Sensor Based Rescue Robot for Catastrophe Management

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Abstract— The use of robots in different fields is common and effective in developed countries. In case of incident management or emergency rescue after a catastrophe, robots are often used to lessen the human effort where it is either impossible or life-threatening for rescuers. In this research paper, thus we proposed a low-cost "Rescue-Robot" for pro-catastrophe management which can overcome the budget-constraints as well as fully capable of rescue purposes for incident management. Alive human body detection system proposed a monitoring system using ultrasonic sensors and camera to record, transmit and analyze conditions of human body. The task of identify human being in rescue operations is difficult for the robotic agent but it is simple for the human agent. Having detected a sign of a living human, the ultrasonic sensor Triggers the camera to show live scene. The video is then displayed on the screen. This approach requires a relatively small number of data to be acquired and processed during the rescue operation. This way, the real-time cost of processing and data transmission is considerably reduced. This system has the potential to achieve high performance in detecting alive humans in devastated environments relatively quickly and cost-effectively. The detection depending on a number of factorssuch as the body position and the light intensity of the scene. Results show that the system provides an efficient way to track human motion. The aim of this article is to present our experience with various sensors designed and developed.

Keywords: transmission, cost-effectively, various sensors designed, Triggers the camera

I. INTRODUCTION

Catastrophecan be classified into two main groups-natural and man-made. Natural catastrophes include Floods, storms, cyclones, and earthquakes, where as human catastrophes such as transportation accidents, industrial accidents and major fires. During such Calamities, especially catastrophes, in order to prevent loss of life and property various essential services (Like fire brigades, medical and paramedical personnel, police) are deployed. According to the field of Urban Search and Rescue (USAR), the probability of saving a victim is high within the first 48 hours of the rescue operation, after that, the probability becomes nearly zero. Generally, Rescue People cannot enter into some parts / places of the war field or in the earth quake affected areas. All of these tasks are performed mostly by human and trained dogs, often in very dangerous and risky situations. The rescuer may become a victim who needs to be rescued. For this project, we will focus only on robots which will work in a catastrophe environment of manmade. The proposed system uses a ultrasonic sensor in order to detect the existence of living humans and a low-cost camera in order to capture video of the scene as needed. Having detected a sign of a living human, the ultrasonic sensor triggers a camera to capture a video of the scene. The simulated robot is assumed to have the capability to determine its current location in real-time, to wirelessly communicate with the rescue team, and to locally store the status and location information about the trapped victims in case the wireless communications link is temporarily disconnected.

This technology can assist rescue workers in four ways:

1) Reduce personal risk to workers by entering unstable structures
2) Increase speed of response by accessing ordinarily inaccessible voids
3) Increase efficiency and reliability by methodically searching areas with multiple sensors

In this section, a brief discussion of some of the related work is presented; focusing on the used approach and its advantages and disadvantages.

Communication is often important to provide some emotional comfort to the victim and to help workers locate rest of the body during removal. In case of tele-operated robots, the multi-objective exploration and search is solved by the human operator, who decides the activities of the robot. Cameras which transmit live videos of the catastrophesite, as well as information about locations of objects with respect to the robot's position to the interface on the laptop. The sensor sends the information weather the human body is alive or not and the structure of robot is flat and free movable wheel so that it can move in multi direction and enter catastrophe sites.

Quality work has been done in the field of robotics. These robots came into existence in the early 21st century but since then enormous improvements have been made in the concept, design owing to which their capabilities have improved significantly. With limited resources urban search and rescue operations have always been very intricate and dangerous.

II. BLOCK DIAGRAM

A. *Block Diagram on PC Side:*

The block diagram on pc side shows our connection interface taking place in computer. We are using wireless receiver, microcontroller, RS232, and an alarm. The wireless receiver is used to receive the signal where in our project we use Zig-bee as both transmitter and receiver. The RS-232 interface is the Electronic Industries Association (EIA) standard for the interchange of serial binary data between two devices. It was initially developed by the EIA to standardize the connection of computers with telephone line modems. The standard allows as many as 20 signals to be defined, but gives complete freedom to the user. Three wires are sufficient: send data, receive data, and signal ground.

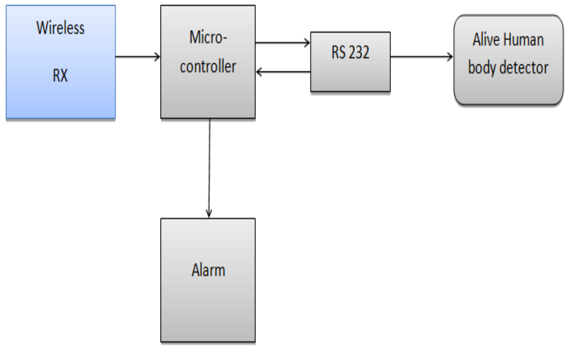

Fig. 1: Page Layout on PC Side

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B. *Block Diagram on Robotic Side:*

