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Design of UGV for Searching and Saving Lives of Lost Persons in Natural Disasters and Military Using GSM Zig-Bee

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ABSTRACT

An unmanned ground vehicle (UGV) is a vehicle that operates while in contact with the ground and without an onboard human presence. UGVs can be used for many applications where it may be inconvenient, dangerous, or impossible to have a human operator present. Thinking on the general SAR context, when a small plane crashes in a remote area, or a fishing boat is lost at sea, or a hurricane devastates a region, or simply a person gets lost while he/she was hiking, SAR teams must scan vast areas in search for victims evidence or wreckage.a hybrid multi-sensor navigation system has been developed, benefitting from the GPS system performance and exploring the use of RIMU sand barometer to assess the potential of lower-cost, highly-redundant.

Keywords : hybrid multi-sensor, wreckage, SAR

I. INTRODUCTION

The UGV is the land-based counterpart to unmanned aerial vehicle and remotelyoperated underwater vehicle. Unmanned robotics are being actively developed for both civilian and military use to perform a variety of dull, dirty and dangerous activities.

The Defencedepartment response was to create the Joint Robotics Program (JRP). As a result of this interest and the efforts by the Department, the forces operating in theatre today will employ nearly 4,000 robots by the end of calendar year 2006. These robots are accomplishing high risk missions while simultaneously reducing the loss of life and limb among the Service members serving in European Command (EUCOM), Iraq, Afghanistan, and other Central Command (CENTCOM) locations. Today's battlefield environment unequivocally demonstrates the military utility of robotics applications in combat. More and more robots are being destroyed or damaged in combat instead of Servicemen and women being killed or wounded, and this is the preferred outcome [1]. As robotics technologies proliferate and applications spread to other mission areas in combat service and Service support, robotics will play an increasing role in the success of a broadening range of future force missions. The Department is responding to these trends by positioning itself to further exploit the promise of robotics technology [9].

Unmanned ground vehicles (UGVs) today are saving lives and providing critical supporting capabilities in current military operations worldwide. A diverse combination of prototypes, commercial off the shelf (COTS) purchases, and fielded systems support our Joint forces in a variety of mission areas, including: improvised explosive device (IED) detection and defeat, scout, explosive ordnance disposal (EOD), force protection (FP), countermining, unexploded ordnance (UXO) clearance, and more. UGV platforms in use today are sized to meet mission capability requirements and range from a hand launched throwbot prototype weighing less than a pound, to large systems like the Abrams Panther mine clearing vehicle weighing in at over forty tons. From the onset of the Global War on Terror (GWOT), employment of available UGVs and new capability needs from our forces have been rising steadily [3].

The Robotic Co-combatant Interaction Technologies task will demonstrate the ability for UGV to operate safely in a semi-autonomous mode in urban environments in the presence of soldiers, pedestrians, and other vehicles. The Robotics Collaboration ATO is expanding the tools, techniques, and autonomy to increase performance and increase effectiveness of Soldier-robot teams. The NAUS ATO develops and demonstrates key robotics technologies on an Armed Robotic Vehicle (ARV) scale mobility platform to reduce risk for PM FCS (BCT) [10].

II. RELATED WORKS

2.1Current Military Operations

UGVs, in varying sizes to meet mission capability requirements, are today saving lives and providing critical supporting capabilities in current military operations worldwide. Included in the mix is a diverse combination of prototypes, commercial off the shelf (COTS) purchases, and fielded systems supporting our Joint forces in a variety of mission areas, including improvised explosive device (IED) detection and defeat, reconnaissance, explosive ordnance disposal (EOD) and force protection (FP).

2.2. Major Acquisition Programs

Developments in robotics and UGV system capabilities support current major defence acquisition programs of the Department of Defence (DoD) with the most obvious program being the Army's Future Combat Systems (FCS) Brigade Combat Team (BCT). In support of the FCS effort, Modeling and Simulations (M&S) have demonstrated that Armed Robotic Vehicles (ARV) supporting the Mounted Force have improved the survivability of Manned Ground Vehicles (MGV) and contributed significantly to the targeting of enemy forces. Furthering robotic developments, Service laboratories have conducted core research to enable levels of autonomous mobility needed for both current and future systems [2]. The Joint Ground Robotics Enterprise (JGRE, formerly the Joint Robotics Program (JRP)) has supported and continues to support technology maturity efforts that have enabled the fielding of the first generation of robotic UGVs providing a range of current force capabilities.

