Computer Vision Based Mobile Robot with Optimized Memory

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Abstract-Robotics is a day to day evolving research area. The Robotics is an ever green topic where lot of research is going on, Rescue robots with wide variety of application are basically designed to strictly cooperate with rescuers during their wide variety missions. In many critical situations the robot should be at some degree of autonomy in order to effectively communicate effectively in impossible environment. This paper basically deals with the performance analysis human driven robot capable of traversing challenging and dangerous terrain and at the same time communicates wirelessly with the controlling laptop. The heart of robot is the Arduino Duemilanove interfaced with a pair of ZIG-BEE transceiver which communicates with the laptop with the help of Graphical User Interface designed in MATLAB software. The robot also has a special feature that it can also be controlled through voice recognition. The robot uses GPS module to give the GPS co-ordinates and its location can be seen on the map using goggle map. It has also has an inbuilt wireless camera which is controlled independently to ease programming. This camera provides live video streaming of the surroundings and can also takes snapshot of the given area whenever required. This image taken from the camera will be processed to remove noise and obtain a much clearer image. These images will be compressed using DWT and saved in the data based and which may be useful for further processing. The Arduino Duemilanove is a microcontroller based on the ATmega328, has 14 digital input/output pins, 6 analog inputs 16 MHz crystal oscillator, a USB connection and has 2KB of SRAM and 1 KB of EEPROM. Thus SRAM based memory controlled algorithm using MATLAB is designed to control mobile robot. The robot has a metal and fire sensors, whenever either metal or fire is detected the sensor output is high, thus the sensor status on the MATLAB GUI changes red. Experimental results are given to demonstrate the development of the hardware-software module.
Keywords- DWT,ZIG-BEE,Mobile robots.

I.   INTRODUCTION

A robot is programmable multifunctional design specialized device to perform a wide variety of tasks. The study of robotics basically deals with the desire to synthesize some features or aspects of human function by the use of mechanism, real time sensors, actuators and computers. The deployment of robotic technology in the rescue missions for the assistance of rescuers for sensor interpretation to perception, decision making, mapping, path-planning and victim detection. There are certain situations where the use of a robot is a necessity, such as travelling in hazardous conditions where human being would be incapable of surviving. These robots can be completely autonomous or can be either operated through a remote system like a laptop and thus achieve the accomplished tasks. Explosions, earthquakes and other natural catastrophes or calamities often result

in collapsed buildings with casualties and wounded people trapped in the debris. When disaster like this happens, it is very important that quick search over the collapsed buildings are to be done. But complicated environment makes this quick search hard and very dangerous to perform. But these robots have the ability to drive in this terrain, explore the affected area and locate the exact location of victims. In order reduce the risk of human life; robots are being deployed to replace search teams in dangerous environment.

The coordination between the MATLAB GUI which is in the laptop to the Arduino in the robot is carried out wireless using XIGBEE module which works on 5V DC supply, provides easy RF communication at 2.4Ghz which ranges up to 70m.It can transmit and receive signal at 9600 baud rates from any standard CMOS/TTL source. It works in half duplex mode that is it provides communication in both directions, but one direction at same time. Either the user sends commands to the robot through GUI to carry out certain operations or the Arduino sends signals of the interfaced sensors back to laptop to display the sensor status.

