A Smart Real Time Fire and Smoke Detection System

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Abstract - Fire plays an important role in our daily life, but it is also a serious threat to human life and properties. Along with the growing science and technology, fire prevention technologies are also constantly innovating. This system is designed to detect the fire and smoke at the early stage and notify the nearest fire station through a push notification. The notification contains the fire or smoke warning and the location information. Whenever a fire occurs, the fire sensor senses the fire at very early stage itself. In case of a smoke, the smoke sensor detects it and sends a notification saying there is a chance of fire which helps the fighters to subdue it before the fire causes damage at a greater extend. Tensilica ESP 8266 processor is used as the brain of the system. This processor contains a built in Wi-Fi and is available at a cheap cost.

IndexTerms – Tensilica ESP 8266, Real Time Fire Detection, Real Time Smoke Detection.
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I. INTRODUCTION

The fire prevention technologies are constantly innovating along with the growing science and technology, because fire is a serious threat to human life and properties. The appearance of the fire is often accompanied by the generation of smoke. Actually in the early stages of the fire, a lot of smoke is produced due to the fuel temperature and combustion is not high enough. Smoke cannot be covered by a large area, and the mobility is relatively high. If the fire can be detected before the occurrence of fire and sent an early warning to the nearest fire station, the occurrence of fire and a large area spreading of fire can be avoided so as to reduce people's material and financial damage.

There are a number of fire and smoke detection systems are available nowadays. But all these systems provide a warning signal on the building premises only. Then the fire detection was done mainly by visual inspection and confirmation by a human being and the fire station only informed when someone make a call to the fire station.

A real time fire and smoke detection system can solve this issue and inform nearest fire station. This system is cheaper compared to all currently available systems in market. This real time fire and smoke detection system is designed to detect the fire and smoke at the early stage and notify the nearest fire station through a push notification. The notification contains the fire or smoke warning and the location information's. Tensilica ESP 8266 processor is used in this system. This processor is selected for the system only because it contains a built in Wi-Fi and is available at a cheap cost.

II. LITERATURE REVIEW

In this section topics related to A Real Time Fire and Smoke Detection System are included. These provide a sampling of problems appropriate for application of A Real Time Fire and Smoke Detection System. The references are summarized below.
A. Need for Wireless Fire Detection Systems using IOT[1]: The interconnection of physical devices embedded with electronics, software and sensors, which is capable of collecting required data from the surrounding and sent those data over internet is called IOT. The fire detection composed of all of the techniques and processes that ensures the early detection of a fire. There are three main categories Smoke detection, Flame detection and Temperature detection. The automatic fire detection system will do a real-time surveillance. Mainly an automatic fire alarm system is designed for high-rise buildings. To do early extinguishing of a fire disaster, large numbers of detectors are deployed in buildings, which will periodically measure smoke concentration or temperature. There are many techniques we had been already used to detect fire, such as fire detection using sensors, image processing, CCTV technology.
B. Unified Smoke and Flame Detection for Intelligent Surveillance System[2]: This paper explains the way ofunification of flame and smoke detection algorithms by merging the common steps into a single processing flow. Smoke detection and flame detection can be done using colour probability, boundary roughness, edge density and area variability filtering processes. The obtained preliminary results show that, by processing smoke and flame in parallel, we can reduce the processing time. The results obtained from unified processing part can be used to feed as input for different tasks of intelligent surveillance systems.
C. Design and Implementation of Smoke Early Warning System[3]: In this paper the author proposes a simple hardware design, which consists of different fire sensors that enables every user to use this wireless fire security system. The challenges, while designing the nodes with different types of fire sensors are discussed and the methods to overcome this problem is analysed. The system is interfaced with the many types of sensor to sense different fire sources like gas leakage, smoke, and heat. This circuit is fully controlled by the PIC microcontroller. All the sensors and detectors are wired to PIC microcontroller. The PIC microcontroller will periodically monitor all the connected sensors and when it senses any security problem then notification sent to the PC central monitoring station wirelessly. The distance should be in a range of 300m indoor/1500m outdoor using zigbee. Also gas, light, smoke, IR, temperature & humidity sensors can be interfaced with this microcontroller to find out

abnormal fire conditions in the surroundings in all possible ways. ARM7 based microcontroller can also be used to build such systems.

