Design of Wireless Robotic System for Rescue Operation in Hazardous Environments

Shaik Asif Hussain
Department of Electronics and communication Engineering, Middle East College, Muscat, Oman
Email: shussain@mec.edu.om

Raza Hasan
Department of Information technology, School of Science and Engineering, Malaysia University of Science and technology, Selangor, Malaysia
Email: raza.hasan@pg.must.edu.my

Salman Mahmood
Department of Information technology, Malaysia University of Science and technology, Selangor, Malaysia
Email: raza.hasan@pg.must.edu.my

Shaik Javeed Hussain
Global college of Engineering and Technology, Muscat, Oman
Email: s.javeedhussain@gcet.edu.om

Abstract— **Technological Advancements in mechanical and electrical engineering has progressed to greater extent these days. The field of Robotics have increased drastically in its usage for various dangerous and repetitive tasks. It is known fact that many Industrial applications are risky and difficult for potential and hazardous environments. Hence there is a need to design a climbing robot wirelessly using RF technology to operate from any remote location for hazardous environments. However robots are faster and accurate in control theory practices with high performance advanced algorithms. The designed Robotic system includes various modules like wireless communication with RF module, DC motors for movements of robots in various angles and dimensions, ARM 8 microcontroller performs controlling and monitoring of operations, driving unit. This robotic unit is controlled and operated using smart phone keys using RF module. Based on the data received from RF module the ARM 8 microcontroller processes the resultant action. The Robotic arm acts accordingly as instructed from microcontroller to perform human user action. The embedded c is used for programming the controller. The controlled action performed by the robotic unit is recorded using wireless AV camera and transmitted as live audio and video in to the receiver section for display in to pc or laptop for a control and user action.**

Index Terms—**robotic arm, ARM 7TDMI, hazardous environments, RF module, smart phone**

I. INTRODUCTION

With advent of pc systems and laptop there is enormous growth in engineering applications. The principle goal in designing a mountaineering rescue robot is to reduce risk in human life for hazardous environments. In reality it is operated with the use of pc wirelessly from a distant location wirelessly using RF modules. The advent of recent upcoming era and the developing pc capability provided pragmatic opportunity for modern robotic controls and reputation of latest strategies of manipulate systems [1]. ARM 8 processor is connected to RF module for wireless monitoring. The DC motors are interfaced through robotic arm. The associated keys of mobile phone are pressed through keypad which are transmitted over RF module. Design of Robotics deals with knowledge creation in different fields [2]. Robotic engineering applications involves in manufacturing, surgical procedures, space industry, Military and Health informatics. Today Robots are becoming a part of everyday life and these elements relieve us from various dangers. A robotic system consists of sensors and actuators which acts as sensing and intelligence unit for performing desired action [3]. In many applications the robotic systems are used for automatic painting, welding and transportation systems etc. This intelligence unit behavior helps the robot for movement from one point to another in performing complex operations [4]. This motive force comes from a command and helps the robot wheels to move and perform any particular work assigned. Robotic system is an integration of hardware and software designed to perform specific task which can also be defined as embedded system. It is a real time system which is designed to perform certain calculations and automatic decisions in timely manner [5]. The tasks assigned are carried out with strict deadlines in structured or unstructured environments with human guidance continuously. These robots are of different types like autonomous, manual and semi-autonomous desirable to

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work in any environments [6]. The security and surveillance is widely used by mobile robots. These systems can be controlled through a remote control for responding automatically in stimuli environment.

Figure 1. Shows the network communication with computing devices(atpsfze.com)

Servo motors are used in propulsion system and the sensors like ultrasonic and infrared are used for distance measurement and the camera placed on the robot are used to record the audio and video and transmit wirelessly to different places [7].

The surveillance systems used in the present world are much active in research areas. These functional robots are extremely challenging in exploration and monitoring in indoor/outdoor environments.

The autonomous robots are used to detect and identify the objects with multisensory platform in various applications like airports and museums [8]. They can be used to work on real time applications of buildings and safety devices also. To prevent from damages and theft also the security system are being installed for remote monitoring and can send the information through the network and automatically detecting the face of invaders for security alarms and also avoiding hazards for extreme environments.

