Autonomous Vehicle for Industrial Supervision Based on Google Assistant Services & IoT Analytics

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Abstract — **In this particular paper, we are going to portray a robotic device that is mainly intended to be used in the field of Industrial Supervision and Maintenance. This device is in the form of a four-wheeler vehicle which can cover a certain area of floor of the industry depending on the range of WLAN connectivity from the main router. Multiple number of sensors are installed on the device and all of them are connected to the main microcontroller. Depending on the values received from the respective sensors, the microcontroller will update the data on a Cloud-based Web Server and in case of any emergency situation, from there the concerned departments will be notified via mail. The device is also equipped with a camera which will click photos, record short videos and also stream live video sessions depending on the situation and the verbal commands received from the respective user. The device's movements can be remotely controlled using Google Assistant Services. Using Voice Commands, the User can instruct the robot to follow Auto-Pilot Mode where the device will drive itself using the 'Obstacle Avoiding Algorithm' or else the robot can also follow the Hand-Gestures of the user and reach a specific location and provide necessary information about any adverse situation detected by the pre-installed sensors. In normal situation, the device will loiter all around the floor of the industry using 'Auto-Pilot Mode'. All sorts of communication between the User and the Device will be done using the Internet of Things Platform therefore the authority can monitor a certain situation closely from any part of the world.**

Keywords— Industrial Supervision, Robotics, WLAN Technology, ThinkSpeak IoT Platform, Google Assistant Services, IoT Analytics, Real-time Data Visualization, Cloud-based Web Services, Voice-Controlled, Hand Gesture

I. INTRODUCTION

In this current era of industrial revolution, for all kinds of industries ranging from small scale to large scale industries, various kinds of issues related to maintenance, surveillance, quality control as well as pollution preventive measures are still present which can only and only be solved using the principles of Robotics, Industry Automation and Internet of Things. Nowadays, in every industry, application of Robotics and automation has become the most common as well as an important pre-requisite to enhance the productivity as well as for maintaining quality standards. But, in real scenario, it is quite evident that although principles of Robotics have been extensively used in all kinds of mechanized works in a certain industry, but if we consider this particular field of Industrial Supervision and maintenance, the industries mainly use CCTV Cameras for monitoring purpose. The problem with this feature is that CCTV Cameras have a particular range of viewing as a result of which multiple CCTV Cameras need to be installed and in case of power-cuts, short-circuits and fire, it would be a problem for multiple number of CCTV cameras to operate simultaneously. Various other research works which have been already done in this particular field and other fields related to this have been elaborately discussed in the Related Works column.

This entire research paper will elaborately describe about an industry-ready prototype which can solve all the above-mentioned problems quite efficiently using the GOOGLE ASSISTANT SERVICES and INTERNET OF THINGS Platform. Keeping in mind about the various hassles related to connectivity, we have used WLAN (Wireless Local Area Network) as the mode of communication between the

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microcontroller (used in the Robot) and the IoT based Cloud Server in order to get a stable Internet Connectivity which is quite important for serving this purpose. Multiple number of sensors which are capable of sensing the INDUSTRIAL ENVIRONMENT quite efficiently have been used in this model. The sensed values received from these sensors will be directly uploaded on to the IoT Platform which can be referred as accurate values for further Analysis and other related procedures based on IoT Analytics. In addition to this, the Robot is equipped with a Camera Module which will stream a Live Video Footage on the Web Server. Moreover, using this camera the Users can click pictures or take a short video remotely as per their requirements. For any diverse situation when the sensors will show up values exceeding a certain threshold, CLOUD-BASED WEB SERVICES will be activated and will publish the messages regarding a certain topic on to the server and the corresponding department/officials who have already subscribed to the same topic previously will receive instant notifications. In order to gather further information about the scenario, the User might use the Hand-Gesture Mode or his Vocal Commands to further inspect the situation. In normal situation, the Robot has the capability of following Smart Self-Driving Techniques wherein it can avoid the nearby obstacles using the 'Obstacle-Avoiding Algorithm' without any human interference. Thus, the Robot is self-sufficient in inspecting its surrounding environment quite efficiently. However, in case of any complications, it will provide necessary updates to its User based on which he/she can control the device from a far-away distance. Most importantly, the Robot is controlled via Voice Commands using Google Assistant Devices. The mode of usage of this robot can be easily switched from one form to the other as per the User's convenience just by pronouncing a Voice Command using the Google Assistant. This Robot on one hand, is a cost-efficient and easy to use product and on the other hand, can be e-controlled and its data can be visualized for further analysis from any part of the world.

