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INDUSTRIAL SECURITY MONITORING & CONTROL SYSTEM THROUGH ANDROID APP USING RASPBERRY PI

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ABSTRACT

The proposed system is real - time Industrial Monitoring & Control using Raspberry Pi and sensors like water flow sensor, flame sensor, temperature ultrasonic distance sensor . This system comprises of digital sensors & camera for smart surveillance. This system alerts by sending Short Message Service (SMS) to Admin User & Concerned Plant Manager if there is occurrence of fire sensed by Flame sensor, overflow or underflow of liquid using water flow sensor. Camera will send intruder image through Email to Admin & Plant in-charge to take appropriate measures. Its advantage is its remote access monitor & control industrial threats before their full-fledged occurrence using ThingSpeak Android App.

Keywords: *— Security System, Raspberry Pi 3, Water flow sensor YF-S201, BMES Flame sensor, BMP180 Sensor,Remote security, Andoid app based monitoring, Internet of things , Single Board Computer , Eavesdropping, Thingspeak.*

I. INTRODUCTION

Nowadays, Security in Industrial sector has become immensely crucial. Due to advent modern technologies, use of security systems has been increased. Industrial hazards include accidental fire breakage, unintentional overflow or underflow of machine fuel level or suspicious individual entry. It is become utmost need of hour to shun such activities.

Present-day scenario exhibits that the safety in industry is relying totally on man-to-man communication which may be faulty, therefore if it is transited to machine-to-machine using Internet of Things (IoT) technology, an error-free and quick responsive security prototype can be devised. Such security systems are mandatorily essential for Staff & product security. In a last few decades, security of industry was supervised via a Central Control Room, where an individual was responsible to monitor each unit of factory.. However, this can be replaced by the Proposed System mentioned below. Manpower requirement is consequently reduced due to remote access through Smartphone App.

Raspberry Pi is chosen as the server as, it holds built-in wireless fidelity (WiFi) module .Variant sensors can be interfaced with Raspberry Pi based on the application-specific requirements varying industry to industry, based on the type of industry. ThingSpeak Cloud is used for sensor data storage & retrieval from authentic App user. Thus, live real-time monitoring of industrial entities is possible remotely using ThingSpeak App.

Monitoring system can be implemented with a virtue to measure temperature, altitude, water flow rate level, fire occurrence or intrusive individual entry. The measured data can be used to maintain safety in industry, for example, room temperature of Server room must be maintained between 59 to 68 degree Fahrenheit. This model is eternally crucial for refrigeration and automobile industry where process monitoring and analysis of stored sensor data is involved.

II. SURVEY OF EXISTING SYSTEMS

Supriya Dhamapurkar et. al. [10] designed Raspberry Pi & embedded Visual Basic VB server based remote operating & supervising of industrial device parameters. VB software is interfaced to Raspberry Pi via RS232 modem It aimed to save energy and control devices in the industry. The Raspberry Pi 3C is interfaced with Sensors

to sense the atmospheric conditions. It is also interfaced with 230V relays which can be turned ON/OFF by the 3C using the environmental conditions such as Light and temperature.

G. Jhansi Rani et. al. [1] implemented ARM 11 processor based motion detection system by using PIR sensor. It could send push notification to web server when there is an alien intrusion spot inside the room.

Yogita V. Narkhede et. al [2] designed Raspberry Pi based smart security model with Zigbee module and PIR sensor. In this, Temperature & light sensor data is sent for mobile devices where Raspberry pi is operated. High Definition HD Cameras and motion detectors, video cameras were attached to Raspberry Pi for live data packet reception. Zigbee module was used for communication purpose.

Jobi Zhanitta D. et al [5], devised Raspberry Pi 3 based embedded webserver for Smart Monitoring of real time sensor data .An IP Address was hosted by HTML webpage , to depict the the concentration of Carbon Monoxide and temperature level in location.

Priyanka S Lonare et. al.[6] developed Raspberry Pi based ARM IoT server to supervise pH level , CO gas concentration temperature, water flow level rate, , humidity, motion detection & intrusion detection .

III. PROPOSED SYSTEM

The aforesaid Security system can developed in two major parts :

- Sensor interfacing to Raspberry pi via I2C and SPI and GPIO Bus pins
- Android User Interface development for real monitoring & control of industrial activities.