A. Usage of Robots

Robotics are quite superior to human in different aspects like flexibility, measurements and accuracy of the work in hazardous environments.

Robots are capable to work in any unstructured applications with many sensors built in it. Some of the risky scenarios and useful fields are underwater exploration, Astronomical space and car production etc. The below figure shows different applications of research robotics in future years.
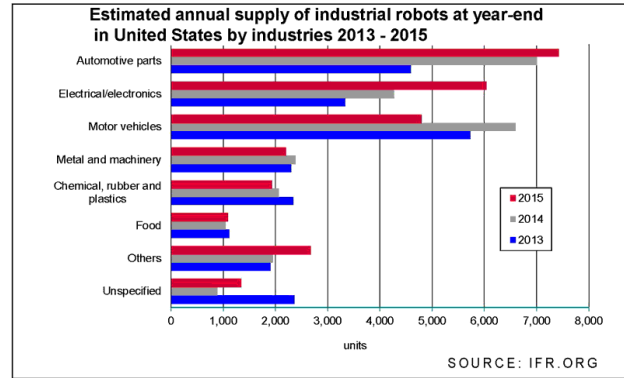

Figure 2. Research of Robots and importance in different applications (therobotreport.com)

II. MAJOR ISSUES

B. Bharathi et.al [1] portrays an automated robotic system design unit for safeguarding the children from underground bore. Normally with the human perception through PC and also by using robotic unit. The robot works by means of PC through RF module. Pal winder Kaur et.al [2] states that wheeled leg system of robotic arm unit is able to involve in the pipe where the legs are circumferentially and symmetrically dispersed out 1200 aside. The mechanical change in legs are adjusted with the pipeline measurements.

The robot unit designed consists of power supply, switch cushion, and rigging engine. The designed unit is able to pick the object from bore legitimately the situation can be monitored with USB virtual camera and observed on PC. Manish Raj et.al [3] states that as the dimensions across the bore well is thin for any individual safeguard. John Jose Patter et. al. [4] states that the robotic unit is designed to rescue baby from bore well or underground passage, and find supply oxygen to protect the child. The support to find the separation is through lifting pole passage.

The wheel engine alters the spiral separation of the lifting pole. When the lifting the bar achieves a sheltered part beneath, an air blower is worked to draw air to the bladder identified with the thwart of lifting bar through an air tube that runs downwards in the lifting bar.

The aim is to design a pipe for climbing mountain using robotic arm. This can be operated by use of pc wireless camera using RF technology. A robot is a system specifically programmed by means of a laptop capable of carrying out a complicated series of movements routinely. Robots can be guided through a tool to manipulate the things in interior manner. Robots are built to deal with human form to perform the desired action.

In present world there are various problems associated towards autonomous robotics. One of the major problem is towards decision making and intelligence system. Another problem is sudden shutdown of the robot due to power failure [13]. The robots are designed to perform specific functions and tasks for security services like navigation, detection and supervision of the premises through camera vision by a network [7]. Some of the major difficulties in the robotics are towards decision

making and locomotion of the robot. The machine learning and its own intelligence is still a challenge for the scientists in face recognition and language processing, path planning, optimal gait and pick and place of the object in unstructured environments.

Figure 3. Shows problems associated in locomotion and AI in robotics (Riggaro.com)

One of the way of solving this problems is by involving collaborative work through easy programming of smart applications with poly scope or open CV software for rapid and efficient development of the robotic system. These robots are being referred as cobots with light weight and compact design with safety features with intuitive programming interface [13].