II.   MOBILE ROBOT DESIGN

2.1. CONSTRUCTION

The construction of this rescue robot is very simple, instead of using MDF (Medium Density Fiber board), we have used metal chasse of dimension 28x18cm, which gives a ground clearance of around 8cm. The reason behind using this was the disadvantages encountered by MDF such as the quality of fiber may get staled due to weather condition and the clearance between the ground and robot was around 1 to 2 cm. The distance between the two wheels is around 24cm from shaft to shaft.
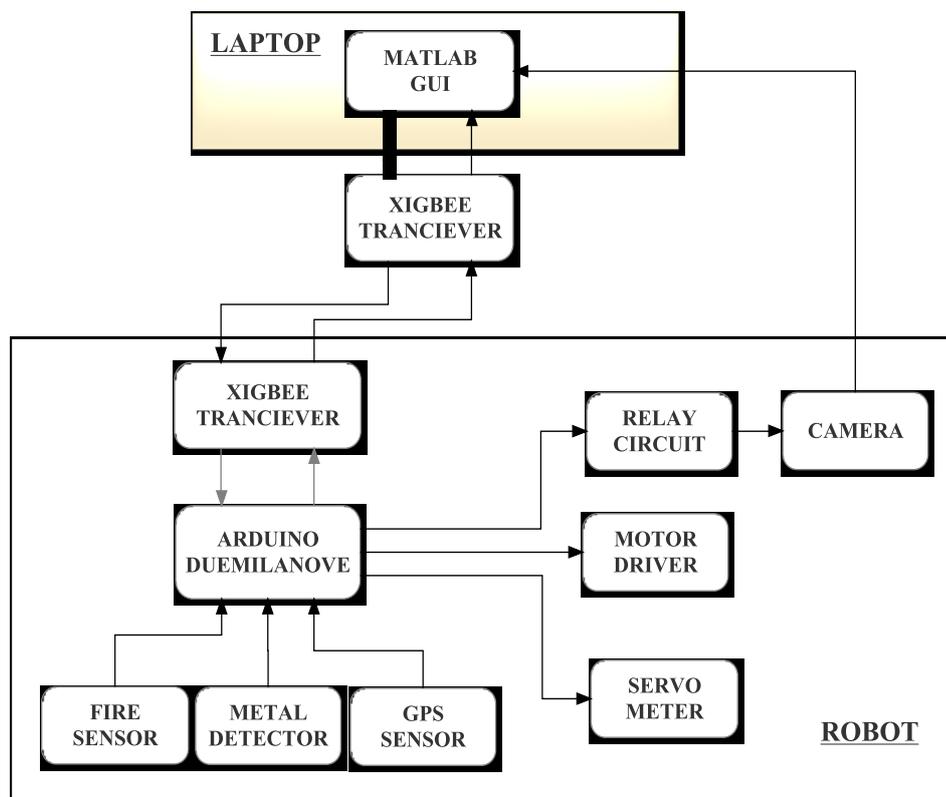

Figure 1. Overall View of System

The chasse is incorporated by fixing Arduino Duemilanove board, motor driver circuit, XIGBEE transceiver, GPS module, metal detection circuit, fire sensor, general purpose board servomotors and finally DC motor. Each are connected separately by maintaining a proper distance between every components and maintain 1cm gap height from metal chasse, the reason behind this is to avoid the shorting of metal in PCB's ,which may cause severe damage to the robot. At the end the battery is clamped at the bottom of the chasse so that there the connection between board and battery is reduced. With the help of GPS transceiver the co-ordinates of the robot will be available on the controlling robot and if the laptop is connected to an internet then the actual location of robot is seen on the map.

III.   HARDWARE APPROACH

3.1.COMPONENTS OF MOBILE ROBOT

To accomplish the above requirements the main components which are used are Arduino Duemilanove microcontroller board, motor driver circuit, motors, servomotors, metal detection sensor, fire sensor, camera, XIGBEE transceiver, GPS module and battery. As various components are used, the two motors fixed on two wheels and connected by 2 dummy wheels by chain system makes the robot to take path on rough areas and also the speed required by the robot will be as per the requirement of the user.

3.2. GPS MODULE

GPS-634R is a highly integrated smart GPS module with a ceramic GPS patch antenna. The module is with 51 channel acquisition engine and 14 channel track engine, which will be capable of receiving signals from up to 65 GPS satellites and transferring them into the precise position and timing information that can be read over either UART port or RS232 serial port. Small size and high-end GPS functionality are at low power consumption. Both of the LV TTL-level and RS232 signal interface are provided on the interface connector, supply voltage of 3.6V to 6.0V is supported.

3.3. L298 MOTOR DRIVER CIRCUIT

The L298 is an integrated H bridge monolithic circuit in a 15-lead Multi watt. It is a high voltage, high current dual full-bridge driver designed to accept standard TTL logic levels and drive inductive loads such as relays, solenoids, DC and stepping motors.

3.4. XIGBEE Trans receiver

CC2500 RF Module is a Tran's receiver module which works on 5V DC supply, provides easy to use RF communication at 2.4 GHz. It can be used to transmit and receive data at 9600 baud rates from any standard CMOS/TTL source. This module is a direct line in replacement for your serial communication it requires no extra hardware and no extra coding too .It works in Half Duplex mode that is it provides communication in both directions, but only one direction at same time.

3.5. METAL AND FIRE DETECTION SENSOR

These circuits are most useful for security checking. Metal Detector available in the market are quite expensive. This metal detector can be used to detect slightly big size metallic objects. It uses a sensing coil. This coil should be kept near metallic objects for detection. Input of circuit is a Colpitt's R.F. Range Oscillator. Sensing coil forms parts of tuned Oscillator.