D. Development of System for Early Fire Detection using Arduino UNO[4]: The fire alarm system proposed in this paper only uses affordable things. The Fire alarm system monitor real-time, when it detects the presence of fire, it will automatically capture images and display it on a screen. The time when output of the associated sensors such as temperature, humidity, CO2 and fire is increased above the threshold limits, the controller start sending signals to GSM module. The main feature of this system is its ability to remotely send an alert whenever a fire and smoke is detected. The system can also alert the users through a GSM module.

III. DESIGN OVERVIEW

The block diagram depicts the total blue print of the proposed project, A Smart Real Time Fire and Smoke Detection System. The total essence and functioning of the project is represented in a single block diagram, shown in figure 1. The Tensilica ESP8266 processor acts as the brain of the system. All other components are linked with this processor. The fire sensor and smoke sensor will send high values towards the Tensilica ESP8266 processor when the flame of the fire or smoke crosses the threshold limits.
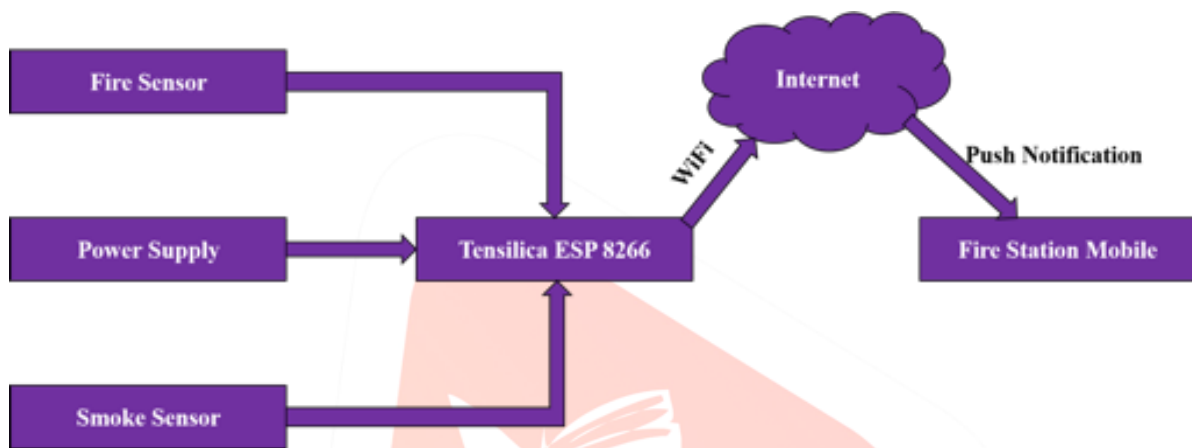

Fig. 1: Block diagram of smart real time fire and smoke detection system

A. Tensilica ESP8266:

The ESP8266 is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability produced by Espressif Systems. This processor simply connects to a Wi-Fi network and make TCP/IP connections simply using Hayes-style commands. The ESP8266 have 1 MB of built-in flash, which makes the single-chip device capable of connecting to Wi-Fi. The price is very low and very few external components are present on the module which suggested that it could eventually be very inexpensive in volume, this attracted everyone.

Espressif's ESP8266 delivers highly integrated Wi-Fi SoC solution to meet users continuous demands for efficient power usage, compact design and reliable performance in the industry, with the complete and self-contained Wi-Fi networking capabilities, ESP8266 can perform either as a standalone application or as the slave to a host MCU. If the ESP8266 is subjected to host an application, it will promptly boots up from the flash. The integrated high speed cache in the processor helps to increase the system performance and optimize the system memory. Also, ESP8266 can be applied to any microcontroller design as a Wi-Fi adaptor through SPI / SDIO or I2C / UART interfaces. ESP8266EX integrates antenna switches, RF balun, power amplifier, low noise receive amplifier, filters and power management modules. This compact design minimizes the PCB size and it requires minimal external circuitries. Besides the Wi-Fi functionalities, the ESP8266 integrated with an enhanced version of Tensilica's L106 Diamond series 32-bit processor and on-chip SRAM. The ESP8266 can be easily interfaced with external sensors and other devices through its GPIOs. ESCP platform enables many sophisticated features, which includes fast switch between sleep and wakeup mode for energy-efficient purpose.
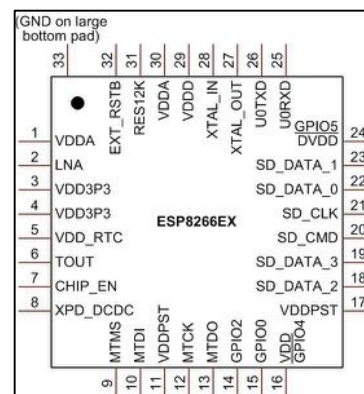