2.3. Department Programs and Activities (FY2004-FY2012)

There has been a steady increase in research and development activities, Service requirements, Congressional interest, and overall robotics investments since 1990 [7]. As technologies have matured, more systems have been fielded, and prototypes have made it into user hands for evaluation. Projections of total current and future DoD investments over the period FY2006-2012 approach $1.7B. DoD plans for near-term robotics investments are focused to leverage rapidly maturing robotics technologies and to meet rising warfighter capability needs for better UGVs.

2.4. Long Term R&D

The military importance of UGV technology is increasing rapidly. UGVs and other robotics now have capabilities to perform missions that are dirty, dull, and dangerous. Science and Technology (S&T) focus is being placed on near and far term research and development (R&D). Research efforts will transition to acquisition programs that will be integrated into the Army, Marines, Air Force, and Naval ground fleets and are described in greater detail in this section. Multiple avenues of technology development and maturation in such areas as mobility, platforms, autonomy, human machine interactions and interfaces, and integration with other UGV and manned systems are being employed to increase the level of DoD unmanned ground system and robotics capabilities [5].

III. PROPOSED SYSTEM

3.1 Existing systems

3.1.1 Mountain rescue

Mountain rescue relates to search and rescue operations specifically in rugged andmountainous terrain. The figure below shows mountain rescue operation.

Fig.3.1.Rescue operation using rope in mountains

3.1.2 Ground search and rescue

Ground search and rescue is the search for persons who are lost or in distress on land or inland waterways. Traditionally associated with wilderness zones, ground search and rescue services are increasingly required in urban and suburban areas to locate persons [4]. Ground search and rescue missions that occur in urban areas should not be confused with "urban search and rescue", which in many jurisdictions refers to the location and extraction of people from collapsed buildings or other entrapments.

Fig.3.2 Rescue team

3.1.3 Air- rescue

Air rescue (ASR) refers to the combined use of aircraft such as flying boats ,floatplanes, amphibious helicopters and non-amphibious helicopters equipped with hoists and surface vessels, to search for and recover survivors of aircraft downed at sea as well as sailors and passengers of sea vessels in distress, autonomous UAVs(Universal Air Vehicles)use to rescue the survivors on land. The use of Unmanned Aerial Vehicles (UAVs) —more in general,Unmanned Aerial Systems (UASs)— for SAR operations isnot new and has been traditionally fed by developments made inother fields. The main driver of UAV technology has been (andstill is) the military field and this is because the nature of militarydevelopments is fairly overlapping SAR needs.

Fig. 3.3 Aerial rescue operation,

These techniques are very effective but cannot be carried out in many cases for manual like in the case of a mini jet crashes in an inaccessible and a remote place like the very dense of Amazon, Africa.Its very difficult to trace the missing person in the huge forest, and if at all the person in the forest is found it is very difficult for the manual rescue operation to be carried out due to many life threatening creatures,and it really consumes a lots of man force to scan such a huge forest [6].

Whereas in the case of aerial rescue operation the aerial instruments are ineffective in forests since objects lying on the ground are not visible to these devices.

3.2 Proposed System

The disadvantage can be eliminated by making use of a ground based robot or unmanned ground vehicle(UGV).UGV or Unmanned Ground Vehicle are a medium sized autonomous robot which operate of their own and do not required any human control over it, hence if a certain range of area is given to be scan in search of a human then this device is very effective.

A large number of these robots are sent in the forest where the missing person is predicted to be there. These mini robots scan the whole area on the ground level and search for the missing person.

Hence it completely eliminates the danger of human life during the rescue operation and one of the best features of UGVs is it do notrequire any human to control it i.e.it is self controls itself and reduces man force.

Fig 3.4 UGV

3.2.1 Locomotion

The most basic problem facing UGVs is mobility, and the choice of locomotion affects the structure of the entire robot. To meet the stated requirements, the vehicle must have a flexible drive system which can adapt to the myriad of conditions and obstacles possible in collapse scenarios, while remaining simple and reliable enough for search and rescue work.

There many options (Table 1) when designing the robot, the first of which was a snake style motion using joints which would expand and retract. This option would provide exceptional manoeuvrability in a relatively small package. The addition of modular sensors and payloads would lead to increased mission flexibility. However, the speed of a snake-style robot is quite limited, and the mechanical complexities would mean a cost far greater than the allotted budget.

