Vol 10, Issue 8, Aug /2019
ISSN NO:0377-9254

WIFI BASED COMMUNICATION WITH MOBILE ROBOT FOR REFINERY INSPECTION WITH RASPBERRY PI

#1BATA SIVA KUMAR, PG STUDENT
#2Dr B DHANANJAYA, PROFESSOR
DEPT OF ECE
BHEEMA INSTITUTE OF TECHNOLOGY AND SCIENCE, ADONI, AP

ABSTRACT: Oil and gas refineries can be a dangerous environment for numerous reasons, including heat, toxic gasses, and unexpected catastrophic failures. In order to augment how human operators interact with this environment, a mobile robotic platform is developed. This paper focuses on the use of WiFi for communicating with and localizing the robot. The robot is line following robot. It collects sensor data from the refineries and send them to thingspeak server.

Key words: Robot, WFI, PI, motor, Temperature sensor,

I.INTRODUCTION:

As advancements in technology continue, new possibilities that increase people's safety are being developed. These advancements range from robotic surgeons to automated factories and can be distributed in environments that are typically hostile to humans. Oil and gas facilities are often located in hostile environments. Whether it is the frigid cold of the frozen north, the extreme heat of the Middle East, or the isolation of an ocean, each location provides its own unique risks. The oil and gas infrastructure consists of four major components: extraction, refinement, distribution, and transportation in between each component. Each stage presents its own unique risks, from drilling practices during extraction, volatile explosions at refineries, to contamination during transportation and distribution. This work aims at reducing risk of human operators at the oil and gas refinement level. More specifically, this work considers oil and gas refineries in Abu Dhabi, United Arab Emirates (UAE), which is among one of the biggest oil and gas industries in the world. Hazards are numerous when it comes to oil and gas refineries in Middle East. Temperatures exceed 50o C for the majority of the summer, which combines with the high humidity of the region. Workers who are exposed often fall victim to heat stroke and related injuries. Sandstorms also ravage the area, reducing visibility to meters, and result in the erosion of equipment. Gas and steam leaks that are invisible to human senses can be fatal if humans are exposed. These leaks can also result in fire or even in an explosion of high-pressure vessels, leading to catastrophic failure. While there exists technology to monitor such environments, these devices are prone to failure. If a refinery is forced to shut down to address a failure, the effects on revenue are substantial. Even if a refinery is forced to shut down for a day, millions of dollars are lost in revenue.

To avoid these significant losses, routine inspection is performed on a daily basis. 1 These inspections vary from reading a gauge, to inspecting pipe and equipment, among other tasks. When a failure occurs, emergency inspection must be performed, which may prove hazardous to humans as they are entering an "unknown environment." A mobile robot capable of monitoring an environment through various sensors is a rational analog to a human. Robotic platforms can be equipped with various forms of locomotion and an array of sensors that are more capable than that of a human. Due to the constraint of these environments, restrictions are applied to physical systems that enter oil and gas facilities. Devices must meet specific industry standards before they are allowed to enter restricted zones. Mobile robots must meet specific criteria as stated in [1], which include: • ATEX or IECEx certified • Drive systems must be suitable for floor conditions, especially for offshore facilities • Size constraints are applied based on the location of the facility (offshore vs onshore) • Perceiving the environment is paramount - perception sensors must be highly reliable The work presented in this thesis is part of a multi-disciplinary project, contracted by the Petroleum Institute in Abu Dhabi, UAE, which aims to automate oil and gas processes. Oil and gas refinery environments can be seen in Figure 1.1. A mobile robotic system capable of autonomous path planning, path tracking, obstacle avoidance, and inspection has been created. The system is capable of tele-operation, various forms of shared control, and full autonomous control for various inspection tasks. The system consists of a Segway Robotic Mobile Platform (RMP), a 5 degree of freedom (DOF) arm, and a sensor package mounted at the end of the arm that is capable of a height of 2 m when fully extended, as seen in Figure 1.2. The sensor package consists of a network imaging camera, a thermal imaging camera, an acoustic sensor used for auditory leak inspection, and a methane gas sniffer. For more information on this system, interested readers may refer to [2].