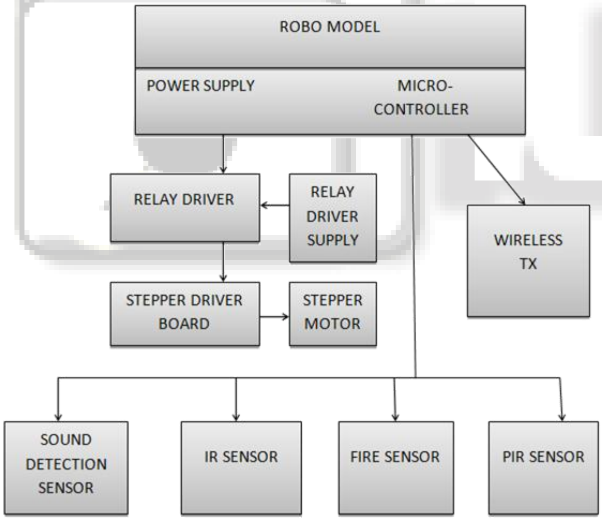

Fig. 2: Block Diagram on Robotic Side

The remaining lines can be hardwired on or off permanently. The signal transmission is bipolar, requiring two voltages, from 5 to 25 volts, of opposite polarity. The high-performance, low-power Atmel 8-bit AVR RISC-based microcontroller combines 16KB of programmable flash memory, 1KB SRAM, 512B EEPROM, an 8-channel 10-bit A/D converter, and a JTAG interface for on-chip debugging. The device supports throughput of 16 MIPS at 16 MHz and operates between 4.5-5.5 volts. By executing instructions in a single clock cycle, the device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed.

The block diagram on robotic side has stepper motor, relay driver, microcontroller, sensors like IR, fire, PIR, sound detection sensors, power supply. A stepper motor (or step motor) is a brushless DC electric motor that divides a full rotation into a number of equal steps. The motor's position can then be commanded to move and hold at one of these steps without any feedback sensor (an open-loop controller), as long as the motor is carefully sized to the application. A relay is an electro-magnetic switch which is useful if you want to use a low voltage circuit to switch on and off a light bulb (or anything else) connected to the 220v mains supply. Sensors are used for sensing fire, sound and human body detection.

C. *Design of the Rescue Robot:*

The concept of the robot involves di errant specialized technical fields and problem solutions, with a huge dependency and interconnection to each other. So the design of the Robot has to be adjusted.

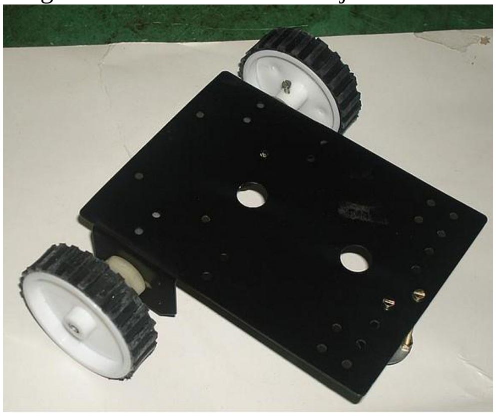

Fig. 3: Design of the Rescue Robot

D. *Mechanical Design:*

In search- and rescue missions, the robot's ability to move in rough outdoor terrain or indoor areas is essential. During a RoboCup Rescue competition the robot must demonstrate its ability within di errant areas, while each arena simulates di errant conditions and includes several tasks and obstacles. In general, to secure enough mobility within the arenas, the robots outer dimensions should not exceed, but are not limited by any rule, the floor conditions vary from a smooth wooden plate up to a rough terrain composed of wood-stacks. Dealing with such an uneven terrain requires a well suspended and damped drive. Past competition results show that tracked vehicles accomplish those areas faster and more successful compared to wheeled vehicles

E. *Wheel Size of 6 cm, Chase Height 12*8cm:*

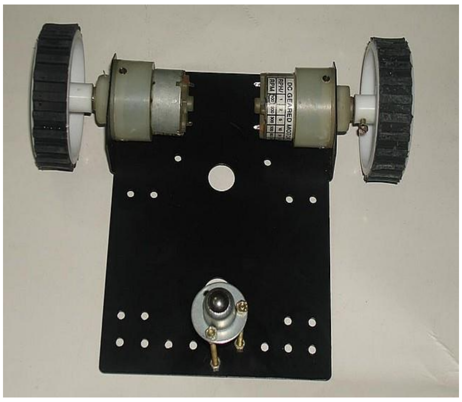

Fig. 4: Wheel Size of 6cm, Chase Height 12*8cm

III. COMMUNICATION STRUCTURE

A key factor of all robot-specific electronic components is the structural organization of information interchange. The communication interface between those components basically has to full the following requirements and therefore provides:

- A bus-system oriented architecture to reduce cabling-effort and increase scalability
- Sufficient amount of nodes which can be con-nested to the system
- Enough bandwidth to avoid loss or unnecessary delay of data-transmissions
- A high grade of compatibility and technical sup-port such as drivers and documentation Low power consumption to support the idea of a accumulator-based PSU

IV. SYSTEM IMPLEMENTATION

The whole system consists of the following main components, explained in greater detail below.