A second locomotion option was a hexapod design with insect-like legs. Legs are most easily adapted to the uneven terrain found in building collapses. However, each leg would require at least 2 joints and 3 degrees of freedom, which greatly increases complexity, both physical and programmatic, as well as cost. This increased complexity also decreases reliability and durability, which were two factors the team considered very important. With a minimum of four legs required for stability, the team decided that insect-like locomotion would be too complex, too costly and too fragile.

A more novel third option involved rotating screws placed on the outside of the robot. When spinning in opposite directions, they would propel the vehicle forward through almost any terrain. These screws (similar to a back-driven worm) provide lots of traction and would work in water. Unfortunately, the screw system cannot climb stairs, thus failing one of the team's key design criteria.

Large wheels were briefly considered as a fourth type of locomotion. Wheels would be the simplest, cheapest and most reliable option, as they require fewer motors and fewer moving parts. However, the mobility of a simple wheeled vehicle is severely limited, and a small wheeled robot would not be able to climb stairs. Placing a wheel at the end of a freely rotating arm would solve the stair-climbing problem, but there would be no traction along the length of the arm.

Using tracks on the arm instead of a wheel was the final option. Tracks supply traction along the entire arm without an increase in complexity over wheels on the end of rotating arms. This design would allow the robot greater mobility than simple wheels and more traction than a wheel on an arm. So depending on the environmental condition the type of locomotives is decided, but here in this model we make use of a simple wheel that can run on a flat surface for a demonstration and these wheels can be changed according to the surrounding.

3.2.2 Communication, Control and Power

The robot will be used in disaster areas inside collapsed buildings and around debris. It will likely be used in collapsed basements or in other radio frequency (RF) shielded environments. It is assumed that there will be no external coverage, such as cellular networks, in the case of natural disasters. The goal is to have a range of up to 150 feet line of sight for the initial prototype, less in confined areas with structural interference. Communication with the robot could be achieved in one of four ways:

The first option was to use a cable tethered to the robot at all times to provide power, communication and other functions such as a fresh water supply. Using a tethering cable from the base station to the robot meant that a battery would not be needed and operating time would not be an issue. Communication between controller and robot would be more reliable and less susceptible to interference. The tether could potentially create problems by snagging on corners of objects or tangling in steel debris. A tether would also have to be stored either on the robot or near the operator. The friction from pulling the cable could prove overwhelming for a robot of this size.

A second option was to utilize a WiFi router to handle all communications between the robot and base station. The popularity of this technology with consumers means that the cost is kept lower than other possible wireless solutions. Using a WiFi router in conjunction with a laptop computer eliminates the need for a dedicated transceiver pair. WiFi will also provide sufficient bandwidth for video streams from the robot provided the signal is free of interference.

Control of the robot would be done via one of several methods which could include a dedicated microcontroller or a processor programmed onto a field programmable gate array (FPGA). Another alternative is to construct a simple computer running an operating system, such as Linux.

A microcontroller can be purchased cheaply and is powerful enough for most functions. Positioning and most sensing could be done with the microcontroller, leaving video streams to another device. This approach would be very simple to design and implement quickly.

To be useful for search and rescue applications, the robot shall have at least 1 hour of runtime. It is assumed that only some of the motors will be run at any time, but power must be provided to all the electronic components continuously. Two appropriately-sized batteries were chosen due to current draw constraints.

3.2.3 Block Diagram

The main goal is to integrate a medium-size, robot type unmanned ground vehicle(UGV),for searching lost people in the natural disasters. UGV is built with camera for detecting the person using image processing and video processing techniques for rescue purpose must know about the person's alive or not. Temperature sensor and pulse sensor or heartbeat sensor is used for detecting the condition of the person. Once the person is detected as alive the rescue team will get the person location through GPS Navigation system via GSM/Zig-Bee.