This focus of this paper is on communication and localization of the robotic system through the use of WiFi. General approach that provides WiFi communication and localization that can be applied in any environment, specifically an oil and gas refinery. Without the capability of remote communication, an operator would have to be within line of sight of the robot in order to control the system. The operator would then still be exposed to most of the hazards originally afflicting the need for such a system. In order for a system to be able to autonomously navigate, it must be confident of its current location within some range of uncertainty; however, no one sensor provides both the precision and scalability required to operate within a large environment, such as an oil and gas refinery. Through sensor fusion, a more accurate localization can be achieved.

II.RELATED WORK

One idea is to deploy a wireless sensor network (WSN) to remotely monitor and detect leaks of harmful by-products of oil refineries [3].

These sensors are deployed throughout the refinery to detect gas leaks, report gauge readings, and perform various other tasks. Two major drawbacks to this approach are the limited battery life of the sensors and their prone to failure nature. Since these sensors have no mobility, one sensor must be placed at every location that requires monitoring. This distribution can become very costly in terms of not only money, but time as well. Augmenting how the operator performs inspection tasks is a reasonable solution to avoid unneeded exposure and cost. Compared to WSNs, a mobile robotic platform can provide reliable two-way wireless communication with less cost and maintenance than WSNs. Systems have been developed [1, 4] to address offshore oil and gas refinery requirements. [1] discusses both the important and most frequent operations required for an off-shore oil and gas facility. The authors also discuss the challenges of using an autonomous system in an oil and gas facility and explain the dangers of such a facility. The first autonomous system for an oil and gas facility is introduced by the authors. Localization is performed through fusing INS with reflective tape to characterize specific shaped objects.

Communication can be performed across WiFi to the operator control station or through Bluetooth to a hand held device. Similarly, [4] discusses the required hardware and software components as well as the necessary abilities of a mobile service robot for offshore oil and gas facilities. Their system is capable of both autonomous and tele-operation control. Inspection is performed 7 through predefined automated scripts. The system uses a form of Simultaneous Localization and Mapping (SLAM); however, no details are provided. Quantitative results for the accuracy of localization are also never given. [5] incorporates WiFi into a localization scheme for a mobile robotic platform. The authors use the existing WiFi infrastructure in an industrial environment to aid in the localization of an autonomous vehicle. The WiFi map is built through a Guassian Process using the popular squared exponential kernel. This information is then combined through a Sequential Monte Carlo location estimation with a laser beacon-based localization system. The authors were able to achieve a localization mean error of 7.4 m through 22.3 m depending on the type of testing environment. In contrast, we have developed an autonomous system capable of localizing to a sub-meter level in both indoor and outdoor environments.

WIFI LOCALIZATION:

In order for the robot to be able to autonomously navigate, it must be aware of its location. As previously discussed, WiFi is being used for communication between the robot and the control station. We have already shown how to expand this coverage to achieve k-coverage of a given region. From this multi-coverage, we will be able to develop a WiFi localization technique to assist in the localization of the robot.

III. HARDWARE SYSTEM

The proposed system is divided into two sections. A mobile robotic platform is a rational analog to a physical human - it can move through an environment either autonomously or through teleoperation while sensing its surroundings with an array of sensors. A PI is used with the sensors to receive the sensor outputs and to take the necessary decision. Once temperature is more than the safety level preprogrammed at PI, PI decodes beep alarms through controller once the measured humidity value is more than the safety level preprogrammed at PI; it decodes different type of beep alarms. Similarly when gas concentration crosses the safety level, PI decodes siren alarms. Different sensors values are displayed of refine workers section. In control station the information is received by WIFI and the status of the sensors is monitored in the laptops and required action is performed by sending signals to PI.

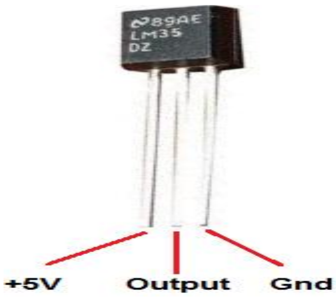
3.1 LM35:

The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in °C).It can measure temperature more accurately than a using a thermistor. The sensor circuitry is sealed and not subject to oxidation.The LM35 generates a higher output voltage than thermocouples and may not require that the output voltage be amplified.The

Vol 10, Issue 8, Aug /2019
ISSN NO:0377-9254

LM35 has an output voltage that is proportional to the Celsius temperature.The scale factor is .01V/°C.