3.6. ARDUINO MICROCONTROLLER BOARD

The Arduino Duemilanove is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The ATmega328has 32 KB, (also with 2 KB used for the boot loader). The ATmega328 has 2 KB of SRAM and 1 KB of EEPROM. The above diagram shows how the various components like metal and fire sensors, motors (Servo and DC motors), Relays, GPS module and XIG-BEE transceivers are interfaced to ATmega328.
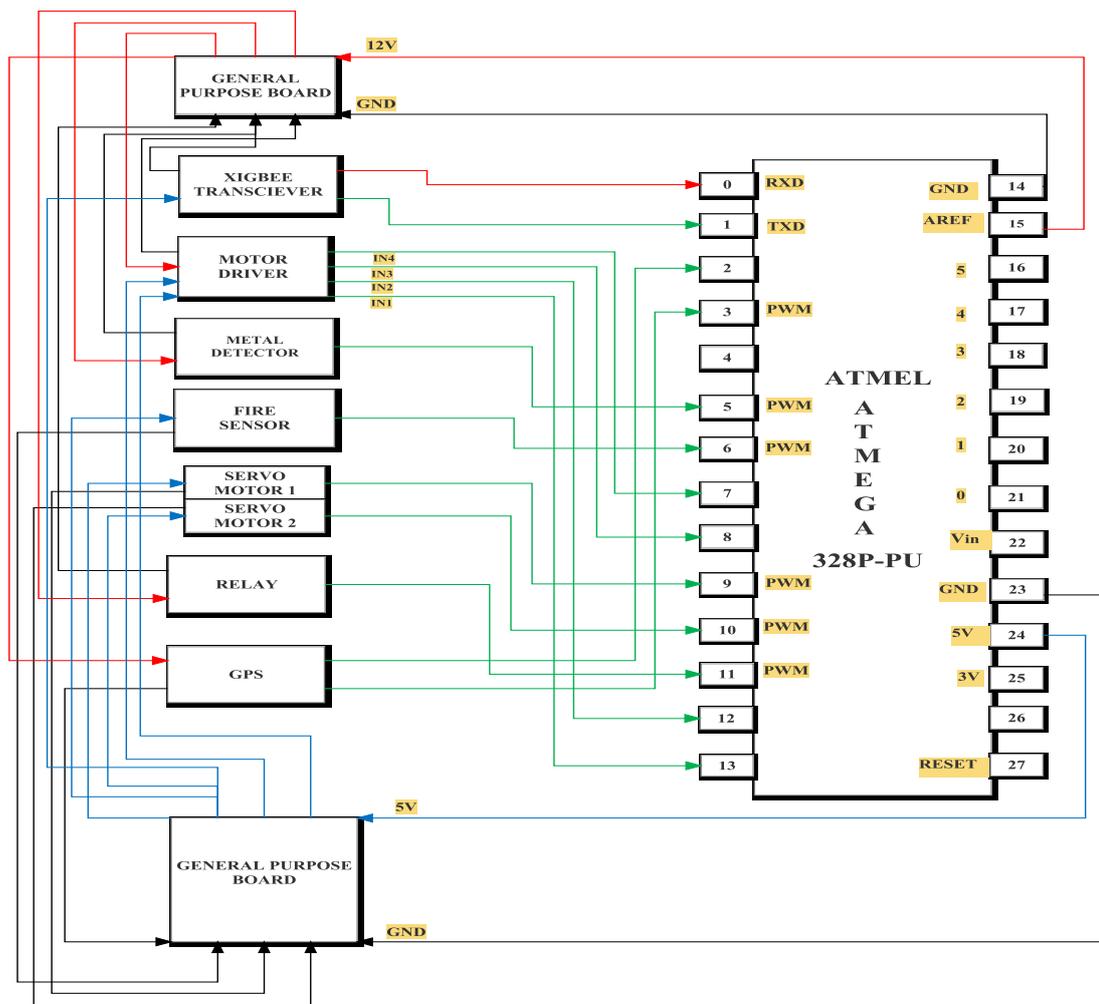

Figure 3. Interfacing of I/O devices with Arduino Microcontroller

IV.   SOFTWARE APPROACH

4.1 GRAPHICAL USER INTERFACE FOR MOBILE ROBOT CONTROL

Graphical User Interface are used for controlling a system; the whole system can be controlled through one technical panel which will be containing all the required buttons, windows, sliders, switches etc. For creating a GUI through MATLAB gives the privilege to program each and every buttons or switches to control a particular system The GUI in this rescue robot project includes the motor control options an on/off button for enabling live video streaming, a snapshot button for taking live snaps of the area, a metal detector sensor grid and fire detector sensor grid ,live video streaming window, a record window through which we can control the robot through human voice ,coordinates button which gives the location of the particular area ,by displaying it in a Google map and also the snaps which have been taken through the camera can be processed such as noise addition using salt and pepper ,noise reduction by using median filter , edge detection and finally the DWT. We have used here a real time video and image filtering using MATLAB Simulink which is further processed in a Spartan 6 FPGA.