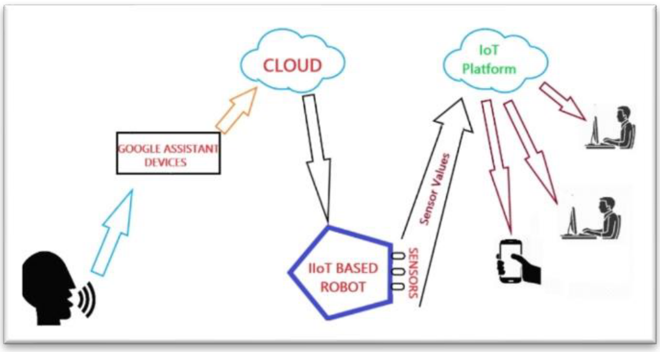

Fig 1- Architecture of entire prototype

II. RELATED WORKS

Nowadays, in industries, fully or partially autonomous robots and various kinds of automated instruments/devices are used mainly for the manufacturing, welding, supply of raw materials, transportation and many other purposes which were previously used to be fulfilled by human beings. For example, companies like KUKA, Yaskawa and ABB have already produced different types of Robotic Arms and Automated Instruments which have made the manufacturing process quite easier, time-efficient and highly precise. However, in the fields of Industrial Supervision and Maintenance, very less amount of progress has been made so far. There are several research papers which explain about robots that can be used ideally for monitoring the industrial supervision systems and other production processes but in the practical world, no such improvements or devices have been invented so far. However, it is quite apparent from the present results, that in the near future, robots will have to take its place without which the production quality of the industries cannot be enhanced.

Let's consider all the research publications done up till now in this particular field of technology. There are few papers which tell us about the usage of 'Swarming Technology' for the entire controlling process of robots. In a way, it is a quite efficient process to govern a particular odd situation. But, controlling the network of robots is quite a difficult one and at times, it might become quite inefficient. Furthermore, the process will become quite expensive both in terms of first time purchase as well as maintenance. In case of any sudden problem in one of the robots, all other robots will malfunction.

There are certain works where the usage of Ramadge-Wonham theory (1987) of supervisory control is mentioned. RW Theory mainly speaks of a mathematical framework which can be used for designing and computing purposes as far as the field of Robotics is concerned.

In one of the research publications, 'Cognitive Info Communication Channels' have been used for supervising the industrial robots. The robots use to function as slave devices who have their own limitations. Here, the User can give commands to the robot through verbal speeches, CAD Documentations and certain gestures.

Usage of 3D Simulation Environment for extracting the possible movements of robots is again one of the most important topics implemented so far. The intersection between the robots' work envelopes and the spatial volumes where collisions are expected to occur are calculated. The targets which the robots have to visit in a certain sequence are pre-assigned into the system. As a result, it can be considered as the most effective collision-free discipline for the movement of robots. For every individual robot, their different sequences of operation are represented as distinct sets of automata. Then, the automatically generated system model is analyzed by using the above mentioned Ramadge-Wonham supervisory control theory.

These are some of the main highlights about the previously done research works which are related to this particular paper.

III. COMPONENTS USED

A. *ARDUINO* - This is an open-source platform used for building electronics projects. Arduino consists of a programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on computer, used to write and upload the C++ code from computer to the physical board. TYPES USED here - Mega 2560 and NANO R3.

B. *NODEMCU (ESP8266)*- This is an open source IoT Platform. NodeMCU is based on a firmware [ESP8266 Wi-Fi SoC from Espressif Systems] and hardware based on ESP-12 Module.

C. *RF MODULE (433 MHz)*- The module is used to transmit and receive the radio signals wirelessly. It works at frequency level of 433 MHz. It is actually a two-device communication system between the transmitter and the receiver and it is widely used in electronic wireless systems.

D. *ADXL335(Accelerometer)*- The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ±3 g. It can measure the static acceleration due to gravity in both tilt-sensing applications as well as dynamic acceleration resulting due to motion, a shock, or any sort of vibration.

E. *L293D (MOTOR DRIVER)*- It is a dual H-Bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors.

F. *DC MOTOR & WHEELS*- DC motor is a class of rotary electrical machines that converts electrical energy (DC) into mechanical energy. Nearly all types of DC motors have some internal mechanism for periodically changing the direction of current flow.

G. *HC-SR04 (ULTRASONIC SENSOR)*- This sensor uses SONAR technology to determine the distance from an obstacle. It comes with an ultrasonic transmitter and receiver module. It offers non-contact range detection with high accuracy.

Fig 2- Ultrasonic Sensor[1]

H. *SG-90(SERVO)*- This motor is used in producing torque or rotatory motion. It operates in the range of 4.5V to 6.5V. These motors can rotate from 0 deg to 180 deg.