1) Hardware requirements

a) Raspberry Pi:

Raspberry Pi is a single board computer innovated by UK based Raspberry Pi Foundation. Raspberry PI can be connected to USB Webcam via USB port. The operating system that can be installed in Raspberry Pi are Raspbian or Noobs . Raspbian operating system is structured on Debian architecture. It has built-in IEEE 802.11b Wireless Fidelity (WiFi) module, which avoids additional external peripheral usage of ESP Module as used in Arduino. Raspberry Pi can be interfaced with open source IoT platform such as NodeRed , ThingSpeak, Alexa and Thinger for Data Acquisition Cloud Service. The programming languages in which codes can be generated for Raspberry Pi are C, Python and Perl. Broadcom There is a separate CSI camera port for connecting the Raspberry Pi camera. To interface the Raspberry Pi touch screen display , a separate DSI display port is there .Micro SD port is inserted with SD Card for data storage and operating system. 5V, 2.5A DC Power Source is given to micro USB power source slot. It contains Broadcom BCM2837 64bit Quad Core Processor running at 1.2GHz frequency and 1GB RAM.

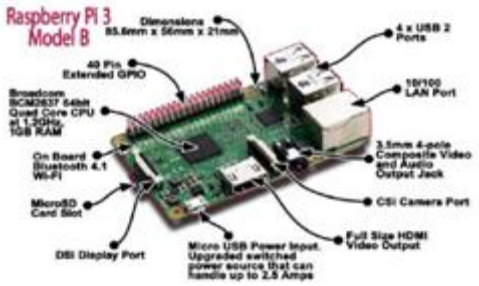

Fig.1 : Raspberry Pi 3 Model B

b) Water Flow Sensor (Hall Effect)YF-S201

This sensor is used to measure the water flow content & it output is in L/min. Flow rate can be computed with the number of pulses sensed in volume of water that is passed through the sensor. Its functioning is based on magnetic Hall Effect. There is a minute pin-wheel installed situated inside it that revolves along with the water flow. 3 wires in sensor are red, black and yellow in color. Red wire is DC power supply, yellow wire gives the digital pulse output (Pulse Width Modulation)

Frequency of Pulse (Hz) / 7.5 = Rate of water flow in L/min.

This sensor senses electromagnetic field and sound wave signals to measure the Fluid flow across a cross-section area.

Fig.2 : Water Flow sensor (YF-S201)

2. Ultrasonic distance sensor HC-SR04:

HC-SR04 Ultrasonic distance sensor has 4 pins namely Trigger, Echo, Vcc, and Ground respectively. Ultrasonic distance sensor has applications like measuring distance or sensing objects that are required. The module has comprises of speakers which act as ultrasonic sound transmitter and receiver contains the controlling unit. The transmitter sends a omnidirectional high frequency ultrasonic acoustic wave , which if strikes the solid body and reflected echo is used for distance measurement . The control unit calculates time interval between the point of transmission to reception.

Fig 3 : Ultrasonic Sensor HC-SR04

The sensor works with formula Distance = Speed *Time

d) BMP-180

BMP-180 is a digital pressure, temperature and altitude sensor module and has less power consumption, is smaller in size and more accurate. It is the modified version of BMP-085 series. It works on minimal DC power 5V.

BMP180 consists of an ADC , a piezo -resistive sensor, and a control unit with a E2PROM and serial I2C interface. I2C allows easy interface with any microcontroller.

Fig. 4: BMP 180 Sensor

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- *Flame Sensor :*

Flame sensor is a digital output sensor (output 0 or 1) which uses a photo diode to detect occurrence of fire flame in ambience. Detection point of about 60 degrees is sensitive flame spectrum. It works in 3.3V to 5V range & uses voltage comparator LM393. It possesses inbuilt potentiometer for sensitivity control. It is durable and compact in size .It has two LEDs: red for input power & green for output.

Fig, 5 : BMES Flame Sensor

a) Webcam:

USB Webcam 2.0 is preferred for surveillance purpose.

g) Power supply :

5 V DC Power supply is with 2.5A current compatibility to Raspberry Pi board.

- *Software requirement:*

Linux (Raspbian Jessie) OS :

Linux is an open source operating system. Linux consists of daemon, bootloader kernel & shell characteristics. Debian, Mint, Fedora and Ubuntu are some of Linux distributions made available to users. It has high efficiency and accuracy. Linux can run for long life time without glitch problem.