Robotic solutions are efficient and simple but during the implementation they often provide the gap of skill sets and experience in manufacturing the human counterparts. One more problem implementation is cost of technology and budget requirements that can be spent to make the robotics as a service and able to sustain the cost in the market these challenges deals with the safety features in monitoring, guiding and limiting the work force for automated solutions. Hence robotics as a service to make the technology more better, faster and smarter in the markets for building the economic future. Such solutions are being provided in the below diagram.
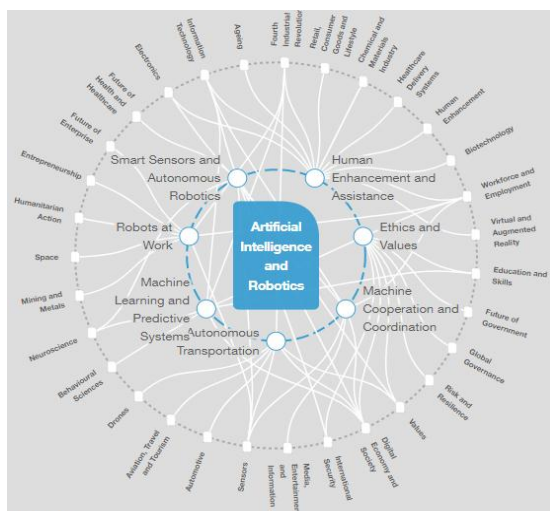

Figure 4. Future trends and economic solutions of robotics (World economic forum.com)

III. SYSTEM DESIGN

In the present system, a robotic unit is designed to rescue the kids falling in to the underground hole passage due to unexpected incidents. The design part has two separate gadgets, one is Transmitter (controller) unit and other is Receiver (automated) unit. The robot design is of low-quality using advanced radios with respect to the IEEE 802.15, Four zigbee transmissions, Wi-Fi individual area Networks (wpans) for transmitting the signal from 1 to 1000meters (around 3 to a few.280 feet) signals. Ideally the temperature is estimated with thermistors which has a set of strain transducer in recognizing the pressure for identifying harmful gases like hydrocarbons, methane and oxygen levels in parts predictable per million (ppm). The estimations of temperature, weight and harmful gases are demonstrated in pc.

Later the parameters are detected through the sensors. The transmitter in borewell is utilized to convey the flag temperature, weight and nearness of dangerous vaporous. In the display any harmful gases are identified, oxygen is outfitted through the test from environmental air until the proportion of poisonous fuel of interior bore well is decreased.

The block diagram provided below in Fig. 5 has different set of components involved for achieving the desired objectives. The first and foremost device in the work is an ARM 8 processor which is just like a microcomputer which consists of one or more processor with memory and input or output devices, which can be easily programmed. They are designed for specific task using the required hardware and software. ARM 8 is acronym for Advanced Reduced Instruction Set Computing, RISC Machines are used in various mobiles and applications to achieve the specific task.

The Vacuum cup block is used to create vacuum by drawing out air from the cup, which helps in holding the object of interest during climbing. The different blocks used in the diagram are sensors which are employed to include the updated values of temperature, pressure and gas sensors to detect and take suitable actions based on the physical environment during rescue robot.

The High Power Drivers are used to control other electronic devices like LED for representing the extreme situations in the environment. Regulated power supply is used to convert unregulated Alternating Current into constant Direct Current. Its purpose is to supply stable voltage to electronic device. The Crystal Oscillator is used to keep track of time precisely. RS 232 is the standard used to communicate with Personal Computer with 9600 baud rate.

The wireless standard of IEEE 802.15.4 is used to create personal area networks for collecting the data from different connected devices as wireless adhoc network. The DC motors are controlled by transistors based driver circuits. The brushless DC motor is used for energy conversion from electrical energy to mechanical energy. Stepper motor is a Brushless DC Motor which rotate in equal number of steps to complete full rotation. These steps of movement can be controlled without using

position sensors. Keyboard controller is device used to connect specialized keyboard to Personal Computer. LED is a Light Emitting Diode which are used as indicators in describing the status of operation and also for displaying results.
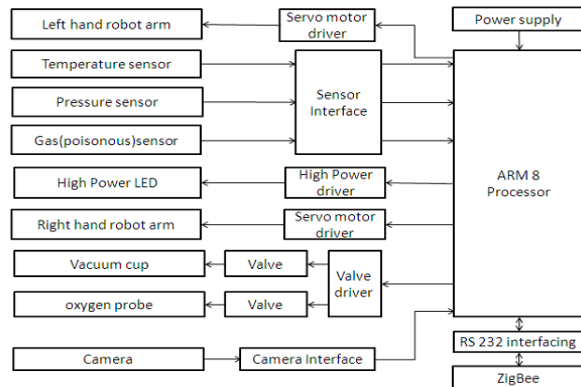