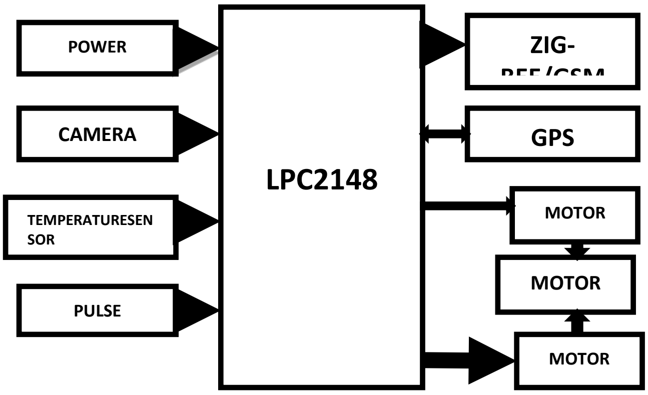


Fig.3.5. Block Diagram

All this sensors and protocols are interfaced in the LPC2148 microcontroller which has 32 bit and have 64 pins high performance ARM-7 in which only 48 pins are used by the user which are multi function pins operating at 3.3V power supply and has a oscillation frequency of 60Mhz.

Two motor drivers are used which are connected to a motor,these motor drivers are nothing but just like a relay which act as a switch used to turn on the motor which indirectly help the vehicle to move.

3.2.4 Algorithm for temperature sensor

Steps 1:The sensor sends the analog signal to the microcontroller.

Step 2:ADC 0,1 converts the analog signal into digital.

Step 3:The digital value will be converted into degrees using the formulae

Temperature =(ADC_value)/19.37

Step 3:Depending on the temperature w.r.t. the threshold.

Step 4:Send a message to the number provided with the exact location of site of accident.

3.2.5 Algorithm for pulse sensor

Step 1:Activate the pulse sensor.

Step 2: Start the timer for one minute.

Step 3: Simultaneously sensor transmit and receive the wave at micro seconds.

Step 4: After one minute stop the timer.

Step 5:Convert the count into pulse rate.

Step 6:Depending on the measured pulse rate w.r.t. the threshold level.

Step 7: A message is send accordingly (alive or dead)

3.2.6.Algorithm for image processing

Step 1: Clear all

Step 2: Activate the camera and start a video.

Step 3:Take the images from the video and store the image in x.

Step 4:Subplot the image in rows and columns and display it on the screen.

Step 5:Crop this image into 40*40 pixel and check for a human face.

Step 5:Face is detected using the protocol Cascade object detection and displayed it on screen.

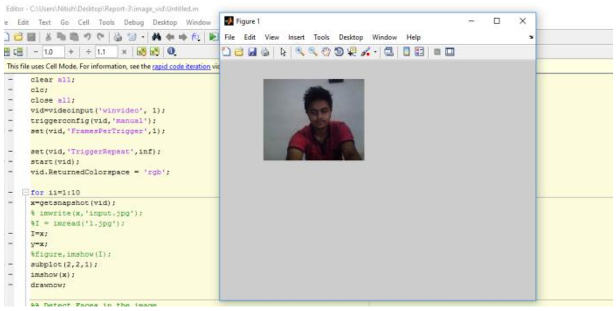
Step 6: Once the face is detected control is send to the controller.

IV. SIMULATION AND RESULTS

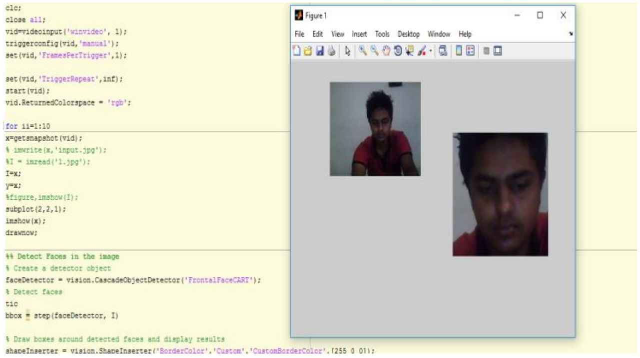
The steps involved in executions are as follows.

Step:1 Motor is switched on and the search operation starts, with the message displayed on the lcd.

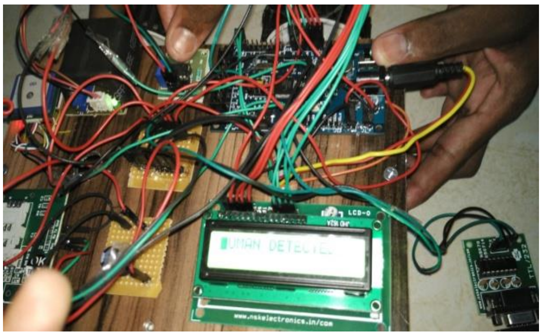
Step 2: The camera starts searching for people and displays objects around it as seen below.



