Zigbee Controlled Human Counting Bot

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Abstract: *The proposed robotic system is used for detecting the presence of human being in the earthquake or in any other disastrous region. The ATMega328 controller provides the control signal to control the operation of entire system. The real time video is captured using a android mobile phone placed. An Android mobile controlled application provides an easy way to transmit the surveillance video wireless over long distance. The motion of robotic vehicle is controlled by sending control signals over the serial communication via Zigbee. The sensor circuitry at the robotic unit determines the range and count of the human being. This paper provides an efficient approach towards robotic control, live streaming of video and human detection. This proposed system can be used for disaster management and Military purposes.*

Index Terms*: ATMega 328, Zigbee, Disaster management.*

I.   Introduction

Robotics is a branch of artificial intelligence which is aimed at freeing the manpower from doing repeated tasks and working in hazardous environment. Every robot has different mechanical components to accomplish the specified task, electrical components which power and control the system and a programming which specifies what, when and how to accomplish the task by the robot. The field of robotics shows its excellence in each and every domain including medical applications, military purposes, space explorations and industries. During natural calamities like earthquake it is onerous to rescue the human beings under the building. Even the human detection is done by rescue team it consumes lots of time and it is not sure every person will be rescued within the stipulated time. This paper presents a real time system for human tracking and detection mechanisms. The system is basically a wireless controlled robotic system. The robots can be controlled via Bluetooth or IR waves but its range is limited. Wireless LAN provides better range but the network connectivity is limited in case of disasters. Our objective is to control the motion of robots over miles via zigbee protocol and video streaming over remote distance. Our proposed system consists of two units mainly a robotic unit and a remotely controlled unit. The robotic unit consists of surveillance camera for real time video surveillance and a sensor circuitry for human detection. The main function of the control unit is to control the motion of robot from remote place and to detect the number of human being available at the place.

II. System Overview

In this proposed system the user can control the motion and direction of robot from a remote place wirelessly and can observe the live stream video using ZigBee module. The ZigBee is a wireless communication protocol that can be interfaced with any sensors and external devices for communication between the devices. The same module can be used as a transceiver to send and receive data and for low power applications. In our proposed system Zigbee module connected to the USB port of laptop is used for serial communication. The data transmitted via the serial port of the laptop in the control unit reaches the serial port of the arduino via receiver zigbee in the robotic unit. The sensor circuitry in the robotic unit consists of PIR sensor to detect the presence of human being. IR sensor counts the number of human beings. Ultrasonic sensor determines the distance between the detected human and robotic unit.

III. Literature Survey

A project called **"Android phone controlled Bluetooth robot"** at MIT implemented a user friendly system using HC-05 bluetooth module, ATMEGA328P-PU microcontroller and android application to control the direction and speed of robot using smart phone. They suggests that this technology could be interfaced with web cameras and used for surveillance purposes as Bluetooth provides inherent security and less hardware requirements.

An extensive survey of remotely controlled robot has been provided in **"Controlling a remotely located robot using hand gestures in real time: A DSP implementation"** implemented in embedded matlab, Simulink and code composer studio. This technique captures the images in real time smoothens, classifies based on hand gestures for pattern matching and transfers over the ethernet. This technique reduces the response time and memory requirements and clearly specifies the method of controlling the robotic arm remotely.

An efficient research on the detection of live person during earthquake is vividly explained in the paper **"Microcontroller based tracking system for the detection of human presence in critical areas".**

In this technique the pir sensor is interfaced to the AT89C52 microcontroller, the sensor absorbs the radiation emitted from the human body as the human body emits 96 degrees it detects and sends the data to the microcontroller for further processing. Thus the presence of human being is detected by this system.