Figure 5. Rescue robot unit block diagram

The utilization of zigbee module is used to transmit the values from the controller setup. The values are displayed and checked with help of camera interface. The advanced camera together has exorbitant power Emitted Diode (LED) for the displaying the values of bore well effectively.
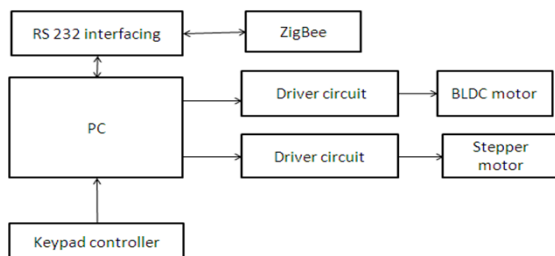

Figure 6. Shows the controller unit section

The designed gadget pursuits in designing a mountain climbing robot operated using Wi-Fi with permitted vicinity wirelessly using RF technology. The appearance of latest robotic controls and recognition helps in accurate management of operations. The collective improvement helps in excessive performance quicker, more accurate and practical improvements. The modules in the work are: RF modules for wireless communication, robotic unit for trekking the pipeline, DC motors are mounted on the robot for the movement of the robots, Microcontroller plays important role in controlling operations of robot in mountain climbing the pipe line. The controlling device is a Microcontroller to which RF module is used for transmitting data. DC motors of robotic arm are interfaced through a motor lagging pressure. Whenever the appropriate keys are pressed in the mobile phone software program, the records associated with the ones keys can be transmitted over RF module. This data is acquired via RF module to control robotic arm. The Microcontroller checks and records the data embedded in to it and plays suitable movements to the robotic arm. The Microcontroller is programmed the usage of

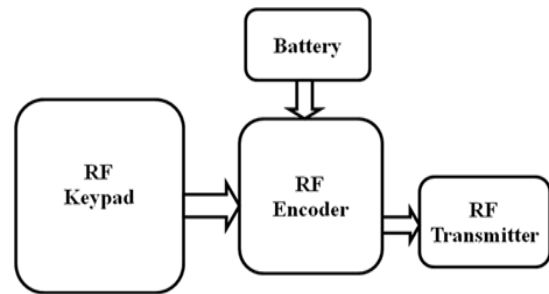Embedded interval. The audio and video is transmitted to the receiver using wireless AV digital.

Figure 7. Bore well Transmitter Section

In the transmitted section of bore well climbing robot the arrangement of transmitted section consists of RF keypad, RF encoder, battery, RF transmitter. The mobile unit gives different commands transmitted through RF transmitter, RF keypad like forward, backward, expansion. Whenever the required command has pressed it can be transmitted through RF encoder in which the commands are encoded and transmitted using RF, the complete operation use 9v battery.
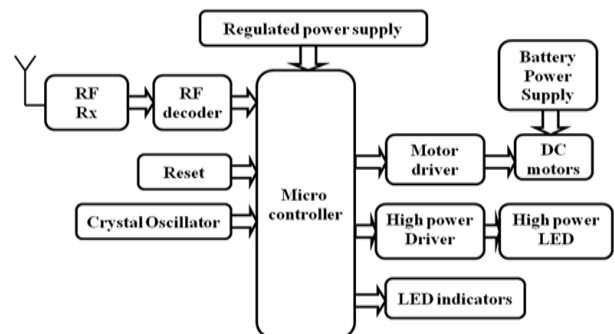

Figure 8. Bore well climbing receiver

In the receiver section the bore well climbing robot consists of different sensors associated with microcontroller. The commands of transmitted section are received to receiver section through wireless antenna which can be decoded in RF decoder and transmitted to microcontroller programming. In the receiver section a 20 MHZ crystal oscillator is used. The DC Motors consists of rotating armature the windings of motor are processed with related commands. The high power LEDs can be used in receiver section of mA greater than Amperes, It is compared with the tens of ma using special LED's. The battery power supply is a linear electricity which delivers the conventional operating power. The above schematic diagram of Pipeline trekking robot explains the interfacing section of every trouble with pic16f877 micro controller and personal laptop. On the transmitting prevent RF is installation to laptop thru RS 232 cable and DB09 serial pin connector and at the receiving prevent RF any other module related to percentage micro controller and managed energy supply is also associated with micro controller and LED's furthermore related to

micro controller via resistors and motor cause pressure related to micro controller.

