps) wired link just by plugging one modem on each end. Connectron-LR96 is a plug-n-play RF Modem with intelligent inbuilt controller. Unlike other RF modems, LR96 is very easy to install and use in home, office and industrial applications.

Features:

1. Low power transmission with the transmission power of 27dBm (500mW).
2. Carrier frequency of 433MHz, also capable of providing 450~470MHz carrier frequency.

Based on the GFSK modulation mode, the high-efficiency forward error correction channel encoding technology is used to enhance data's resistance to both burst interference and random interference and the actual bit error rate of 10-5 ~ 10-6 can be achieved when channel bit error rate is 10-2.

1. Long transmission distance reliable transmission distance is >2000m.
2. Multi-channel: The standard LR-96 configuration provides 8 channels. If the user needs, it can be extended to 16/32 channels, meeting the multiple communication combination mode of the user.
3. Intelligent data control and the user don't need to prepare excessive programs: Even for semi duplex communication, the user doesn't need to prepare excessive programs, only receiving/transmitting the data from the interface. LM96 will automatically complete the other operations, such as transmission/receiving conversion in the air, control, etc.
4. Low power consumption and sleeping function: For receiving, current is <50mA, transmitting current is <300mA.
5. High reliability, small and light: Single chip radio-frequency integrated circuit and single chip MCU are used for lessened peripheral circuits, high reliability, and low failure rate.

TABLE II

Frequency points of 0~7 channels

Channel No.	Frequency	Channel No.	Frequency
CBA=000(0)	430.2000 MHz	CBA=100(4)	434.6940 MHz
CBA=001(1)	431.4288 MHz	CBA=101(5)	434.2332 MHz
CBA=010(2)	431.7360 MHz	CBA=110(6)	433.1580 MHz
CBA=011(3)	430.5072 MHz	CBA=111(7)	433.9260MHz

C. ARM Processor

The central part of the proposed sensor node is the ARM controller module. Its main functions are control of the sensing element, synchronization of the data transfer between sensor and memory, and control of the saved data transmission on the wireless channel. The processor module uses a LPC 2148 ARM controller. Due to their tiny size and low power consumption, these microcontrollers are ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale. Integrated functions like analog-to-digital converter (ADC), digital input/output, or timer are easy to implement. Various 32-bit timers, single or dual 10-bit 8 channel ADC(s), 10-bit DAC, PWM channels and 47 GPIO lines with up to nine edge or level sensitive external interrupt pins make these microcontrollers particularly suitable for industrial control and medical systems.[6],[7].

D. MAX 232

The DS14C232 is a low power dual driver/receiver featuring an onboard DC to DC converter, eliminating the need for ±12V power supplies. The device only requires a +5V power supply. ICC is specified at 3.0 mA maximum, making the device ideal for battery and power conscious applications.

E. LCD Display

In our system we prefer to choose LCD to indicate the step by step operation of the system. We have used is the 16 by 2 LCD means it can display two lines containing 16 characters each.

F. Gas Leakage Sensor

This system to detect trace gas leaks from pressurized systems consists of a microprocessor-based control unit that operates a network of sensors. The sensors can be deployed around pipes, connectors, flanges, and tanks of pressurized systems where leaks may occur. The control unit monitors the sensors and provides the operator with a visual representation of the magnitude and locations of the leak as a function of time. The system can be customized to fit the user's needs; for

example, it can monitor and display the condition of the flanges and fittings associated with the tank of a natural gas vehicle. [8]

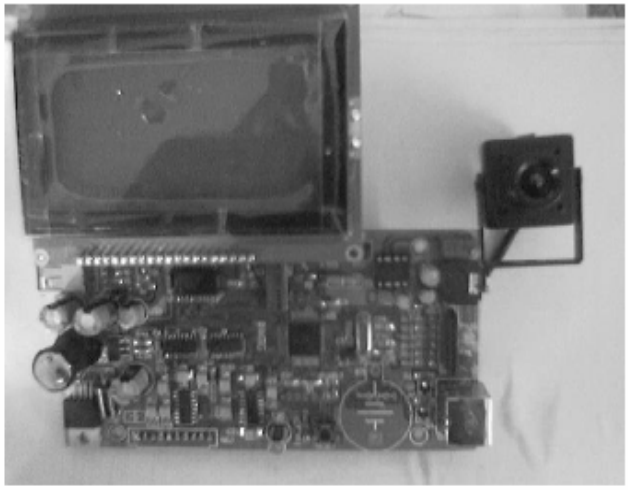

Fig.6 Actual System Setup

III. WORKING

Using keypad we can store some fixed or reference value of gas in the memory of ARM processor. Processor always compares the value of gas with the readings shown by gas leakage sensor and the decision is taken accordingly. When gas leakage is detected, the system gives audio indication .At the same time processor collects the visual/picture information sends it at the remote receiver.

A. Timing Calculations

1. Data transmission format – 8data bits, 1- start bit, 1 – stop bit @9600bps.

2. For 1 picture – 131 KB are required.

3. Hence, 131KB * 10 bits / 9600 = 131*1024*10 / 9600 = 139 sec.

4. Hence, Time required for transmission of 1picture/ image = 139sec = 2.3 minutes. (approx.)

B. Key Features of System

1. Low Power Consumption.

2. Fastest speed of operation.

3. Camera – easy interfacing with ARM processor.

4. Gas leakage is detection is possible & gives audio indication & at the same time it sends the visual/picture information at the remote receiver.

5. Reduces the overhead on the controlling person & hence the time for controlling.

6. So, collecting data from all the sensors at the control room by single person becomes easier.

C. Applications

1. Remote monitoring.

2. Environmental & Hazard monitoring.

3. At Bio-gas plant, Gas filling plant or in any other related industries.

4. In Residential areas.

5. The project presents a visual sensor node equipped to be inserted in wireless networks.

6. The sensor design is driven by three main specifications; low cost, energy saving, and enough bandwidth for image transfers.

7. This project finds its application in industries where gas leakage detection with visual information is an important criterion like Bio-gas plant, gas filling plant etc.

IV. CONCLUSION

This project finds its application in industries where gas leakage detection with visual information is an important criterion like Bio-gas plant, gas filling plant etc.

When gas leakage is detected this system takes pictures /photographs and send wirelessly to the remote receiver. Time required for transmission of 1picture/ image is approximately 2.3 minutes.

This project presents a visual sensor with gas leakage sensor to be inserted in wireless networks.

Fig.7 Picture showing image transmitted after the gas leakage detection

V. FUTURE SCOPE

We can build two way systems (Half Duplex Communication) i.e. we can send commands & receive acknowledgment back.

We can use the same system in natural – gas vehicles to detect the gas leakage & send data wirelessly to the control room.

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VII. BIOGRAPHIES

Ms. M.S. Tadpatrikar completed her Graduation in Electronics & Telecommunication Engineering from Pravara Engineering College, Loni, MH, India. She is doing M.E. (Electronics) from J.N. E.C, Aurangabad.

She has presented two papers in national conferences, one on Software Defined Radio using General Purpose Processor & other on Wireless Visual Sensor.

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