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Implementation of Cloud Robotics using Raspberry Pi to Monitor Production in Industry

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Abstract - *Cloud robotics is a field of robotics that attempts to invoke cloud technologies such as cloud computing, cloud storage, and other Internet technologies centred on the benefits of converged infrastructure and shared services for robotics. This paper is a study of cloud robot which is used in industrial and manufacturing environment. It works on a ROS platform. Here a Raspberry Pi controller is used to control the various devices attached to it. For testing this implementation, Android phone, camera, DC motor, sensors and a Raspberry pi controller have been used. The movement of the robot is provided by DC motors and the direction is controlled from an android environment using Robot Operating System (ROS). The controller and the receiver end is connected by Wi-Fi. The data input from the gas, temperature and Infra Red sensors is given to the Raspberry Pi controller. A camera is used to provide visual input of the surrounding environment to the robot. The data obtained by the sensors and camera are processed by the controller and stored in cloud.*

Keywords:- ***ROS, Cloud robotics, Raspberry Pi***

1. INTRODUCTION

With the advances in technology, a new area called Cloud Robotics (CR) has evolved from conventional robotics which can create a wide impact in industrial areas. When connected to the cloud, robots can benefit from the powerful computational, storage, and communications resources of modern data centre in the cloud, which can process and share information from various robots or agent (other machines, smart objects, humans, etc.). The goal is to construct a robot with sensors and alert system which works within the control of cloud. To make this work, a separate platform for the robot is needed to work on which is, the ROS- Robot Operating System.

Robot Operating System (ROS) is a collection of software frame works for robot software development providing operating system-like functionality. ROS provides standard operating system services such as hardware abstraction, low-level device control, implementation of commonly used functionality, message-passing between processes, and package management.

2. EXISTING SYSTEM

Existing industrial control and monitoring systems have a significant portion of their costs in cable installation and the maintenance costs associated with moving and replacing cables during machinery maintenance and re-configuration.

2.1Wired device

Wired devices are fixed to or near the machinery. These devices are wired to power supply. The lack of wireless system and large power consumption are the drawbacks of wired device.

Disadvantages- fixed in particular place, cost, cable installation, maintenance.

2.2 Manual system

Manually control the devices inside the industry. Disadvantages-Lack of wireless communication (e.g. - RFID, ZIGBEE). Large power consumption in order to automate the entire industrial system.

3. PROPOSED SYSTEM

The above disadvantages have been eliminated in the proposed system. In this method, we a locomotive Cloud Robot is introduced. A Raspberry-pi controller is used in the robot to control its movement. The directions are controlled by an android device or computer using ROS.

A Robot Operating System (ROS) allows a user to easily control the mobile operations of a robot. A Camera is used to give input to the Raspberry pi microcontroller. Temperature sensor and gas sensor is used to sense the temperature and gas leakage with the use of Raspberry Pi controller.

An IR sensor is used to alert attempt to access restricted area. An alarm system with a danger indication lamp, cooling fan and speaker alert are fixed with the Raspberry Pi controller. Wi-Fi is used to send the data from controller to Mobile using the IP address of the Raspberry-Pi kit. Using a mobile, the robot movement can be controlled. The monitored data will be sent to the cloud enabling access of information from anywhere.

3.1. Transmission Section

3.1.1 Raspberry Pi

This credit card-sized single board computer is a fully programmable PC that runs in open-source Robot operating system. The board consists of Video Core IV graphics

processing unit (GPU), ARMv7-compatible quad-core one, 512 MB of RAM. It has a MicroSD to boot media and for persistent storage.

One powerful feature of the Raspberry Pi is the row of GPIO - General Purpose Input/output pins along the edge of the board (refer Fig.1.1). These pins are a physical interface between the Pi and the outside world. At the simplest level, these are called as switches. Seventeen of the 26 pins are GPIO pins; the others are power or ground pins.