- *Python IDLE :*

Python is a high level general purpose programming language implementation language etc. Python IDLE is integrated development and learning environment. Python IDLE 2.7.3 and IDLE 3 are two successive versions. Both versions are compatible with each other but some codes need version 3. Python is cross-platform language compatible with Macintosh, Unix, Linux, or Windows. It owns an gigantic library support. It can be combined with CORBO, Java, ActiveX etc. programming languages.

- *Raspbian OS :*

Raspbian is a Debian -based operating system for Raspberry. This operating system is still under development for update purposes. It contains 35,000 packages for optimization of performance. Raspbian contains Java, Sonic Pi, Scratch and Mathematica etc. kind of programming platforms. The Desktop Environment of Raspbian is also called Lightweight Desktop Environment (LXDE) .There are two versions of Raspbian are Raspbian Jessie and Raspbian Stretch. This O.S. belongs to Unix-like family.

- *Win 32 disk imager :*

Win32 Disk Imager is an open sourced Windows program for saving or restoring images from removable drives like USB drives, SD and Memory card

- *Twilio Cloud service :*

Twilio is a platform as a service of cloud communications. Twilio uses Web service APIs for making & receiving phone calls and also to send and receive text messages (SMS Short message service) . Twilio has unique API key & Twilio Number assigned to every user to be used in coding. In this prototype, Twilio service is used to send SMS if there fire threat or water overflow or underflow is predicted by the system.

HTTP protocol is utilized for access to Twilio's services.

- *Android OS:*

Android Marshmallow is a member of Android operating system Family. Marshmallow is improvement over the overall user experience of its previous generation, Lollipop. It comprises of new APIs for contextual assistants along with a new power management that minimizes the background activity when a Smartphone is not being physically handled by user.

- *Thing Speak IoT platform :*

ThinkSpeak is open source API platform that can real- time sensor data of several Internet of Things applications and depict the data in pictorial form of analysis graphs . The Internet Connection serves as Data packet carrier between sensor assembly and the cloud to store, recall & retrieve the data sensed on the host microcontroller like Raspberry Pi , Arduino UNO etc.The channels in Thingspeak cloud have distinct field for data, location & status. All sensed data can be visualized graphically with statistics involved if MathWorks account is synchronized with Thingspeak cloud.

IV. SYSTEM DESIGN AND WORKING

A. *Hardware workflow design:*

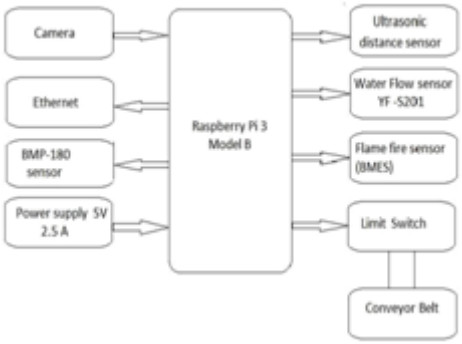

Fig 6: Design of Hardware Workflow

Raspberry Pi 3 board is given 5V, 2.5A power supply & is connector to sensor assembly & Ethernet LAN connection. Live camera capturing is carried out by USB Webcam 2.0.

Ultrasonic distance sensor HC -04 measures distance of suspicious intruder in authorized zone . HC-04 sensor has pins Echo , Trigger and Ground connected to GPIO.15, GPIO.14 & pin 9 respectively.

Water flow sensor YF-S201 measures the fluid level flowing between two pipes on basis of pulses counted.10K and 4.7 K sensors are needed to build voltage divider circuit.YF-S201 has pins connected to Vcc -pin 2,Gnd - pin 20,Output-pin 13.

BMES Fire Flame sensor is used in model for security purpose to detect fire at its onset stage. Photodiode checks flame in vicinity. Flame sensor has Vcc to pin 1,Gnd to pin 6 & digital output DO is connected to GPIO.21 of Raspberry Pi.

Conveyor Belt is controlled through Limit switch as shown in figure. Conveyor belt is operated through 500 RPM DC motor which connected limit switch for Android app-generated ON-OFF Commands.BMP-180 sensor denotes three parameters like temperature, barometric pressure & altitude.