The LM35 does not require any external calibration or trimming and maintains an accuracy of +/-0.4°C at room temperature and +/-0.8°C over a range of 0°C to +100°C.Another important characteristic of the LM35 is that it draws only 60 micro amps from its supply and possesses a low self-heating capability.The LM35 comes in many different packages such as TO-92 plastic transistor-like package,T0-46 metal can transistor-like package,8-lead surface mount SO-8 small outline package.



3.2 GAS sensor: Sensitive material of MQ-3 gas sensor is SnO2, which with lower conductivity in clean air. When the target alcohol gas exist, the sensor's conductivity is higher along with the gas concentration rising. Please use simple electro circuit, Convert change of conductivity to correspond output signal of gas concentration. MQ-3 gas sensor has high sensitivity to Alcohol, and has good resistance to disturb of gasoline, smoke and vapor. The sensor could be used to detect alcohol with different concentration; it is with low cost and suitable for different application.

3.3. Raspberry Pi

It is a powerful, low cost, and a small card sized device which is a perfect platform for interfacing with many devices. The board contains a processor, graphics chip, RAM memory, interfaces to other devices and connectors for external devices, of which some are necessary and some are optional. There are much versions of Raspberry Pi but the CPU (BCM2835) of all the models of Raspberry Pi remains same. The CPU is somewhat cheap, powerful and efficient and it does not consume a lot of power. It works in the same way as a standard PC requiring a keyboard for giving commands, a display unit and power supply.

Here, in Raspberry Pi, SD card is used in the same way as the hard disc in the computer. The connectivity of raspberry pi to the internet may be via a LAN (Local Area Network) cable / Ethernet or via a USB modem. The main advantage of Raspberry Pi is that it has a large number of applications. It also has 4 pole stereo output and composite video port. Video processing applications are also possible using raspberry pi like video compression.

Compressed video can successfully decrease the bandwidth required to transmit the video through terrestrial broadcast, cable TV, or satellite TV services [19]. The Raspberry-Pi runs on Linux based OS, an open source operating system. In this system we used Raspbian OS which is Linux based OS. The programming language for the Raspberry-Pi for the system implementation is Python.

3.3.1 Hardware

The Raspberry Pi hardware has evolved through several versions that feature variations in memory capacity and peripheral-device support.

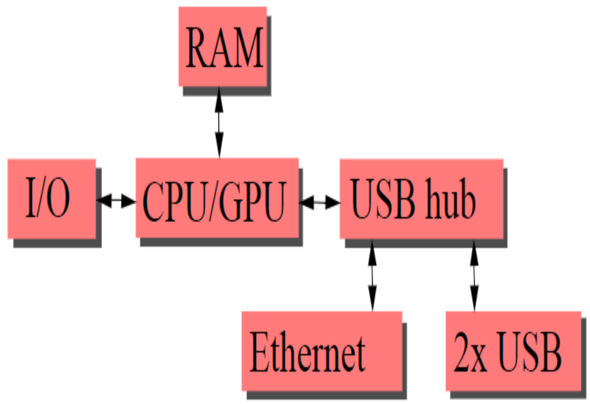


Fig 5 Raspberrypi block function

This block diagram depicts Models A, B, A+, and B+. Model A, A+, and the Pi Zero lack the Ethernet and USB hub components. The Ethernet adapter is internally connected to an additional USB port. In Model A, A+, and the Pi Zero, the USB port is connected directly to the system on a chip (SoC). On the Pi 1 Model B+ and later models the USB/Ethernet chip contains a five-point USB hub, of which four ports are available, while the Pi 1 Model B only provides two. On the Pi Zero, the USB port is also connected directly to the SoC, but it uses a micro USB (OTG) port.

3.3.1.1 Processor

The Raspberry Pi 2 uses a 32-bit 900 MHz quad-core ARM Cortex-A7 processor. The

Vol 10, Issue 8, Aug /2019
ISSN NO:0377-9254

Broadcom BCM2835 SoC used in the first generation Raspberry Pi is somewhat equivalent to the chip used in first modern generation smartphones (its CPU is an older ARMv6 architecture),[22] which includes a 700 MHz ARM1176JZF-S processor, VideoCore IV graphics processing unit (GPU),[23] and RAM. It has a level 1 (L1) cache of 16 KB and a level 2 (L2) cache of 128 KB. The level 2 cache is used primarily by the GPU. The SoC is stacked underneath the RAM chip, so only its edge is visible.