IV. Block Diagram

The control unit consists of a ZigBee module interfaced to the USB port of the Laptop or System. The control unit consists of robotic vehicle the 900 rpm DC motor are powered using 12V power supply. The control signal sent from the laptop reaches the zigbee1(Transmitter) module interfaced to it. The arduino uno controls the operation of entire system. The zigbee2(Receiver) interfaced to the serial port of arduino decodes the received signal and provides necessary control to the controller. The real time captured video and the data manipulated using the sensor circuitry are shared via the zigbee pairs.
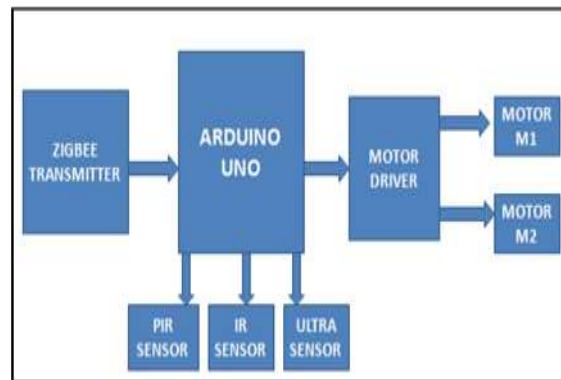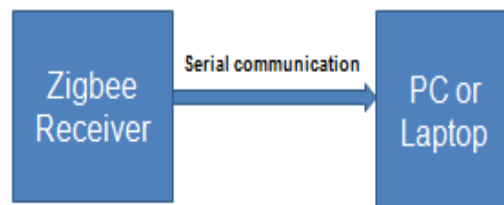

Fig.1.Block Diagram of Transmitter

Fig.2.Block Diagram of Receiver

V. Hardware Requirements

5.1.ZIGBEE:

Zigbee is a wireless technology which can transmit data over a long distances of about 10m to 100m.The most important feature of zigbee is its low power consumption and low data rate. Zigbee pin details include digital I/O pins, analog I/O pins of 10 bit resolution and pulse width modulation etc. The most important advantage is that it can be easily deployed, as it has a long battery life and provides well secured communication. It is used in wireless light switches, home automation, industrial automation and smart grid monitoring etc.

Fig.3.Zigbee

2.ARDUINO UNO:

Arduino uno is the heart of our project which is interfaced with sensors and motors at the receiver side. It is an open source software. Arduino UNO can be interfaced with various microprocessors and controllers. Arduino board consist of an ATMega 328 controller with varying amounts of flash memory and pins. The pins include 14 digital I/O pins which is used for pulse width modulation signal and 6 analog I/O pins. 7V to 12V power can be applied to an arduino board. Using the USB port in arduino, PC or laptop can be connected to it.

The board also includes a 16 MHZ quartz crystal, serial data, serial clock, interrupts and reset button etc. An arduino IDE is used to run the programs written in C. The programs can be written in any language like C, C++, Java etc. A program written in the arduino IDE is called a sketch

Fig.4.Arduino UNO

5.3. DC MOTOR:

. All the electro-mechanical movements we see are caused either by an AC or a DC motor. DC motor is a device that converts DC electrical energy to a mechanical energy. "Whenever a current carrying conductor is placed in a magnetic field, it experiences a mechanical force or torque and tends to move. This is known as motoring action". The direction of the force is given by Fleming's left hand rule.

This is principle of operation of a DC motor. If the direction of current in the wire is reversed, the direction of rotation also reverses. Since DC motors are advantageous to convert alternating current into direct current, it is widely used in steel mills, mines and electric trains etc.

Fig.5.DC Motor

5.4.PIR SENSOR:

PIR Sensor is a Pyro-electic or Passive Infra red sensor. The pyro-electic sensor is a bunch of supporting circuitry, resistors and capacitors along with a special integrated chip called **BISS0001 (Micro Power PIR Motion Detector IC).** PIR sensor consists of three pins–ground(GND), signal(OUT), and power(VCC) at the side or bottom. Generally, the PIR sensor provides a power up to 5V. This sensor does not actively take part in the process and it does not emit the IR signals itself, rather it detects the infrared radiations coming from the human body in the surrounding area. The detected radiations are converted into an electrical charge. PIR sensor detects a human being moving around within approximately 10m from the sensor. This is an average value, as the actual detection range is between 5m and 12m. The PIR sensor circuit is used in numerous electronics projects to discover a human being entering or leaving the particular area or room.
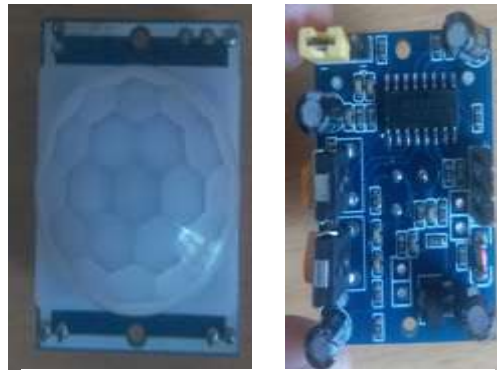
Fig.6. Front and Back view of PIR Sensor