4.2 MAXIMIZING CODE PERFORMANCE BY OPTIMIZING MEMORY ACCESS

Most MATLAB users want their code to be fast, especially when it is processing very large data sets. Because memory performance has not increased at the same rate as CPU performance, code today is often "memory-bound," its overall performance limited by the time it takes to access memory. So we have some techniques to reduce the memory accesses so as to optimize the memory available. We are Reallocate Arrays Before accessing those Within Loops. When creating or repeatedly modifying arrays within loops, always we have allocated the arrays beforehand. Of all three techniques, this familiar one can give the biggest performance improvement. The MATLAB language does not require you to declare the types and sizes of variables before we use them. As a result, we can increase the size of an array merely by indexing into it at a point larger than the current size. This approach is convenient for quick prototyping of code, but each time we use it, MATLAB must allocate memory for a new larger array and then copy the existing data into it. Code that repeats this procedure several times, as in a loop, is slow and inefficient. When creating new variables or variables that are functions of existing data sets, we have ensured that they are essential to our algorithm, particularly if our data set is large. Reduced memory usage is particularly important when dealing with data sets that are larger than the available RAM. Operating systems supplement physical RAM memory with a swap or page file stored on disk. Accessing data stored on disk is orders of magnitude slower than accessing data stored in RAM, however. For maximum performance, keep memory usage low enough to prevent your system from running out of RAM when MATLAB is executing.

4.3 VIDEO, IMAGE AND VOICE PROCESSING RESUTS

Once the snapshot button in the MATLAB GUI is pressed, MATLAB takes the picture from the Camera detection and image compression. The image from the MATLAB program folder is accessed and a salt pepper Noise is added to it and which again is being remove by the Filter. The filter that we have used 2D MEDIAN filter which will remove the salt pepper Noise present in that image. That image is now taken up by the edge detection block which will process it according to the

algorithm given in methodology and gives us the edge detected image. In the same way the filtered image is taken up by the DWT image compression block which will process and gives the compressed image. Thus in this project the captured image is processed to give us the image with added Noise, the Noise filtered Image, EDGE Detected image and DWT compressed Image, which will be stored in the MATLAB Program folder. Every time the snap shot button is pressed the process happens and gives us the results and stored in the MATLAB Program folder with separate names to it .The samples of the voices which are 82 in number are stored in the Voice recognition folder inside the MATLAB program folder. When RECORD button in the GUI is pressed and a command is given. The MATLAB program compares with the stored Samples and the least difference value is selected and the process is carried out. So our Robot is controlled by VOICE. All the movements of the robot can be controlled.
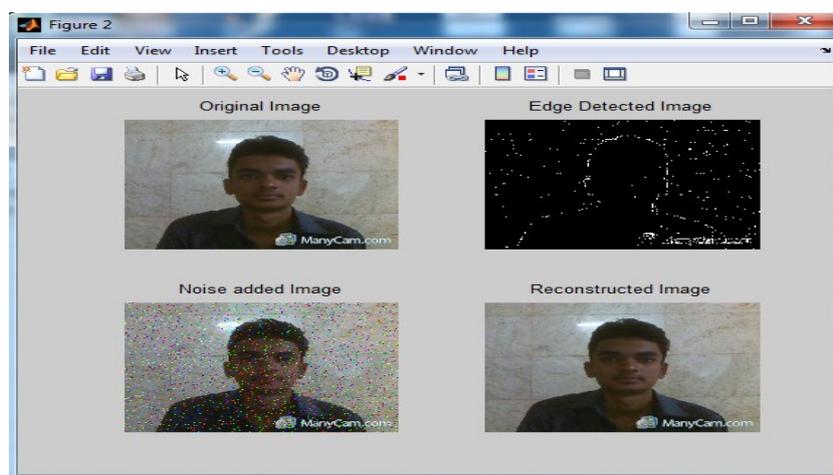

Figure 4. Real time video streaming and processing

V.   CONCLUSION

 In this project of rescue robot, a MATLAB GUI was created which incorporated the motion control of robot, motion control of servomotors ,live video streaming through robot to the GUI with a snapshot option, the received image was processed by adding salt and pepper noise which is then removed by 2D median filter ,then the edges are detected of the filtered image, the image so obtained is then compressed using DWT and also the metal and fire detection sensors were able to detect the same by sending RF signals from robot to GUI through wireless XIGBEE module. To get an exact location of the area, the robot was featured with GPS module which displayed the location of the area in Google maps .the robot was able to control through human voice by programming in MATLAB software, the voice samples which were previously stored in the software gets compared with the input voice of the user and finally by matching the frequency and pitch of the voice, the robot was able to move.

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