Fig. 2: Tensilica ESP8266 processor

Fig. 3: Tensilica ESP8266 processor pin definitions

TABLE I SPECIFICATIONS OF ESP8266

Specifications of ESP8266		
CPU	:	32-bit processor
Peripheral Interface	:	UART/SDIO/SPI/I2C/I2S/IR Remote Control GPIO/ADC/PWM/LED Light & Button
Operating Voltage	:	2.5V ~ 3.6V
Operating Current Average value	:	80 mA
Operating Temperature Range	:	–40°C ~ 125°C
Storage Temperature Range	:	–40°C ~ 125°C
Package Size	:	QFN32-pin (5 mm x 5 mm)
Wi-Fi Mode	:	Station/SoftAP/SoftAP+Station
Security	:	WPA/WPA2
Network Protocols	:	IPv4, TCP/UDP/HTTP/FTP
User Configuration	:	AT Instruction Set, Cloud Server, Android/iOS App

B. Fire Sensor:

Basically the fire sensor is an IR sensor. The working of IR sensor is just like a photo sensor. Its working principle is, when a photon with sufficient energy knocks out electrons, the resistance of the circuit will be changed. The IR sensor circuit consists of two parts; the emitter circuit and the receiver circuit. The emitter circuit consists of an IR LED (Light Emitting Diode) and the detector part consists of an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED. If IR light fall on photodiode, its resistance will be changed and its output voltage changes in proportion to the magnitude of the IR light that is received by the photodiode.

TABLE II SPECIFICATIONS OF YG1006

Specifications of YG1006		
Package type	:	Leaded
Dimensions	:	5mm
Peak Wavelength	:	$\lambda p = 940$ nm
Reliability	:	High
Response Time	:	Fast
Photo Sensitivity	:	High
Forward Voltage	:	1.2V ~ 1.5V
Operating Voltage	:	3.3V - 5V

Fig. 4: Fire sensor YG1006

C. Smoke Sensor:

The Smoke Sensor(MQ2) module is useful for detecting H2, LPG, CH4, CO2 and Smoke. Due to it's high sensitivity and fast response time we get measurements very fast. The sensitivity of the smoke sensor can be adjusted by the potentiometer, which is present on it. Since it is highly sensitive, it is most suitable for early smoke warnings. Smoke sensor needs 5 volt to power it and it indicate smoke by the voltage in it's outputs. More smoke will give more output. Sn02 is the sensor used in it, which will be in low conductivity when the air is clean. But when smoke exist in the environment the sensor provides an analog resistive output, which will be based on the concentration of smoke. The circuit contains a heater. Power is provided to the heater by VCC and GND from the power supply. Also the circuit contains a variable resistor. The resistance across the pin of variable resistor depends on the smoke in the air, where the sensor is placed. The resistance will be pulled to low value when the smoke content in the air is more and it will increase the voltage between the sensor and load resistor.

TABLE III SPECIFICATIONS OF MQ-2 SMOKE SENSOR

Specifications of MQ-2 Smoke Sensor		
Power Supply	:	4.5V to 5V DC
Highly sensitive to	:	Propane, Smoke, LPG and Butane
Durability & Cost	:	Long life and Low cost
Indicator Type	:	On-board visual indicator (LED)
Output Type	:	Analog and Digital output available
Pin Configuration	:	Simple 4 PIN header interface
Driver Circuit Type	:	Simple
Sensor Type	:	Semiconductor
Concentration	:	300-10000ppm (Combustible gas)
Supply Voltage	:	5V
Size	:	Compact design and easily mountable

