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Backtracking : An Essential Feature For Military Vehicles

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Abstract :
The military robot will be able to substitute the real human soldier in the battle field. The authors have tried to explore how a military vehicle/robot will function. Wireless cameras will send back real time video and audio inputs which can be seen on a remote monitor in the base station from where the robot is being controlled and action can be taken accordingly. The robot can be controlled from a base station by means of GSM communication module which uses DTMF module. It also has the ability to re-establish contact with the base station in case of a signal failure by retracing its path back for some distance. It can silently enter into an enemy area and send us all the information through its camera eyes. Its performance is analysed theoretically by calculating MTBF and failure rate of its circuit components.

Keywords: *GSM, DTMF, Backtracking, military vehicles, connection re-establishment, MTBF, failure rate.*

1.Introduction

The military forces always tried to use new gadgets and weapons for reducing the risk of their causalities and to defeat their enemies. With the development of sophisticated technology, it mostly relies on the high tech weapons or machinery being used. Robotics is one of the hot fields of modern age in which the nations are concentrating to use it for military purposes in the state of war and peace.

Most of the army equipments in India are of foreign design and their license is produced in India. Now efforts are on to progressively design and manufacture equipments indigenously. Indian industry over a period has grown in strength and today has the financial capability and the potential to become a partner in defence research and production so that it leads to a self-reliant defence industrial and technological base for the country.

Robustness, range and security of the communication link between the remote base station and the robot, obstacle avoidance and the real time control of the robot are some of the major issues encountered while deploying robots. In this paper, the design of a versatile UGV which leverages the already existing GSM mobile telephony network to establish a long-range, secure, fast and reliable connection with the remote base station is presented. The Figure 1 shows schematic representation.

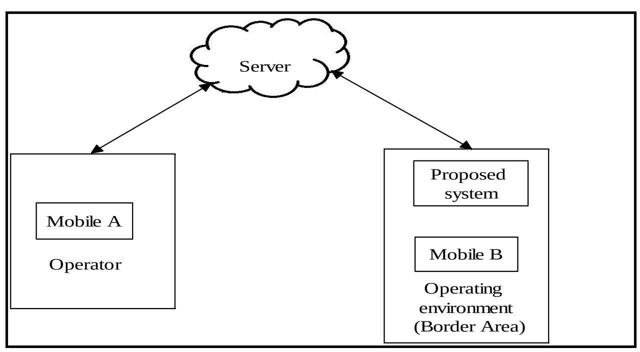

Figure 1: Schematic representation of security vehicle for military purpose

The operator at remote location having a mobile will make a call to the proposed system. The system will receive a call automatically, and follow the instructions of the operator. The functionalities are provided to the vehicle on the account of requirements which it must fulfil. The goal of the project is to develop a low cost system to carry out surveillance at border area. Thus the term robot ‘robot’ is not used for this system. The health of the system itself is maintained in sound condition by providing following functionalities to it:

- Camera for vision and feedback
- Obstacle and ditch detection
- Backtracking

2.Backtracking

The earliest and easiest method of backtracking [2,5] for vehicles was to leave marking (like specific predefined objects) on the path which it has traversed. The soldiers were able to track these markings. This was case for operator driven vehicles. Then the line follower [1] vehicles arrived which used color sensors for line tracking. But the field of robotics and communication is growing tremendously. So, it is possible to control the system or vehicle to be controlled from the safe distance. This communication is either achieved by RF (radio frequency), GSM, 802.11 wireless standards or Bluetooth. Among all these options GSM covers larger area for operation. But like others it also has one drawback: If the connection is lost, the system becomes dumb. Thus automatic backtracking is essential, to re-establish the connection between the system and operator.

