Hand Gesture Following Robot for Security
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Abstract— Hand gesture following robot for security is designed using MATLAB and embedded technology. The Hand Gesture Following Robot for Security uses Mat lab image processing. The main components used are PC (MATLAB), microcontroller (Attmega328), Zigbee module, wireless video camera, video RF transmitter, RF tuner card, motor driver circuit and DC gear motors, PIR sensor, temperature sensor, fire sensor, GPS module, GSM module. Here image processing technique is used to control the movement of the robotic car using motors in areas which are hazardous and isolated. Hand gestures are used to control the movement of the robotic car. The control commands are sent to microcontroller using Zigbee module. The DC gear motors drive the robotic car. It consists of a wireless video camera which monitors the surroundings and communicate that data to the pc using RF tuner card. The PIR sensor in the car can be used to find humans in situations where a disaster has occurred and it is difficult to find people around using the camera, since there may be people under collapsed building. The location of the robotic car can be found using GPS module and the GSM module can be used to send message to mobile about the sensor output details and location of the robotic car. It has variety of applications like in defence, as spy robot, for search missions in natural disaster occurred area, in mining fields where humans can’t go inside, in house hold security, for surveillance of specific areas like industries etc.

Key words: Hand Gesture Following, Image Processing, Mat Lab

I. INTRODUCTION

Gesture is a most natural, expressive way of communication between human and computer in real system. We naturally use various gestures to express our own intention in everyday life. Hand gesture is one of the important methods of non-verbal communications human being. In real time hand gestures are being shown in front of a web cam which captures the hand signs and are compared with those in the database of the computer and after comparison the gestures are interpreted as commands to the microcontroller using a zigbee attached to the transmitter. At the receiver section a receiver Zigbee receives these commands and pass on to the microcontroller attached to the robotic car. These commands to the microcontroller drives the robotic car in the desired direction. Sensors and wireless video cam helps in surveillance of the surroundings of the robotic car. Here mechanical devices like switches and keyboards are removed and human hand gestures are being used. So, a natural interaction between humans and computing devices can be achieved by using hand gestures for communication between them which is one of the main advantage of this project. Also the use of the robotic car is varying, it can travel in any kind of difficult terrain and hazardous areas. With the wireless video cam mounted over the robotic car surveillance of the surrounding can be done easily and can be seen in a laptop, wherein wireless connection is established using Zigbee modules. Also GSM and GPS modules are mounted on this robotic car. GPS enable to find the exact location details of the robotic car and with the help of GSM location details and outputs from the sensors can be obtained as SMS.

II. LITERATURE REVIEW

A. Real-time robot control using hand sign recognition [1]

Ankit Multanmal Oswal, et al (2014) suggests that the demand for the robots has increased tremendously. Therefore increased opportunities for many people to operate the robots have emerged. However, for many people, it is often difficult to operate a robot using the conventional methods like remote control. A simple definition of the term gesture is suggestive movement of body parts such as fingers, arms etc. which convey some information. Gesture is one of the most natural and expressive ways of communications between human and computer in a real system. Hand gesture recognition research has gained a lot of attention because of its applications for interactive human-machine interface and virtual environments. Based on one unified set of hand gestures, the robotic system interprets the user hand gestures into pre-defined commands to control the robotic car wirelessly using Zigbee module. Unlike the conventional method for hand gesture recognition which makes use of markers, special gloves or any other devices, this method does not require any additional devices and makes the user comfortable as in the glove-based system user needs to wear burdensome accessories, which are generally connected to computer. A webcam is used to obtain the image data of the human palm and fingers. The image or video acquired as input may be noisy or may reduce the performance by recognizing surrounding as hand region. The acquired data is subjected to enhancement and processed further to make it fit for approximation with the gestures (data) stored in the database. Then the data are processed to recognize the gesture. Each gesture is corresponding to a different robot control command. Then the Zigbee wireless module is used to send these different robot control commands to the robot controller. Accordingly, the robotic car will do actions according to different human hand gestures, thus human-robot interaction can be achieved. The gesture recognition system is developed with MATLAB.