WebCam 2.0 is connected through USB port for live image surveillance of the industry unit for security reasons. Live Image is sent to Email if App user requests for the same.

All sensor data is constantly updated to Android App through Raspberry Pi server for monitoring and control actions to be taken by Admin & Plant In-charge.

A. Software Workflow Design

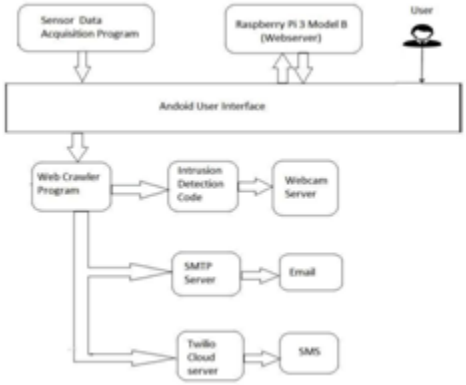

Fig. 7: Design of Software Workflow

Android User Interface is developed through ThingSpeak App. User is given access to glimpse current Snapshot of Industry in Android Application using Webcam server.

In case there is an overflow or underflow of water level seen in water flow sensor YF-S201 then user is notified with Caution warning on SMS & Email. Moreover, Fire borne losses can with-held after alerting the user using flame sensor data.

Email is sent via SMTP Server, whereas Short Messaging Service (SMS) is sent through Twilio Cloud server to user for taking needful measures.

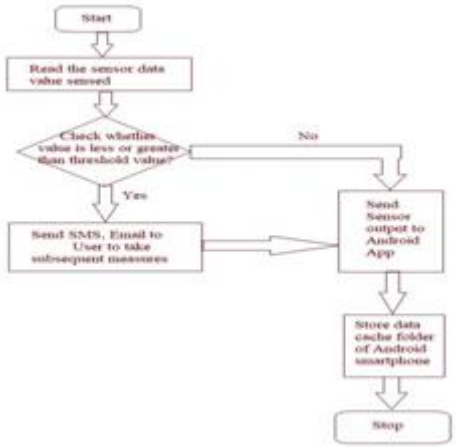

Fig. 8 : Proposed System Model Working Flowchart

V. RESULTS

Thinkspeak is open source API platform that can real-time sensor data of varied IoT applications and depict the data in pictorial graphical form. We have to enter the unique API key and Channel ID in the python code after login.

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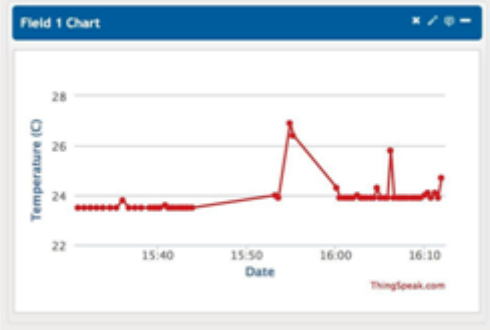

Fig 9 :BMP 180 Sensor output on Thingspeak App

Fig 10 : Water flow sensor YF-S201 output on Thingspeak

The following sensor outputs are received on Android App ThingSpeak when the data is being measured. If there fire threat sensed, the Plant In-charge and Admin user are alerted by sending SMS and Email caution warning. Thus security is ensured & threat can be prevented before its occurrence.

VI. ADVANTAGES

The proposed system is a user friendly system as the industrial threats can be avoided using it before the massive destruction on large scale. ThingSpeak Cloud service is free of cost. All visualization of industrial data is possible at just one click on ThingSpeak Application. The major advantage of it is global remote access through Android App. Manpower requirement specially for security can be reduced.

VII. FUTURE SCOPE

If more control necessities are implemented it will become highly automated controlling & supervisory model. Database storage enhanced with Google Firebase for Cache storage. More reliable application can be developed using myRio with Labview 2016 software. Error risk factor is minimized since system is automated in nature. More Bug fixation in the Android App can be made for respective advanced Android versions yet to come. If ThingSpeak data is visualized with MATLAB software more useful results can be obtained useful data analytics and statistics.

VIII. CONCLUSION

Hence, a system is proposed to develop that monitors & controls the industrial activities through Android User Interface and to take valid measures to avoid losses with cost effective circuitry & power consumption before unnecessary situations to happen.

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