IV. EXPERIMENTAL RESULTS

In this section, the results of work are explained and at the same time it gives the comprehensive discussion. The main motive of this system is to utilize wireless RF module for controlling the robot to move forward, backward and spinning actions also. With the help of spring, the wheels can experience expansion and compression action such that the robot can track along the pipe and can easily move about interior surface of pipe.
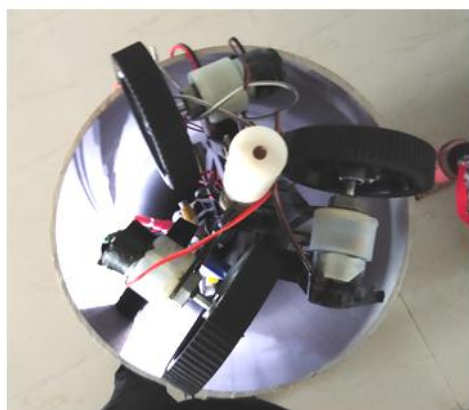

Figure 9. Bore well climbing robot

Fig. 9 shows the prototype system in implementation of the climbing pipeline for rescue of victim in the bore well. The system uses wireless RF technology in tracking of victim from bore well or underground passage. Climbing robot of the system uses high power LEDS for tracking the victim even at dark stages. In this system the excessive strength of LED's is from Philips Lumi LED's lights(HPLEDS) which can pushed at currents from masses of ma to greater than an ampere.
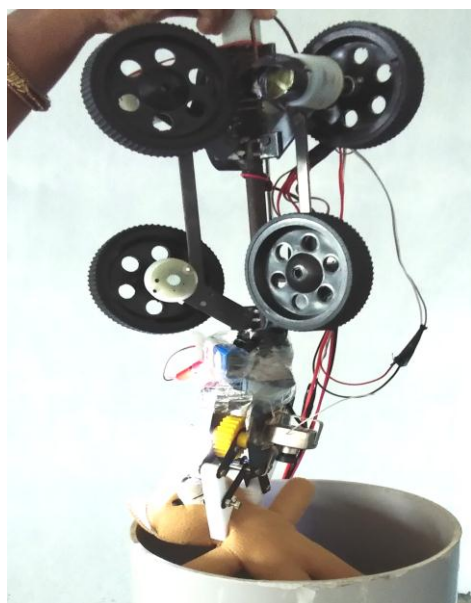

Figure 10. Picking of victim from bore well

Fig. 10 Illustrates picking of victim from bore well. Robotic system is combination of hardware and software program by which device is turned into rescuing system for adjustable wheels which are used to climb along the pipe for the rescuing.

Figure 11. Live monitoring of kid from bore well

Fig. 11 shows examining of victim live monitoring for every minute and live audio transmission itself through wireless AV camera. PC is used to monitor through the screen display for automatic guidance and navigation.

V. CONCLUSION

A bore well climbing robot is implemented to lift baby in bore well. In this proposed system, the climbing robot is developed with the help of two DC motors, Four L293D drivers, and PIC16F877. Some other components are also attached on it to provide live monitoring of audio as well video by wireless camera and high power LEDs. The user can easily monitor the baby orientation in the bore well. Through the help of the robot he/she can able to save the child without any harm. Therefore, this bore well climbing robot can be utilized in real time. In future, this proposed system can use this task in numerous applications with the aid of completing the task. The useful resource of connecting GPRS and GPS modules is by monitoring the robot using Google maps. Therefore the robotic unit is responsible for emergency situations.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

For the titled manuscript there are four authors where each author has contributed in their own way to support and obtain better results for the given work. Shaik is a primary author who has taken the most of the responsibility of performing and conceiving the design analysis and also revising the manuscript. Raza holds the responsibility of collecting the data and writing the reflections for the literature reviewed. Salman wrote the paper and worked on grammar and spelling. Shaik javeed contributed to check the microcontroller data analysis mainly for the results obtained. All the authors had approved the final version

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