I. *BATTERY*- Here we have used a lithium-polymer battery which is a rechargeable battery based on lithium-ion technology where it uses a polymer electrolyte instead of a liquid electrolyte. The 3-cell battery has 2500 mAh capacity.

J. *ARDUCAM (OV7670)*- It is a SPI camera solution for Arduino. Arducam mini version is actually a 2-megapixel image sensor OV7670 which reduces the complexity of the camera control interface. This is a TTL communication-based module which can read image and data via UART serial port.

Fig 3- ArduCam [OV7670] [2]

K. *GAS SENSOR (MQ-6)*- This sensor can detect or measure the concentration of gases like LPG, butane etc. in its surrounding environment. The sensor comes with a digital pin which makes this sensor to operate even without a microcontroller. When it comes to measuring the concentration of gas in ppm, the analog pin needs to be used. The module also has an onboard comparator for comparing against an adjustable pre-set value and gives out a digital signal- ‘High’ or ‘Low’. The MQ-6 sensor can detect gas concentrations anywhere between 200 to 10,000 ppm. This sensor has a high sensitivity and fast response time. The sensor’s output is an analog resistance. The module works on 5V.

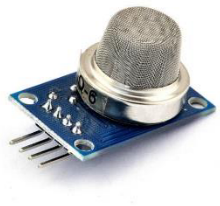

Fig 4- Gas Sensor [MQ-6] [3]

L. *TEMPERATURE-HUMIDITY SENSOR (DHT 11)*- It is a low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the contents in the surrounding air and gives out a digital signal on the data pin. The sensor can measure temperature from 0°C to 50°C and humidity from 20% to 90% with an accuracy of ±1°C and ±1%.

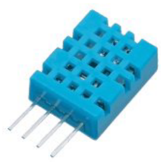

Fig 5- Temperature & Humidity Sensor [DHT-11] [4]

M. *FLAME DETECTOR*- These detectors are based on Infrared based Flame detection Algorithm. This sensor has a perfect sensing field of approximately 120 degree.

Fig 6- Flame Detector [5]

N. *ADAFRUIT SI1145 DIGITAL UV INDEX / IR / VISIBLE LIGHT SENSOR*- The SI1145 sensor works on the basis of a 'Calibrated Light Sensing Algorithm' using which it can calculate UV Index. It does not contain an actual UV sensing element. It actually approximates the values based on the values received with respect to visible light (centered on 530) & IR light (centered on 800) from the sun.

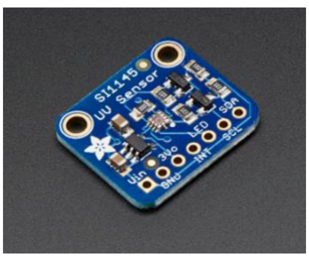

Fig 7- Adafruit SI1145 Digital UV index / IR / Visible light sensor [6]

IV. TECHNICAL FEATURES

A. *GOOGLE ASSISTANT SERVICES: -*

The user can maneuver the device's movements and switch over the various modes available by using a Google Assistant Device (for example, any Google Home Products, Android Devices or any kind of Google Assistant SDK enabled SBC device). The google account with which the device is signed in needs to be previously linked with backend architecture of the entire protocol. The Google Assistant Device as well as the Robot need to be connected to the Internet in order to communicate properly.

Firstly, the user needs to switch ON the robotic device using a specific voice command before which no other commands will be accepted. After the robot is turned on, the user can switch over various modes available for controlling (Voice-control Mode, Auto-pilot Mode and the Hand-Gesture Mode) the Device's movements just by mentioning the name of the mode verbally. The entire process is depicted in Fig.8.

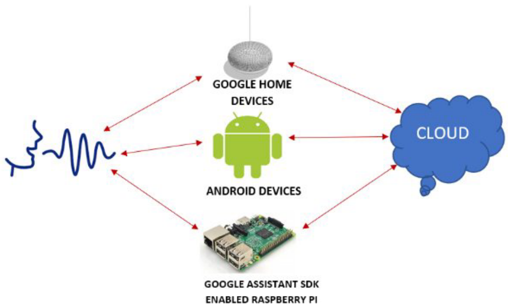

Fig 8- System Flow Diagram for Triggering (Using Google Assistant Services)

B. *VOICE-CONTROLLED MODE: -*

After the Robot is turned on, the User needs to use the command 'Start Voice-Controlled Mode' as the initial step. Instantly, an audio response message will be received as confirmation of the above given command. Next, the user needs to use voice commands (like FORWARD, BACKWARD, RIGHT, LEFT, STOP) for controlling the Robot's movements.