5.4.ULTRASONIC SENSOR:

It is a device that measures the distance to an object. It uses sound waves for measuring the distance. The sound waves are transmitted to the particular object at a particular frequency which is then bounced back. By recording the time between sending and receiving time of the sound wave, the distance is measured from the sensor to the object. An ultra sonic sensor can measure a distance from 3cm to 3m.

It has four pins. They are VCC, trigger, echo, ground. A trigger is a pulse which is used as a range for object detection. Echo sends a signal back which determines whether the object is detected or not.

Fig.7.Ultrasonic Sensor

5.5. IR SENSOR:

The sensor module consists of IR Transmitter and IR Receiver. The IR transmitter is similar to LED emits IR radiation of particular frequency which is invisible to the naked eye. The IR Receiver is a photodiode or phototransistor. In case of any reflecting surface the radiation bounces back in some direction and IR receiver detects the presence of object in its path. When the surface is absorbent the IR signal is not reflected, it detects the absence of object in its path.
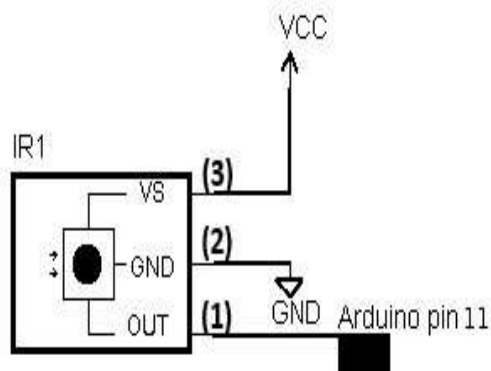
Fig.8.IR Sensor Pin Diagram

5.6. ROBOT CHASIS AND WHEEL:

The Robot chassis and wheel provides mechanical support to the robot. The torque of the wheel depends on the mass of the objects carried and power rating provided to the wheel. The roller caster is used at the front instead of front wheels. It provides easy to move in uneven regions.

Fig.9.Robot Set-up

VI. Implementation Schemes

The proposed system is to detect and count the presence of human being in a disastrous region. A live streaming video is used for processing the acquired image and Pyroelectric InfraRred (PIR) sensor to absorb the radiation emitted from the human body. The implementation scheme is divided into three stages:

- Controlling robotic vehicle direction.
- Live streaming video to remote place.
- Sensor interface to find the human presence

These techniques are implemented using Proteus 8.1 and Arduino IDE software.

6.1. CONTROLLING ROBOTIC VEHICLE DIRECTION:

The process of sending data bits one bit at a time is called serial communication. Here the motion and direction of robot is controlled using the keys in the keyboard. The Arduino UNO controls the whole motion of the robot. The Arduino board is powered with a separate adapter. The zigbee module is interfaced to the USB port of the laptop which receives and encodes the control signal generated from the keyboard and transmits it to the receiving zigbee module which is interfaced to the serial port of arduino board.

The decoded digital signal received at the serial port of the arduino provides corresponding control signal to control the direction and motion of robotic vehicle.It works on the principle of operation of motor drive IC L293D.Motor drive IC provides sufficient current and voltage to drive the DC motors for operation. The 16 pin IC works on the principle of Dual H-bridge. H bridge allows voltage to flow in either direction. The change in direction of voltage is utilized for changing the direction of motor.

6.2.LIVE STREAMING VIDEO TO REMOTE PLACE:

To transmit the real time video from a remote place to the control unit an ad-hoc wireless network is set up between the devices. Both the devices the android mobile phone and the laptop in the control unit are connected to the same network.   A wifi network in ad-hoc mode allows two or more devices to communicate with each other without infrastructure or access point.