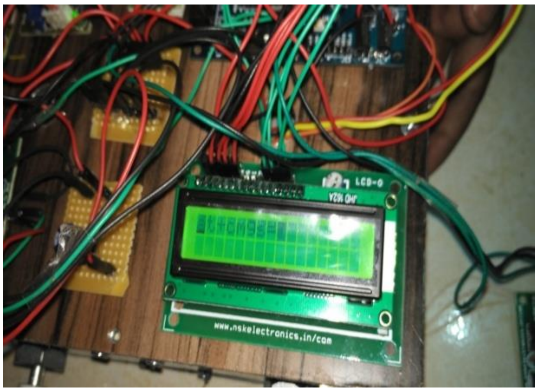
Step 3: The captured image is cropped and the face is detected and displayed on the screen.



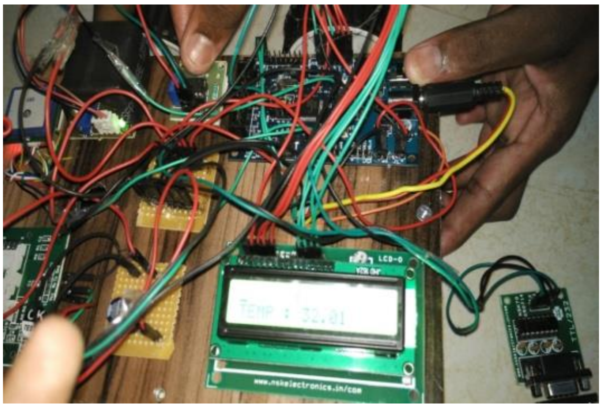
Step 4: Following that a message is sent to the number provided with the message of "human detected".



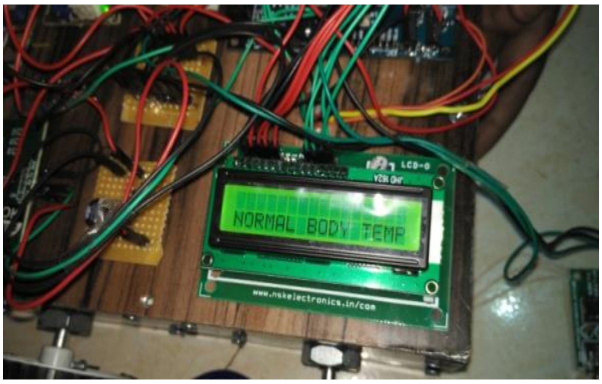
Step 5: The location of the site is also send to the number.



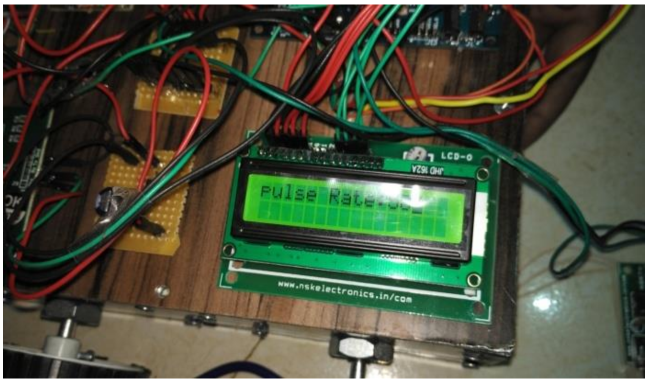
After detecting the human temperature of the body is measured and displayed on lcd.



Step 6:If the temperature is found to be normal then a "normal body temperature " message is sent.



Step 7: Finally the pulse rate of the body is calculated and message of alive or dead person is sent accordingly.



V. CONCLUSION

The proposed system is designed to integrate a medium-size, robot type unmanned ground vehicle (UGV),for searching lost people in the natural disasters. UGV is built with camera for detecting the person using image processing and video processing techniques for rescue purpose must know about the person's alive or not. Temperature sensor and pulse sensor or heartbeat sensor is used for detecting the condition of the person. Once the person is detected as alive the rescue team will get the person location through GPS Navigation system via GSM/Zig-Bee.

While budget was a limiting factor for the features included in the robot, it did not limit the imagination of the team. Among these ideas were several improvements to the existing equipment as well as quite a few new features. The prototype designed by the team has only one camera, placed at the front of the vehicle. This presents a problem if the robot gets stuck in a dead end and has to back out. To nullify this, the team originally planned to have a second camera in the "rear" of the robot to allow reversing direction without driving blind.

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