C. *HAND GESTURE: -*

This Robotic Device is fully controlled using the Google Assistant Services. So here using the command 'Start the Hand Gesture Mode' via GOOGLE ASSISTANT we can change the mode of the robot car from any corner of the world. Firstly, we have to wear a glove where the Accelerometer, Arduino Nano R3, RF transmitter are installed. Basically, by measuring the change in rate of acceleration or deceleration along X and Y axes using Accelerometer, the glove sends a signal to the robot so that it can move in accordance with the input gesture. From approximately 80-meter distance we can control the robot car with high accuracy. On bending the wrist, the glove will send a specific signal to the robot specifying the direction in which it should move. There is a tap switch which turns the glove on or off. When it is off, the robot will continue to follow its last command. The glove which is intended to be used for this purpose is shown in Fig. 9.

Fig 9-The Picture of Glove with all the Connections

Graph showing transmission of signals from gloves to robot: -

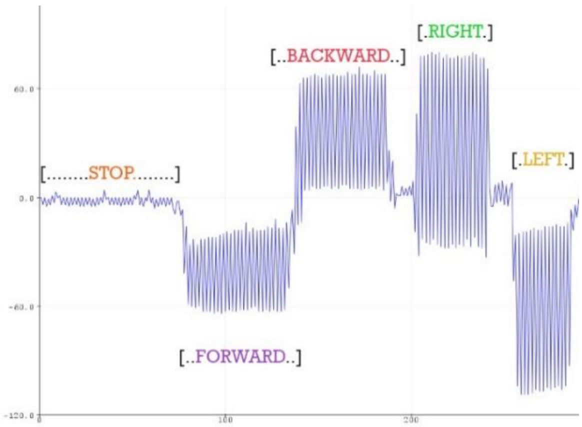

Fig 10- This is a combined graph showing the mapped values for each and every gesture detected by the Accelerometer.

This graph is made by using Arduino Plotter.

D. *AUTO PILOT: -*

Apart from the hand gesture mode, the robot has another capability which is the Auto Pilot mode or the Self-Driving Mode. Here firstly we can change the mode via GOOGLE ASSISTANT using the command ‘Start the Auto Pilot Mode’ and it can automatically switch to the self-driving mode. Mainly in this mode it can sense all the static objects in front of it and avoid them. In this model there are total 3 ultrasonic sensors. Ultrasonic sensors can sense the object in front of it and measure the distance. After getting the distance, robot will avoid the specific object which will be considered as an obstacle in its path. The two front corners of the robot are totally safe because of the presence of two ultrasonic sensors over there. Here we are using the SONAR technology which means that by calculating the time lapse between the generation and the sound waves getting reflected back, we can measure the distance between the source and the obstacle. If any obstacle is sensed by the ultrasonic sensors, then at first the robot moves backward then ultrasonic sensor which is mounted on a servo motor rotates left to right and as per the signal received from this sensor, the micro-controller decides where it should turn- left or right by calculating the respective distances. After turning, if the obstacle is avoided successfully then it continues to move in the forward direction. Until and unless the obstacle is avoided, the above-mentioned process will run continuously. In the front side, two other ultrasonic sensors are fitted at the two corners which are always active to avoid collision. The sensitivity of the ultrasonic sensor can be changed manually. The entire setup for the ‘Autopilot’ Mode is shown in Fig.11.

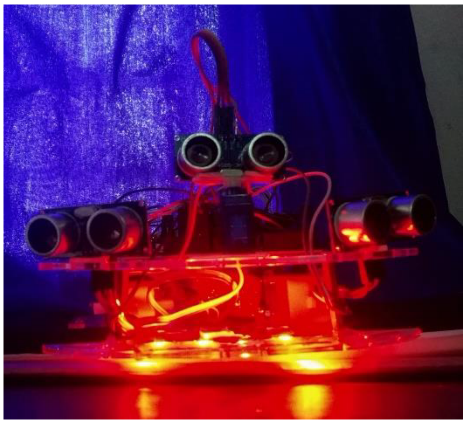

Fig 11-The Picture of Project Model

E. *DATA ACQUISITION AND ANALYTICS: -*

The four sensors installed on the Robotic device will continue to sense its surrounding environment and after every fixed time interval of 15 minutes, it will upload the pre-collected data on to the ThinkSpeak IoT Platform. The data will be stored over there and the user can refer to it anytime for further analysis and visualization. Some specific MATLAB programmes are already stored in the Cloud using which the User can obtain the correlated graphs based on Real-time analysis.

The graphical method used for analysis of the acquired data is described by the plot shown in Fig.12.