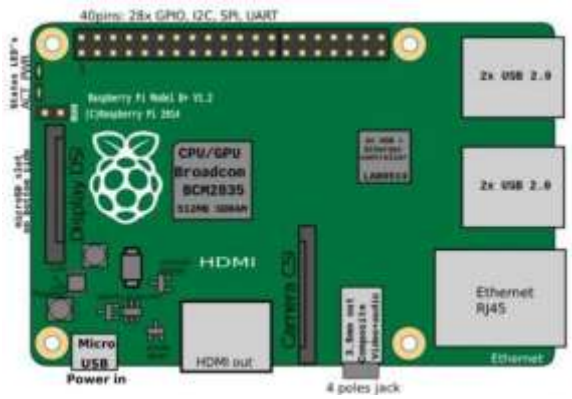

Fig. 1.1 Example for Raspberry Pi connectors.

3.1.2. Sensors

I. **Temperature sensor-** The DS18B20 Digital Thermometer provides 9 to 12-bit (configurable) temperature readings which indicate the temperature of the device. Information is sent to/from the DS18B20 over a 1-Wire interface. It can be powered from its own data line. Power supply range is from 3.0V to 5.5V. It measures temperatures from - 55°C to +125°C. It has 0.5§C accuracy.

II. **IR sensor-** These are miniaturized IR receiver modules for remote control systems. The sensors detect the wavelength and spectral radiation of the light from the IR emitter. It provides high communication speed and high level of security.

III. **Gas Sensor-** It is used in gas leakage detecting equipments the industry. It is suitable for detecting of LPG, iso-butane, propane. It had Small sensitivity to alcohol and smoke. Highlighting features include Fast response and Stable and long life. The sensor can be directly powered by DC supply or through a diver circuit.

3.1.3. Camera

The type of camera used here is an IP camera which has recording function built-in and can thus record directly to any standard storage media, such as SD cards, NAS (network-attached storage) or a PC/server. The camera feeds or streams its image in real time to a computer or a mobile using network. When "captured" by the computer, the video stream may be saved, viewed or sent on to other networks via Wi-Fi. When sent to a receiver side, the video stream is saved in cloud.

The resolution offered by the camera is 1280x720 (720p) or even 1920x1080 (1080p) resolution. The video stream is viewed in mobile or computer by connecting to the IP of Raspberry Pi controller kit.

3.1.4. Power supply

There are several ways to convert an AC voltage into the DC voltage. Traditionally, this has been done with a transformer and rectifier circuit.

However, in applications that involve providing a DC voltage to only the controller and a few other low-current devices, transformer-based or switcher-based power supplies may not be cost effective. So, Transformer less power supplies which provide a low-cost alternative to transformer-based are used in this robot. A transformer less power supply typically incorporates:

- Rectification
- Voltage Division
- Regulation
- Filtering
- Inrush Limiting

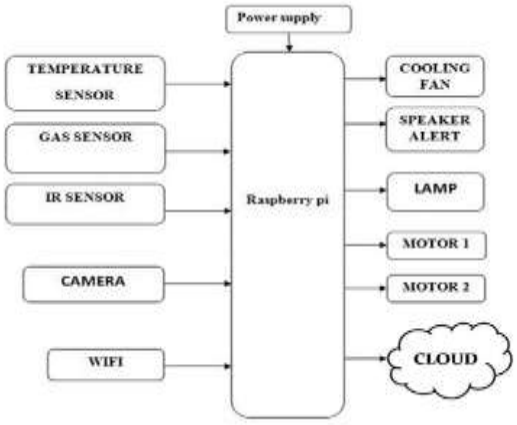

Fig. 1.2 Transmitter side block diagram

3.2. Receiver Section

3.2.1. Alarm system

i. **Cooling fan-** the robot is fitted with a cooling fan which turns on when the temperature sensor detects a reading

which is more than the desired value. The fan is focused in the area where the temperature dissipation is more and cools the area. It is powered by DC supply.

ii**. Indication lamp**- The light source powered by DC supply automatically turns on when the IR sensor detects access to restricted area. The lamp glows when IR receiver senses undesirable access into a particular area.

iii.**Speaker alert-** In case of emergency situation, say here a gas leakage, the gas sensor detects the presence of harmful gas in the environment and signals the controller. The controller in turn switches on the Speaker alert.

3.2.2. Cloud

Cloud computing is a synonym for distributed computing over a network. Its highlighting feature is the ability to run a program on many connected computers at the same time. Its advantages proved in history include on-demand self-service, ubiquitous network access, location independent resource pooling, rapid resource elasticity, usage-based pricing and transference of risk. Some of the Services offered by cloud include 'SaaS' (Software as a Service), 'PaaS' (Platform as a Service), 'IaaS' (Infrastructure as a Service), 'HaaS' (Hardware as a Service) and 'NaaS' (Network as a Service).