MATLAB is very renowned software which is used by engineers extensively for solving the scientific and engineering problems. We can use MATLAB models to access the data in real time and based on that we can take several decisions which again can be seen on the output devices which are interfaced with the computer in real time.
B. Intelligent Combat Robot [2]

B T Hemanth, et al (2015) says that, robot is described as a machine that performs complicated and often repetitive tasks. A robot needs to sense the surrounding environment and act accordingly. There are sound, light, magnetic field and many more to help robot to collect information about its environment. The processor powered by software helps the robot to sense the environmental data and instruct it what to do next and also the visual display helps the robot to interact with humans. This robot minimizes human causalities. A wireless camera has been installed which can transmit real time video. This robot is very much useful for spying, war fields, Terror attacks, Natural disasters and mining areas. At transmitting end using command buttons the movement of receiver is controlled either to move forward, backward, left, right or stop. Camera mechanism is installed in the robot where it helps the person at watching station to monitor its direction of movement. Wireless camera will send real time video and audio signals, which could be seen on a remote monitor, and action can be taken accordingly. Since manpower is always precious, these robots minimize the human risks and replace the humans at dangerous situation. For the movement of the robot DC motors are used. Remote controllers are designed to direct the orientation of robot.

C. Real time video controlled Traction for surveillance Robots in coal mine [3]

C. Sathish Chandran, et al (2014) suggests that, various efforts are undertaken for the developments of a video based coal mine rescue robot. The gas, temperature, motion, distance and fire are detected and transmitted to the ground control centre through the wireless network module by using the camera and different sensors. It helps the rescue team for better planning and execution of their operation. It also has a flame detection system, which provides more accurate and faster information on the fire scene. A coal mine enterprise is a high risk profession and technique. In recent years, the situation about which safety production is serious in the coal mine field, hazard accidents are occurring. To minimize the chance of accidents and thereby increasing the productivity of the mining operations using autonomous robots. The coal mine robot is a peculiar kind of robot, which operates without human control, comes under embedded system. The robot was controlled by software. It is used to detect the current situation of the tunnel. It sends the information throughout its path i.e., detected gas, flame and temperature signals through the zigbee transmitter, and a receiver is used to receiving the signals and it displayed on the monitor. It consists of a microcontroller based embedded system connected to various sensors that monitoring different situations and conditions of the mine. This system also checks live videos from mine to the ground station using zigbee. This data determines the position and current situations inside the mine and provides the rescuers a chance of making an immediate action if necessary.

A sensor (also called detector) is a converter that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument. The temperature sensor also give the temperature rates and compare the current reading to the previous reading. Robot, finding fire in the area stops, moving and move backward, then detects information and sends it to the base station. The camera module consists of a wireless camera and an AV receiver and an AV tuner card. The wireless camera is mounted on the robot and the video signal is transmitted to the AV receiver and it is tuned to get the original signal. The video is then transmitted to the PC by interfacing an AV tuner card. Every mining operation needs a special attention in order to deflate the chances of any kind of accidents and this is carried out without human intervention using the field of robotics. Wireless small size camera is used for surveillance and robotics.

D. Implementation of a Wireless Gesture Controlled Robotic Arm [4]

Saurabh A. Khajone, et al (2015) suggests that, in today’s world, in most of all sectors the work is done by robots or robotic arm having different number of degree of freedoms (DOF’s) as per the requirement. This paper presents a thought and a way to eradicate the buttons, joysticks and replace them with some of the more intuitive technique that is, controlling the complete Robotic Arm by the operators hand gesture. The proposed electronics system recognizes a particular hand gesture that will be performed in front of webcam & transmitted respected signals wirelessly. In recent years there has been a growing interest in a class of methods based on computational vision due to its ability to recognize the human gestures in a natural way. Such methods use as input the images acquired from a camera or from a stereo pair of cameras. The main goal of such algorithms is to measure the hand configuration in each time instant. To facilitate this process many gesture recognition applications resort to the use of uniquely coloured gloves or markers on hands or on the fingers. In addition, using a controlled background makes it possible to localize the different hand efficiently and even in real-time. We have specifically avoided solutions which require coloured gloves or markers and a controlled background because of the initial requirements of our application.

Webcam precedes several of recognizing values to the computer. MATLAB tool recognizing the preferred gestures by comparing stored gestures values & gives respective outputs. A pair of wireless communication modules connected with the gesture recognition system and the robot controller respectively. Each gesture is corresponding to a different robot control command. Then wireless module is used to send these different robot control commands to the robot controller. Accordingly, the robotic arm will do actions according to different human hand gestures, thus human-robot interaction can be achieved. The gesture recognition system is developed with MATLAB tool. DC motors are used to physically drive the application as per the received code. To drive a dc motor, we must need a dc motor driver. The hand gestures is a novel approach and whose applications are myriad.