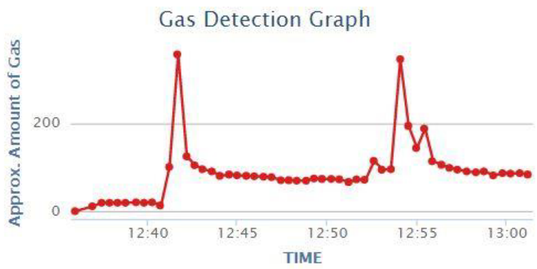

Fig 12- Graph showing the Raw values received from the Gas Sensor

F. VIDEO SURVEILLANCE: -

The NodeMCU will use the ArduCam for streaming Live Video Sessions. The user can watch live video sessions, click snapshots, record a short videoclip using his/her smartphone. This entire feature will help the authority to monitor an emergency situation closely depending on which they can take necessary actions.

G. AUTO-GENERATED RESPONSES: -

As soon as the cloud will receive a value crossing the pre-defined threshold from one of the sensors, the head of the entire industry will be notified via mail. In addition to this, the head of the concerned department will receive a notification alert so that he can monitor and control the situation effectively. A sample format of the email notification alert to be received by user is shown in Fig.13.

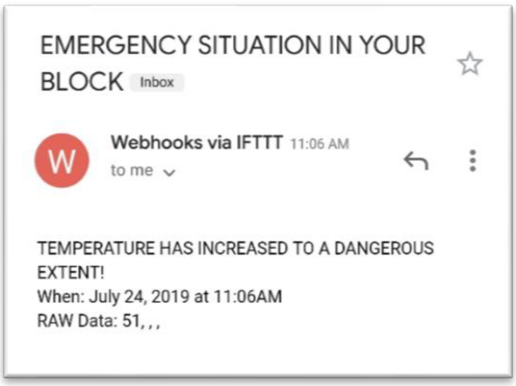

Fig 13- Format of the E-mail Notification Alert

H. CONNECTIVITY ENHANCEMENTS FOR THE ROBOT: -

Firstly, the Robot needs to be connected to a Wi-Fi Network for getting a stable Internet Connection. The device on getting power, will first search for the pre-used Wi-Fi credentials. The built-in LED of the NodeMCU will blink with a certain frequency. If it finds that particular hotspot within its range, it will get automatically connected and the LED will turn solid.

In case when the device cannot connect using the previously defined Wi-Fi credentials, the NodeMCU will act as a HTTP Server. In this configuration part, the LED will blink at a faster rate. Automatically, a webpage will be generated and after signing in to the NodeMCU Server, the user can log into the new Wi-Fi Hotspot by entering the correct Wi-Fi SSID and Password. From then onwards, the Robot will use that Wi-Fi hotspot for receiving commands and uploading all the necessary informations. Moreover, from that captive portal the user can get information about the Chip ID, Flash Size, IP Address and MAC address and can also reset the entire module. In case if the Web-page do not open instantly due to certain security factors, the user can use the IP Address- 192.168.4.1 to directly sign in to the NodeMCU using any local Web Browser. Fig.14 is showing the self-generated captive portal to be used for entering the Wi-Fi credentials.

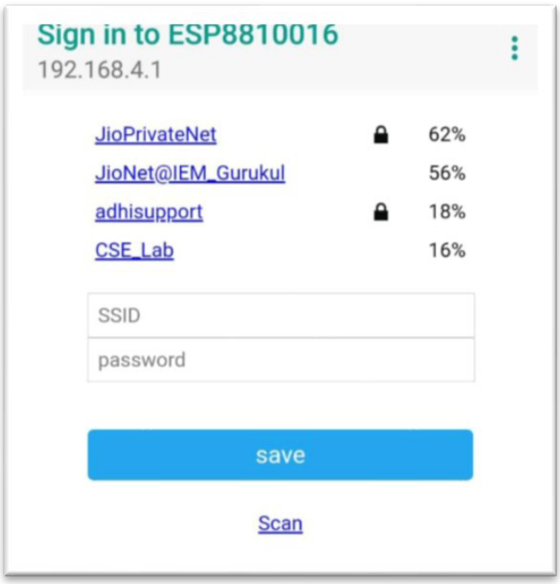

Fig 14- Sample Picture of the Captive Portal

V. METHODOLOGY

A. Google Assistant Web Services: -

The most important factor to be used in this case is the Web Service Chain. The web service chain accepts the voice commands from the user using the Google Assistant device and, in the output, it gives necessary commands for controlling the Robot. The entire Web Chain is discussed in the following mentioned points: -

- On receiving the voice commands, the IFTTT (If This Then That) applet will be triggered directly.

IFTTT is a web-based service for creating web chains.