The earlier models of Raspberry Pi 2 use a Broadcom BCM2836 SoC with a 900 MHz 32-bit quad-core ARM Cortex-A7 processor, with 256 KB shared L2 cache.[24] The Raspberry Pi 2 V1.2 was upgraded to a Broadcom BCM2837 SoC with a 1.2 GHz 64-bit quad-core ARM Cortex-A53 processor,[25] the same SoC which is used on the Raspberry Pi 3. The Raspberry Pi 3 uses a Broadcom BCM2837 SoC with a 1.2 GHz 64-bit quad-core ARM Cortex-A53 processor, with 512 KB shared L2 cache.[26]

Fig 6 The Model B boards incorporate four USB ports for connecting peripherals.

3.4. POWER SUPPLY:

The power supplies are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function. A d.c power supply which maintains the output voltage constant irrespective of a.c mains fluctuations or load variations is known as “Regulated D.C Power Supply”.

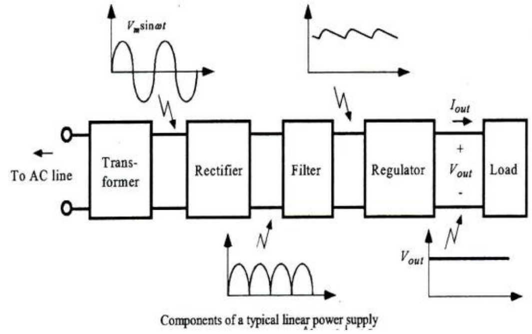
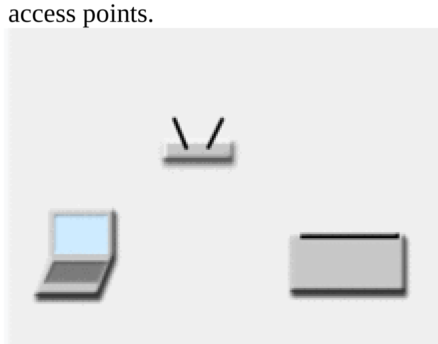


Fig:7. Block Diagram of Power Supply

3.5 WIFI: Wi-Fi or WiFi (/ˈwaɪfaɪ/) is a technology for wireless local area networking with devices based on the IEEE 802.11 standards. Wi-Fi is a trademark of the Wi-Fi Alliance, which restricts the use of the term Wi-Fi Certified to products that successfully complete interoperability certification testing.[1]

Devices that can use Wi-Fi technology include personal computers, video-game consoles, phones and tablets, digital cameras, smart TVs, digital audio players and modern printers. Wi-Fi compatible devices can connect to the Internet via a WLAN and a wireless access point. Such an access point (or hotspot) has a range of about 20 meters (66 feet) indoors and a greater range outdoors. Hotspot coverage can be as small as a single room with walls that block radio waves, or as large as many square kilometres achieved by using multiple overlapping access points.



Depiction of a device sending information wirelessly to another device, both connected to the local network, in order to print a document

Wi-Fi most commonly uses the 2.4 gigahertz (12 cm) UHF and 5.8 gigahertz (5 cm) SHF ISM radio bands. Anyone within range with a wireless modem can attempt to access the network; because of this, Wi-Fi is more vulnerable to attack (called eavesdropping) than wired networks.

3.6 Buzzer: A buzzer or beeper is a signaling device, usually electronic, typically used in automobiles, household appliances such as a microwave ovens, &

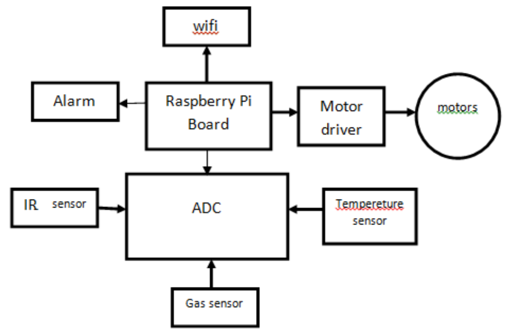
game shows. The word "buzzer" comes from the rasping noise that buzzers made when they were electromechanical devices, operated from stepped-down AC line voltage at 50 or 60 cycles. Other sounds commonly used to indicate that a button has been pressed are a ring or a beep. The "Piezoelectric sound components" introduced herein operate on an innovative principle utilizing natural oscillation of piezoelectric ceramics. These buzzers are offered in lightweight compact sizes from the smallest diameter of 12mm to large Piezo electric sounders. Today, piezoelectric sound components are used in many ways such as home appliances, OA equipment, audio equipment telephones, etc. And they are applied widely, for example, in alarms, speakers, telephone ringers, receivers, transmitters, beep sounds, etc