3.2.3 DC motor

The DC motor is connected to a set of four wheels and is responsible for the movement of robot. A DC motor is a class of electrical machine that converts direct current electrical power into mechanical power. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings.

3.2.4 Wi-Fi (Wireless Fidelity)

Wireless Fidelity or Wi-Fi is a local area wireless computer networking technology that allows the Raspberry Pi kit to connect to the network. It uses a bandwidth of 2.4 gigahertz.

The Wi-Fi network provides the connection of unique IP address from the Raspberry Pi kit to the devices in receiving end. Using the various encryption technologies in Wi-Fi, the network is made secure.

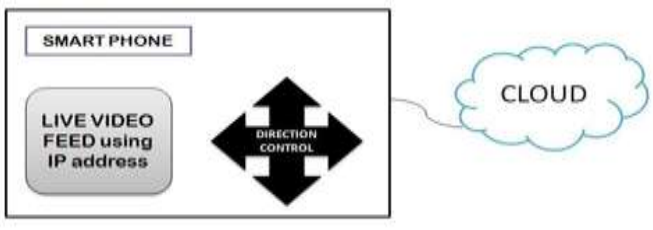

Fig. 2.1 Receiver side block diagram

4. OPERATION

A robot is designed that can move and monitor the entire industry from the inside. The movement is provided by wheels attached to the DC motor. Wheeled robots are the most energy efficient and simplest to control. The motor is controlled by the Raspberry Pi controller. The controller and the mobile or computer at the receiver station is connected by a unique IP address. Therefore the movement of the robot is controlled by the person at the receiver side by operating in a separate platform called the ROS- Robot Operating System. The live video feed obtained by the camera is streamed to the receiver and viewed in the screen.

In robot, If Temperature level increases above the threshold value then the controller switches on the cooling fan. If Gas level increases above the threshold value then the controller invokes the speaker announcement. IR sensor signals if a person is trying to cross a restricted area and switches on the lamp. All the data obtained in mobile is uploaded to cloud. The uploaded information can be viewed, saved from anywhere by entering the IP address.

Wi-Fi is provided for the entire process by a Wi-Fi dongle which is fitted along with the robot. The power supply for all the components is provided by DC transformer less power supply.

5. RESULTS AND DISCUSSIONS

Fig.2.2 Temperature, gas and IR sensor outputs in IOT.

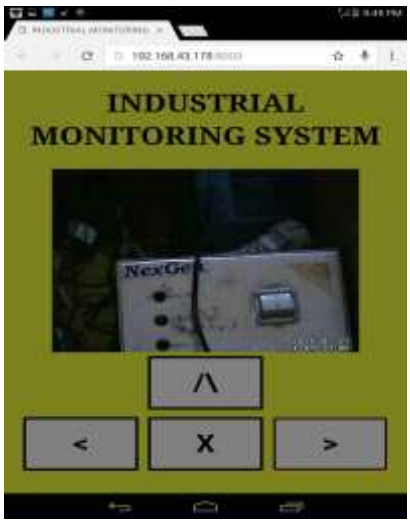

Fig.2.3 Receiver Screen In Mobile Phone

6. ADVANTAGES

- 24 hour surveillance is maintained. Provided, all the values obtained by the robot are stored in cloud.
- Safety is ensured by the IR sensor. Unwanted access inside restricted area can be avoided.
- Provides immediate attention to over temperature and heat dissipation by turning on the cooling fan.
- Smoke, harmful gas can be immediately detected and alerted.
- Industry monitoring can be done from anywhere. Even from home.

7. FUTURE WORKS AND CONCLUSION

i. The robot can be improved by implementing Obstacle detection.

ii. By making the robot fly the whole industry can be viewed properly.

A multi tasking robot that can make monitoring and securing an easy job inside an industry is designed. This cost efficient robot can save lots of manpower and also provide an accurate database of all the data obtained from inside the industry. With this he robot solution, Millions of lives can be saved by detecting gas leakages in industry

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