- The triggered applet is directly connected to ADAFRUIT.IO (a Cloud based IoT Service Platform) before which all necessary authorization steps are needed to be taken.
- For every verbal command made by the User, the applet will publish specific data on to the ADAFRUIT.IO cloud platform.
- That published or the retrieved value will be stored as a feed in ADAFRUIT.IO.
- Now the microcontroller installed on the device needs to be previously subscribed to that specific feed in order to receive commands from the cloud.
- Depending on the commands received from the Cloud, the microcontroller will take necessary decisions.
- Once, the web chain is established properly, the user will just have to mention the mode of operation verbally and accordingly the robot to begin to work. As a confirmation, a response message will also be generated.

This entire Web Service Chain is shown in Fig.15.

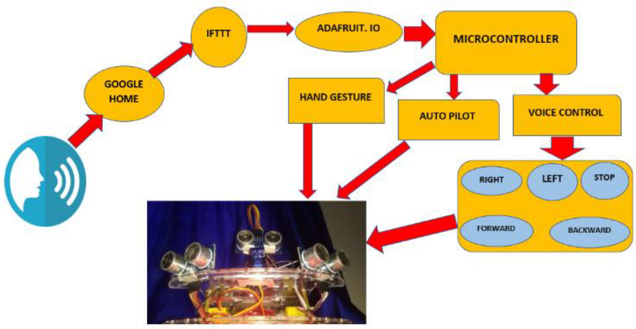

Fig 15- System Flow Diagram explaining the entire Web Service Chain

B. Hand Gesture

- The system mainly consists of a RF (radio frequency) module controlled by ARDUINO UNO. RF Module is a cheap wireless communication module used for low cost applications. RF Module comprises of a transmitter and a receiver both of which operate at radio frequency range. Usually, the frequency at which these modules communicate will be 433 MHz.
- The RF module mainly transmits the data of the accelerometer which is to be fitted on the hand glove.
- Jumper wires are used to connect the Arduino board and the transmitter module. Fig.16 shows the entire connection diagram of Arduino and RF TX module.

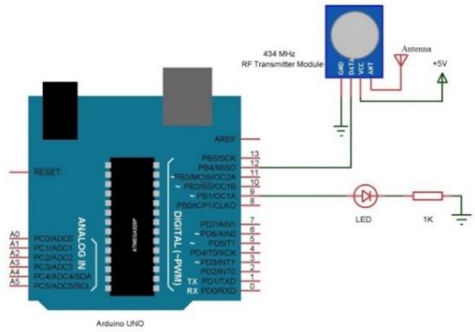

Fig 16-The Circuit Diagram of Arduino and Transmitter Module of RF [7]

- Then the accelerometer sensor will also be connected with that Arduino.
- The circuit is our main transmitter circuit which is to be fitted on the glove.
- In order to increase its range and also the strength, we have connected an antenna to the transmitter module. Then the final code is uploaded into the Arduino installed on the hand glove.
- After that, the receiver is connected to the main Robot's Arduino. Fig.17 shows the circuit diagram of Arduino and RX of RF.

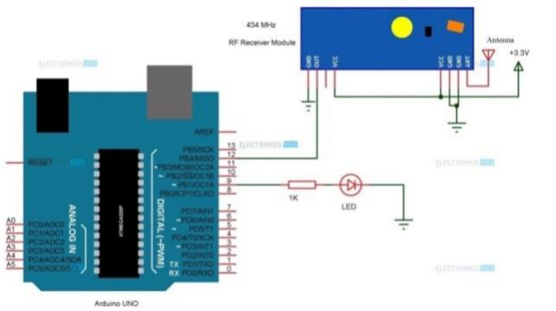

Fig 17- The Circuit Diagram of Arduino and Receiver module [7]

- Here, in the code according to the data received from the accelerometer, the robot's motors are rotated in accordance with that received data.
- The accelerometer's data is mapped along the X axis to –X axis for forward and backward direction.

  Along Y axis to –Y axis, movements from left to right direction is mapped.
- There is a certain gesture where the palm is to be held at a horizontal level which indicates the motors to stop their rotation.
- The motor driver is installed with all the necessary connections. The code is uploaded into the Arduino UNO. Finally, the entire setup is complete.

C. *Auto-Pilot*

- Here we have used 3 ultrasonic sensors (**HC-SR04**) and 1 **SG90 Servo Motor.** One Ultrasonic Sensor is attached to the armature of the servo motor. Mainly ultrasonic sensors are used for measuring the distance by ultrasonic sound waves. It emits an ultrasound at 40,000 Hz which travels through the air and if there is an object or obstacle in its path, it will get reflected back to the module. Considering the travel time and the speed of the sound wave, we can calculate the distance. A schematic diagram of function of ultra-sonic sensors is shown in the Fig 18.