3.7 DC Motor: A DC motor relies on the fact that like magnet poles repels and unlike magnetic poles attracts each other. A coil of wire with a current running through it generates an electromagnetic field aligned with the center of the coil. By switching the current on or off in a coil its magnetic field can be switched on or off or by switching the direction of the current in the coil the direction of the generated magnetic field can be switched 180°.

IV. PROJECT DESCRIPTION:

Raspberry Pi based hardware design with Software development using sensor implementation with wifi communication.

Block Diagram:



Software Required:

- Raspbian Server
- Thingspeak web application
- Wiringpi library

Hardware Required:

- Raspberry Pi Board
- Motor driver
- Wifi module

This focus of this project is on communication and localization of the robotic system through the use of WiFi. General approach that provides WiFi communication and localization that can be applied in any environment, specifically an oil and gas refinery. Without the capability of remote communication, an operator would have to be within line of sight of the robot in order to control the system. The operator would then still be exposed to most of the hazards originally afflicting the need for such a system. In order for a system to be able to autonomously navigate, it must be confident of its current location within some range of uncertainty; however, no one sensor provides both the precision and scalability required to operate within a large environment, such as an oil and gas refinery. Through sensor fusion, a more accurate localization can be achieved.

V. CONCLUSION: For a robotic system to autonomously navigate in an oil and gas refinery, it must be able to communicate with the control room and also localize itself. In this work we define the kinds of communication required to deploy an autonomous robot. We study Wi-Fi signal propagation characteristics and apply the findings to determine Wi-Fi AP placement. We also assign channels to interfering APs. Wi-Fi fingerprinting based localization will be proposed to achieve a reasonable accuracy when used alone and achieves desired accuracy.

Vol 10, Issue 8, Aug /2019
ISSN NO:0377-9254

REFERENCES: [1] M. R. Akhondi, A. Talevski, S. Carlsen, and S. Petersen, "Applications of wireless sensor networks in the oil, gas and resources industries," in Advanced Information Networking and Applications (AINA), 2010 24th IEEE International Conference on. IEEE, 2010, pp. 941–948.

[2] B. Graf and K. Pfeiffer, "Mobile robotics for offshore automation," Proceedings of the EURON/IARP International Workshop on Robotics for Risky Interventions and Surveillance of the Environment, Benicassim, Spain, 2008.

[3] J. P. H. Steele, Q. Han, A. A. Ayoade, M. R. Sweatt, W. A. Yearsley, and D. P. Albert, "Development of an oil and gas refinery inspection robot," ASME, pp. 1–10, 2014.

[4] M. Bengel, "Mobile Robots for Offshore Inspection and Manipulation," in Intelligent Robots and Systems, 2009.

[5] E. Malaguti and P. Toth, "A survey on vertex coloring problems," International Transactions in Operational Research, vol. 17, no. 1,pp. 1–34, Jan. 2010.

[6] A. Aggarwal, "The art gallery theorem: Its variations, applications, and algorithmic aspects," PhD thesis, Johns Hopkins University, 1984.

[7] D. Plets, W. Joseph, K. Vanhecke, E. Tanghe, and L. Martens, "On Coverage Prediction and Optimization Algorithms for Indoor Environments," EURASIP Journal on Wireless Communications and Networking, vol. 2012, no. 123, 2012.

[8] J.-m. Gorce, "On predicting in-building Wi-Fi coverage with a fast discrete approach Guillaume de la Roche, * Katia Jaffr`es-Runser and," vol. 2, no. 1, 2007.

[9] A. R. T.-c. Chiueh, "Deployment issues in enterprise wireless lans,"2003.

[10] J. Yick, B. Mukherjee, and D. Ghosal, "Wireless sensor network survey," Computer Networks, vol. 52, no. 12, pp. 2292–2330, Aug. 2008.