- A set of robots, which implement local on-board walking and head motion routines in the OPEN-R system.
- An operator console, that implements the operator's interface in the Linux system using the X11, Gtk and OpenGL suite.
- A communication infrastructure, which establish a bi-directional communication between these components, and consists of a combination of an Image Router and TCP-Gateway processes.

For communication between the robots and the interface something we prefer to call Image Router was used. This is basically just a Sony Remote Processing (RP) unit that runs in the background and communicates with the robots in the same way as the robots themselves communicate with each other. The RP unit is just a middle layer in the communication between the robots and the interface, that in the direction from the robots, receives information, translates it into UDP-packet and sends the UDP-packet forward to the interface. And in the other direction receives UDP-packet from the interface, translate them into suitable information for sending them to the right listening observer of the addressed robot.

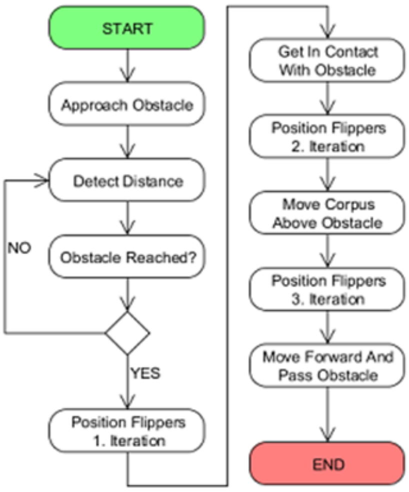

Fig. 5: Communication Structure

From the beginning the interface was meant to be implemented completely within Gtk (a language for writing window-based applications for Linux systems). But during the beginning of this project it turned out that Gtk had a major drawback in the sense of handling advanced computer graphics, so a hybrid between Gtk and OpenGL was tried out instead. But it became clearer and clearer during the implementation that there wasn't actually any need for making a window-based interface, because of the absence of actual window components (e.g. menus, buttons), so the implementation ended up totally within OpenGL, and that is mainly for two simple reasons:

- It became (however strange it may sound) easier building the interface from the programming point of view
- OpenGL handles graphic much smoother than a classic Window GUI could do.

When ultrasonic sensor detects the signal, the controlprogram orders the camera to display the surrounding area. If human is detected it sends the signal to rescue team in audition of video as well as in signals the zig-bee act as receiver and transmitter.

V. APPLICATIONS

1) Used in military applications to detect the presence of human being
2) In rescue operations where human reach is not possible
3) In catastrophe areas to detect human.

VI. CONCLUSIONS AND FUTURE WORK

In this paper, we have described a working prototype urban search and rescue robot employing structural features designed to enhancethe robot's movement capabilities. The adjustable compliance joint and cooperative top-and-bottom tracks are unique features that have never been applied to urban search and rescue robot designs. The robot's ability to control the relative angles between the cars, while at the same time allowing them a degree of compliance, was critical in creating a design that had a significant degree of flexibility. Dual top and bottom tracks significantly enhance mobility in confined spaces and loose rubble. A simpleprototype was developed to demonstrate the ability to implement these mechanisms in a real, low-cost and readily repairable unit. A physical simulation was developed to assist with the design of user interfaces for simple control.

Future work on the robot morphology involves generation of the second generation of the vehicle. In the next prototype, the spring tensioners will be re-designed for more efficient control, the overall system will be tightened to reduce weight while still providing ease of maintenance, and new front/end modules will be built according to the design. The next prototype will include six segments plus the end links, and will be tested using the methods from and those discussed in Section IV above for the canyon and ladder obstacles.

There are three main improvements in development for the simulation and the genetic algorithm: improved model of the tracks, a model of the adjustable compliance on the joints, and the serial bendabilityof the actions. For the tank tracks, weare currently expands the capabilities of ODE to include a specialized object that can approximate track behavior. This process involves creating a new object, the elliptical cylinder, in the set of geometries. This will enable the simulated robot to represent an approximation of the physical space that would be taken up by a complex track system. Once the elliptical cylinder is completed, a specialized motor will be added to apply forces at the contact points of the cylinder as if it were a track, without rotating the cylinder itself. Together, these new features should more adequately model the tracks of the physical robot. We are further modifying ODE to introduce springing parameters for joints that can be applied to specific degrees of freedom. This will enable more a closer model of the adjustable compliance of the robots joints. As discussed in section III, one of the challenging aspects of controller development is bendability, the ability of the actions to blend into one another as one completes and other begins. This is difficult because the evolution of the individual behaviors is done in isolation, with no guarantee that the beginning of one action would not interfere with the completion of the previous. One possible solution for blending is to gradually shift cars from one behavior to the next, from the front car to the rear. This would most likely work for simple turns, but may fail in cases where the action of the front cars are required to complete the action for the rear cars, such as pulling them through the maneuver. In these situations, the action is unbendablewith a successive action. Instead, we intend to try to evolve bendable actions. We will do this by first evolving the actions as described above. Once base controllers are obtained, the fitness function will be modified so that the controllers are evaluated when blended with other controllers. This should result controllers that generate bendable actions, but will continue to be an area of active research.

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