E. Live Human Detecting Robot for Earthquake Rescue Operation [5]

S P Vijayaragavan et al (2015) says that, humans are becoming increasingly aware in the concept of intelligent rescue operations in natural calamities so that precious life and material can be saved though calamities cannot be stopped. Earthquakes produce a devastating effect and they see no difference between human and material. Hence a lot of times humans are buried among the debris and it become
impossible to detect them. A timely rescue can only save the people who are buried and wounded. Detection by rescue workers becomes time consuming and due to the vast area that gets affected it becomes more difficult. So the project proposes an autonomous robotic vehicle that moves in the earthquake prone area and helps in identifying the alive people and rescue operations. A unique Passive Infrared sensor is used in the project which emits infrared rays to detect humans. As live human body emits thermal radiation it is received and manipulated by the PIR sensor to detect humans. Once the people are located it immediately gives audio alert and visual alerts to the authorities so that help can reach the live person so fast. This PIR sensor is placed on a moving all direction robot that can manoeuvre in the earthquake prone areas. The robot is driven on a geared dc motor for increased torque and low speed and stepper motor for increased turning accuracy hence the precise control of position is monitored. The robot consists of a three wheel geared drive with DC motors attached to perform forward and reverse movement.

The PIR (Passive Infra-Red) Sensor is a pyroelectric device that detects motion by measuring changes in the infrared (heat) levels emitted by surrounding objects. As live human body emits thermal radiation it is received and manipulated by the PIR sensor to detect humans. They detect change in the heat and this can be used to detect movement of people. It has digital output.

Zigbee transceiver is used to send and receive data between robot and the control unit. Zigbee is a digital wireless communication protocol. It is a very low power communication technology. Zigbees are a very versatile communication technology that can be used for many applications. The modules require minimal power and provide reliable delivery of critical data between devices. The modules operate within the ISM 2.4 GHz frequency band and are pin-for-pin compatible with each other. Many lifes can be saved by using this autonomous vehicle during an earthquake disaster in a short duration.

III. BLOCK DIAGRAM

A. Transmitter Section

![Fig. 1: Transmitter Section](image1)

B. Receiver Section

![Fig. 2: Receiver Section](image2)

C. Block Diagram Description

The block diagram provides a quick, high-level view of the proposed project. The principal parts of the project and their interconnections are represented in a single block diagram. Fig 3.1 shows the block diagram of hand gesture following robot for security. The main components used are PC (MATLAB), microcontroller, Zigbee module, LCD display, wireless video camera, video RF transmitter, RF tuner card, motor driver circuit and DC gear motors, PIR sensor, temperature sensor, gas sensors, GPS module, GSM module. It consists of two sections: section 1 & section 2.

1) Section 1:
Section 1 consists of a PC, RF tuner card and a Zigbee module. In real time hand gestures are being shown in front of a webcam in PC which captures the hand signs and are compared with those in the database of the computer. MATLAB tool recognizes the preferred gestures by comparing stored gestures values. After comparison the gestures are interpreted as commands to the microcontroller which is transmitted using a zigbee module. The videos of the surroundings of robotic car is received by using RF tuner card.

2) Section 2:
The power supply most important for electronic circuits, which is provide the required power to microcontroller and other electronics devices. Here we are a battery for providing power. Microcontroller we use here is ATMEGA 328. It consists of a microcontroller based embedded system connected to various sensors that monitoring connected to various sensors that monitoring different situations and conditions of the surroundings of robotic car. The Zigbee module is used to receive the different robot control commands corresponding to each hand gesture in section 2. DC motors are used to physically drive the application as per the received command. To drive a dc motor, a dc motor driver is needed. This system also transfers live videos from the surroundings to the section 1 using video RF transmitter. The data from GPS determines the position of the robot. The
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output from gas sensor, PIR sensor and temperature sensor determines the current situations of the surroundings and provides a chance of making an immediate action if necessary. The data from the sensors are send as SMS by using GSM module. A unique Passive Infrared sensor is used in the project which emits infrared rays to detect humans. LCD display is used for demo purpose. It is used to display the various commands.