Fig. 5: MQ-2 smoke sensor module

D. Power Supply Unit:

A regulated power supply is actually an embedded system, which provides energy for the proper functioning of the system. It can convert unregulated AC into a constant DC voltage. It uses a rectifier to do so. The main function of power supply unit is to supply a stable voltage (or less often current) to a circuit or device, which was working under certain power supply limits. The output from the power supply unit may be alternating or it can be unidirectional, but it is nearly always a DC. The type of stabilization used will be restricted to ensure that the output remains within the required limits under various conditions of load. For this system 7805 voltage regulator IC is used for getting 5V supply and AP111733 voltage regulator IC for getting 3.3V supply.
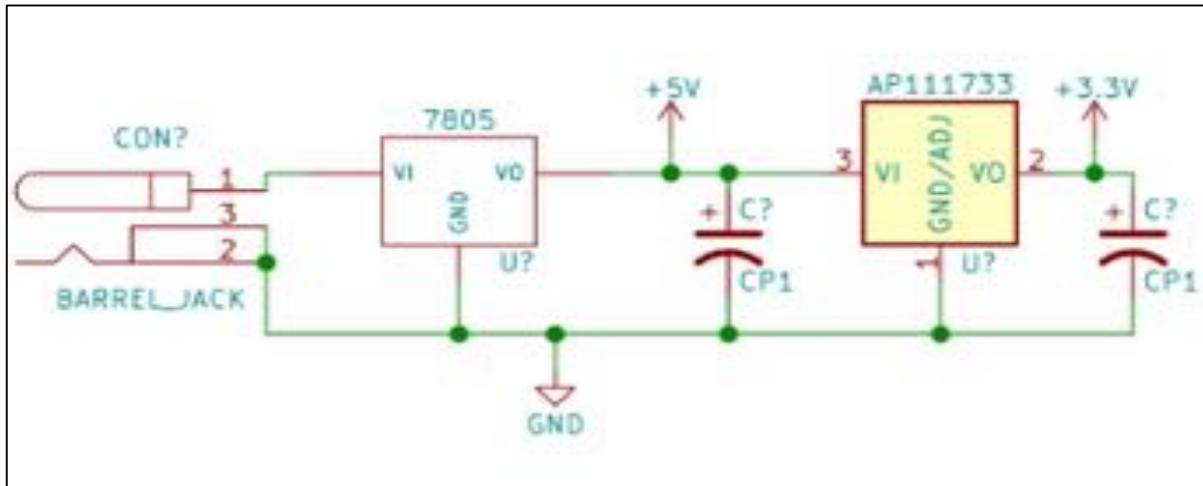

Fig. 6: Circuit diagram for power supply unit

IV. RESULT

Experiment using smart real time fire and smoke detection system was completed successfully and the results obtained is given in Table IV. The prototype of smart real time fire and smoke detection system is given in figure 7 and it is ready to be implemented on any building. When we implementing this system on a building, we have to add the GPS address of the location with the notification message through programming the system. This will help the fire fighters to reach the place faster.

TABLE IV
EXPERIMENT RESULTS

Sl. No.	Trials Using	No. of Times Checked	No. of Times Results Obtained Correctly
1	Fire Only	20	20
2	Smoke Only	20	20
3	Fire and Smoke	15	15

Fig. 7: A smart real time fire and smoke detection system

V. CONCLUSION

This paper describe an idea to built "A Smart Real Time Fire and Smoke Detection System". It gives an easy and less expensive way to implement a fire and smoke detection system with a notification to nearest fire station. By using this system, the fighters can subdue fire before it causes damage at a greater extend. This system is one of the useful, costless and fastest system for safety precaution. Thus an efficient microprocessor based system that provide an early warning to the nearest fire station, if there is a chance of fire is successfully developed.

VI. FUTURESCOPE

Besides notification to the fire department the smart real time fire and smoke detection system can have lot of additional functions, since this processor can support even digital signal processing. Some of the additional function examples are listed below:

A. Can use digital signal processing (DSP) to predict fire.
B. Supervision of fire sprinkler systems.
C. Surveillance of control valves.
D. Indication of water flow.
E. Monitoring of fire pumps.
F. Release of fire doors.
G. Release of some extinguishing systems.
H. Activation of smoke control systems.

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