For remote surveillance the android application streams the video over network. The resolution, quality, orientation and FPS limit can be customized. The URL of the video is headed in the browser to communicate with the device.

Fig.10.Android application for live stream video

6.3. SENSOR INTERFACE TO FIND THE   HUMAN PRESENCE:

The passive infra red sensor are efficiently used for motion detection as the window or the cover is made up of Fresnel lenses to gather radiation from outside world and focus it directly into the sensor. The sensitivity of the PIR can be changed by changing the pulse time and the timeout length.

Pulse time is the time during which the output remains high after triggering. Timeout length is the duration of time when the triggering is inhibited.

Pulse time $T_x = 24576 * R10 * c6$

Timeout length $T_i = 24 * R9 * C7$

R10=4.7K,   C6=10nF

R9=47K,   C7=0.1microF

$T_i = T_x = 1.2$ seconds.

The PIR sensor BISS0001(Micro power PIR motion detector IC) is powered up with 3-5Volt The output of the PIR sensor is 3 Volt digital pulses when it detects the presence of human being or a low value in case of absence.

To determine the distance of human presence ultrasonic sensor HC-SR04 is interfaced to the serial port of arduino uno. The ultrasonic sensor transmits a sound wave of ultrasonic frequency, the time taken for the signal to hit an object and to retransmit is calculated to determine the distance. The ultrasonic sensor emits a trigger pulse of short 40kHz ultrasonic signal under the control of microcontroller. It is used for the range of about 2 cm to 400 cm. By measuring the width of the ECHO signal the range of human presence can be calculated.

Distance =(Speed of sound wave * Time   taken) / 2

The distance includes round trip time and it is divided by two to calculate the distance of human.
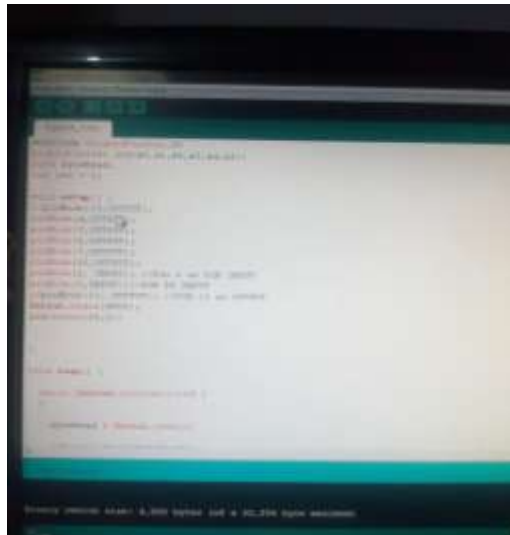
Fig.11.Arduino IDE

VII.   Conclusion

As our proposed system can be controlled and monitored from remote place, it can be used for applications which human cannot do. The use of zigbee module and mobile phone for video surveillance makes the system more cost effective and efficient than other wireless technologies.

VIII.   Result

As Arduino plays the heart of the entire system, the system is cost effective and simple. The value of human count displayed in the LCD device is not visible over remote distance. Hence the system can be simulated using easy to use Proteus 8.1 simulation software which provides more accurate result. The design, compilation, debugging becomes easier using Proteus tool.

The PIR sensor can also be tuned to detect human within particular range or within particular distance. It makes the system more efficient.

Fig.12.Robotic Unit
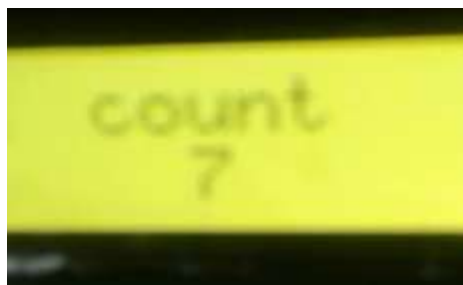
Fig.13.Final Output

IX. Future Scope

The proposed system can be used in rescue operations in disastrous region and crisis management. The system can also be used in military applications to detect the presence of human being . Inclusion of night cameras and other sensor circuitry like metal detectors and bomb detectors makes the system more efficient.

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