IV. PROGRAMMING
The strategy is being programmed at the embedded system. However through the integrated structure it is already possible to capture and process the image with success. The program is able to detect, interpret and respond to the stored database in order to define the desired action for the robot.

A. MATLAB
MATLAB is very renowned software which is used by engineers extensively for solving the scientific and engineering problems. We can use MATLAB models to access the data in real time and based on that we can take several decisions which again can be seen on the output devices which are interfaced with the computer in real time.

MATLAB (matrix laboratory) is a multi-paradigm numerical computing environment and fourth-generation programming language.

A proprietary programming language developed by Math Works, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces.

Although MATLAB is intended primarily for numerical computing an optional tool box uses the MuPAD symbolic engine, allowing access to symbolic computing capabilities. An additional package, Simulink, adds graphical multi-domain simulation and model-based design for dynamic and embedded systems.

In 2004, MATLAB had around one million users across industry and academia. MATLAB users come from various backgrounds of engineering, science and economics.

B. Embedded C Programming
C is an imperative language. It was designed to be compiled using a relatively straightforward compiler, to provide low-level access to memory, to provide language constructs that map efficiently to machine instructions, and to require minimal run-time support. C was therefore useful for many applications that had formerly been coded in assembly language, such as in system programming. Despite its low-level capabilities, the language was designed to encourage cross-platform programming. A standards-compliant and portable written C program can be compiled for a very wide variety of computer platforms and operating systems with few changes to its source code. The language has become available on a very wide range of platforms, from embedded microcontrollers to supercomputers. Like most imperative languages in the ALGOL tradition, C has facilities for structured programming and allows lexical variable scope and recursion, while a static type system prevents many unintended operations. In C, all executable code is contained within subroutines, which are called "functions" (although not in the strict sense of functional programming). Function parameters are always passed by value. Pass-by-reference is simulated in C by explicitly passing pointer values. C program source text is free-format, using the semicolon as a statement terminator and curly braces for grouping blocks of statements.

For the software implementation, we are using Keil μVision 3.0. The Keil Debugger accurately simulates on chip peripherals (PC, CAN, UART, SPI, Interrupts, I/O Ports, A/D Converter, D/A Converter, and PWM Modules) of 89S52 device.

Simulation helps to understand hardware configurations and avoids time wasted on setup problems. With simulation, we can write and test applications before target hardware is available. The system program written in embedded C [6] using KEIL IDE software will be stored in Microcontroller. Keil development tools for the Microcontroller Architecture support every level of software developer from the professional applications engineer to the student for learning about embedded software development. The industry-standard Keil C Compilers, Macro Assemblers, Debuggers, Real-time Kernels, Single-board Computers, and Emulators support all 89S52 derivatives. The Keil Development Tools are designed to solve the complex problems facing embedded software developers. Flash magic is used to dump the code to microcontroller from PC.

V. CONCLUSION
This paper describes the development of image processing system for a moving mechanism so that it becomes capable of identifying human gestures. This research presents a preliminary approach to perform any type of image processing task in MATLAB and then interfacing it with serial port to the microcontroller. Arduino Uno has been used for controlling the robot motion. Even though this attempt is aimed at gesture following, the research opens up possibilities for many other algorithms related to signal and image processing that can be implemented using the same low-cost hardware.

VI. APPLICATIONS
- Defence
- Can be used as spy robot.
- Search missions in natural disaster occurred area.
- Mining fields where humans can’t go inside.
- This robot can also be used in house hold security.
- Surveillance of specific areas like industries.
- Human prohibited areas such as nuclear plant.

VII. FUTURE SCOPE
In the future this can be acquired by the exercise of higher transmission range so that it can travel for a greater distance and can be utilized in different environments based on the transmission range. Development can also be made in the number of sensors incorporated in the robot. Various other sensors like liquid, O2 sensor can be added and thus helping to get a much improved image of the environment inside. System applications like Explorer, Media Player etc. to create a website which operates using hand gestures. JavaScript can be dynamically combined with the gesture recognition logic for the same. To use the gesture recognition logic in sensitive areas of work like hospitals

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and nuclear power plants where sterility between machines and human is vital. To create a battery free technology that enables the operation of mobile devices with hand gestures.

REFERENCES