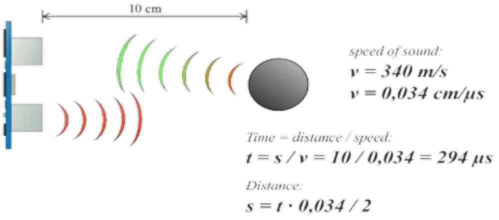

Fig 18- The Basic Concept of Ultrasonic Sensor[8]

- The **HC-SR04** Ultrasonic Module has 4 pins - Ground, VCC, Trig and Echo. The Ground and the VCC pins of the module needs to be connected to the Ground and the 5 Volts Supply Pin on the Arduino Board respectively and the Trig and Echo pins are connected to any of the digital I/O pins on the Arduino Board.
- After that, a specific distance parameter is mentioned inside the code to avoid any kind of collision. On sensing this particular distance from the obstacle, the Robot will stop moving forward.
- The servo equipped with the ultrasonic sensor will move from 0 degree to 90 degree from left to right. Then it calculates the distance between obstacle and itself. After that, as per the algorithm used, it decides in which direction, distance from the obstacle is greater and accordingly makes its move. This information is sent to the motor driver through Arduino.
- The rest two ultrasonic sensors are kept at the two corners of the robot for better perfection in order to avoid collision.
- After that, the entire code is merged and uploaded in to the Arduino UNO board.

D. *Voice Control*

- In order to activate the Voice-Controlled Mode, the user needs to use the command- 'START THE VOICE-CONTROLLED MODE' or similar kinds of commands which will be taken as an input command through the Google Assistant enabled device. Instantly, the user will receive an audio feedback message.
- After initiating the voice-controlled mode, the User need to use commands like- 'FORWARD, BACKWARD, RIGHT & LEFT' to control the movements of the Robot verbally.
- To stop the movements, the User needs to use the command- 'STOP THE ROBOT'.

E. *Data Acquisition and IoT Analytics*

Multiple number of sensors are already installed on the device to sense its surrounding environment effectively. For example, we have used Gas Sensor, Flame Sensor, UV Ray detector, Humidity and temperature sensor.

We will explain the entire process of Data Collection and corresponding analysis/visualization using IoT Cloud Platform with the help of a single sensor i.e. the Gas Sensor (MQ-6): -

- MQ-6 Gas Sensor can detect/measure the concentration of gases like LPG (Liquefied Petroleum Gas) and butane anywhere from 200 to 10,000ppm in its surrounding environment.
- All the values detected by the sensors will be published on the Cloud Platform so that the entire data is stored securely and can be used as references for future analysis/visualization.
- By using the MATLAB codes, automatically the values will be analyzed on the Cloud Platform. As an example, the plotting of Maximum and Minimum values obtained from the hourly-based analysis using the MQ-6 Gas Sensor in general environment is given below in Fig.19.

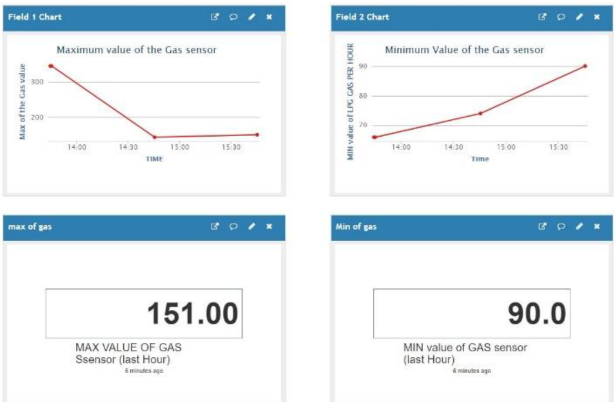

Fig 19- Plotting of Maximum and Minimum values obtained from the hourly-based analysis using MQ-6 Gas Sensor

- The entire visualization process will be carried out in such a manner that the user can get a clear idea about any unwanted situation from the graph itself. As an example, we have created a histogram which depicts the variation of values received from the Gas Sensor. The histogram is shown below in Fig-20.

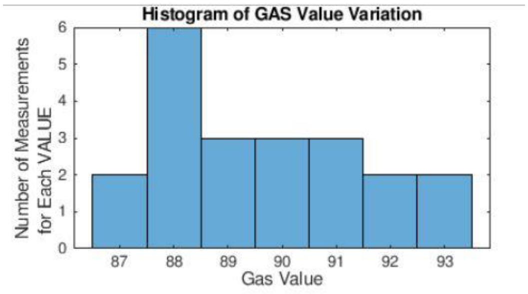

Fig 20- Histogram showing the variation of values received from the Gas Sensor

F. Live Video Surveillance

- A 2MP ArduCam is installed on the device which is connected to the NodeMCU. The connection diagram is shown in Fig.21.
- The NodeMCU will act as a HTTP Server and it will use the Web Socket Technology to stream Live Video Sessions using the Cloud Platform.
- This Web Socket Service is a completely standalone Web Interface and can be easily accessed using any other web server.
- In addition to the Live Video Streaming applications, there will be options for capturing snapshots and recording short duration videos.

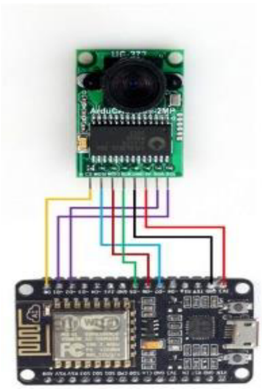

Fig 21 – Connection Diagram of ArduCam with NodeMCU [9]

G. Auto-Generated Responses

- From the data received from the sensors, if the values received from any one of the sensors crosses the user defined threshold value, an email will be generated which will mention the specific sensor name (applicable for all the departments) and the corresponding values along with the link for live video streaming. This email will be sent to the central authority of the entire industry.
- To that concerned department under whose jurisdiction the problem has occurred, a specific notification alert will be sent. But for this, the department needs to subscribe to that particular topic beforehand. Name of the sensor along with all the necessary details will be included along with that notification.

Fig.22 is showing the process used for automatic generation of responses via Cloud Platform.

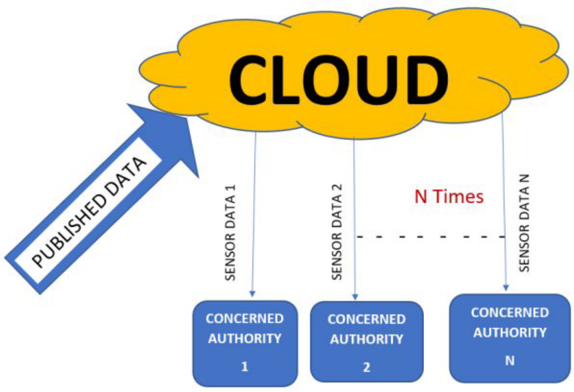

Fig 22- Automatic Generation of Responses via Cloud Platform

VI. FUTURE SCOPE AND IMPLEMENTATION

This robotic device can sense its surrounding environment efficiently and accordingly notifies the concerned user. In addition to this, the user will have the full independence of choosing the mode for controlling the robot's movements as per his/her convenience. Although we have tried our best to prepare the device in such a way that it will be compatible with all kinds of industrial environments and can effectively serve all the purposes related to Industrial Supervision/Monitoring, but like all other devices we also agree to the fact that certain other changes or further developments can contribute in making the robot far more efficient.

This robot uses HAND GESTURE RECOGNITION which is very significant not only in this decade but also in the upcoming century. In future, this robot can be set up in such a manner that it can be controlled using the movements of other body parts like the usage of Eye-Ball tracking mechanism and rotating the head in various directions. Thus, the entire hand gesture control module can be used as a PERPETUAL USER INTERFACE, a completely new way with which we can coordinate with robots and computer systems and it will improve the effectiveness by leaps and bounds. It will also extend the field of usage as these kinds of devices can be efficiently handled by the physically handicapped people.

In order to secure the usage of Voice-Controlled Mode, 'Speech Recognition Algorithm' needs to be implemented so that the robot will respond only to the commands given by a certain individual from the concerned department. This will enhance the security level and will make the device much more trustworthy for using it in industries where high level of confidentiality is needed to be maintained.

Different other sensors can be installed on the device as we have left several open ports for inclusion of new sensors into the main board. Adding new sensors depending on the environment of that particular workplace will increase the sensation power of the entire device and at the same time, several other issues can be resolved effectively.

VII. CONCLUSION

This proposed system comprises of a versatile and robust robot which will work as an ideal device for INDUSTRIAL SURVEILLANCE. The robot is fully voice-controlled using the ‘GOOGLE ASSISTANT SERVICES’. Based on the data received from the sensors, the concerned department/user will be immediately notified. There are options for clicking photos, recording short video clips and streaming live video sessions which will ultimately help the user to closely monitor the entire situation. Depending on these informations, the user can take necessary actions. Thus, this entire system will give an effective solution for Industrial Surveillance/Monitoring purpose which will indirectly contribute in enhancing the production quality of any industry.

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