The method used by Naskar [3] is an important in backtracking of vehicles. Here the signal is sent from the base station to the receiver on the robot to direct it. The receiver receives the signal and a timer counter is initialized by 0 sec. The signal then passes to the signal analyzer which checks if the signal strength is greater than the required threshold strength. If so, the signal moves to the signal processing state of the microcontroller. The signal contains a command instruction generated when certain control keys are pressed by the operator at the base station. These instructions are transmitted to the robot. The instructions are analyzed and only those instructions which control the movement of the robot are stored in the memory of the microcontroller in the form of a queue. The size of the queue is 5KB. If we consider each control instruction to be 1 byte, then the queue can store 5120 instructions in it as its elements. A new instruction received by the robot is inserted into the queue at the rear. When the queue is full (rear=max. size of the queue) and a new element is to be inserted, then we delete the element from the front and give a left shift to the entire queue. The rear shifts left accordingly. This creates a vacant space at the rear of the queue, wherein the new element is inserted. This is how the state of the queue goes on changing as the robot travels along.

When the robot goes into the back tracking mode, the above mentioned queue works as a stack with the rear acting as the top of the stack. While back tracking is in progress, the elements/instructions popped are analyzed by the microcontroller and a reverse instruction of it is executed. For example, if the original instruction was ‘move left’, then ‘move right’ will get executed by the microcontroller.

If at any point of time during the back tracking phase the signal strength reaches the threshold strength, then the control is transferred back to the signal analyzer phase. But this method has drawback of complex chassis and even complex software coding. The mechanics of system is complex due to tank steering mechanism. This system weighs around 503kg, which can be easily detected. Thus it is risky to use such heavy system for surveillance.

The method proposed in this paper can be implemented by using AT89C51, which is reliable and famous microcontroller in field of robotics. Here mechanics of system is slightly modified. Six wheels are replaced with four wheels, which are powered by one pair of DC motors. It can be observed that, front and rear wheels of right side and those of left side are connected. Thus, motion of vehicle is controlled by only two pins of microcontrollers. This modification also resulted simple mobility. The system can move forward, backward in straight line and move right and left with U-shaped turning.

The requirement of large memory block is replaced by using the timer (set for 5min through software coding) to indicate that the system is connected. If DTMF signal is not received by system after 5min, the system will execute backtracking by revering the last instruction unless the connection is re-established. But during testing it was observed that if the operator doesn’t press any key within 5min, the system automatically goes into backtracking phase even though connection is alive. Due to this erroneous result the modification was required.

The problem was solved by adding a simple programming. The DTMF signal generated consist of at least one number of 1’s except “0” is pressed. Thus “0” is not for functionalities. The available nine buttons “1” to “9” are used for controlling the system. Now the status of call connection is determined by checking the existence of 1’s in the receiver side. As a result though the operator does not press any key after 5min system will not go into backtracking phase erroneously. In this way backtracking is achieved by simple programming without any complex steering mechanism.

3.Design Overview

The chassis gives space for electronic compartment. The chassis is constructed of mild steel, which is a light weight material with a high tensile strength. The wheels are actuated using two DC motors. The Electronic system of this robot consists of the microcontroller (AT89C51), power supply (IC 7805), mobile phone, DTMF circuitry (IC MT8870), DC motors, motor driver (IC L293D), IR obstacle sensor (with timer IC 555) and a camera [4]. The block diagram is shown in Figure 2.

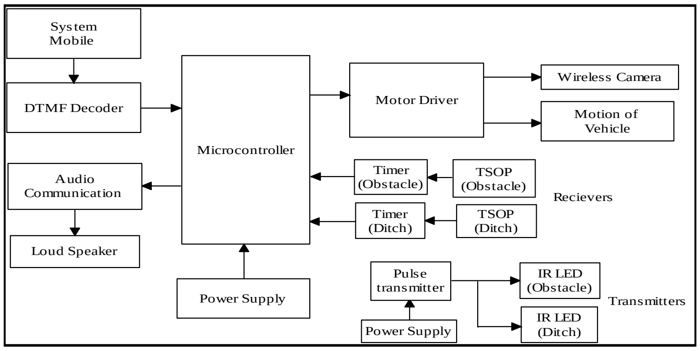

Figure 2: Block diagram of the system

4.System operation

Initially system must be powered manually by placing the switch on 'TURN ON' position. Also the system mobile must be kept on auto answering mode. This is all about hardware concerns now move towards the software part. This includes assignments of the functions to the different keys, for the DTMF format of dialling system, to a specific task such as movement of robot, motor rotation, etc. It is interesting to note that though seemed small number of keys available DTMF provides enough keys for the assignments. The flowchart of the system operation is sown in Figure 3.

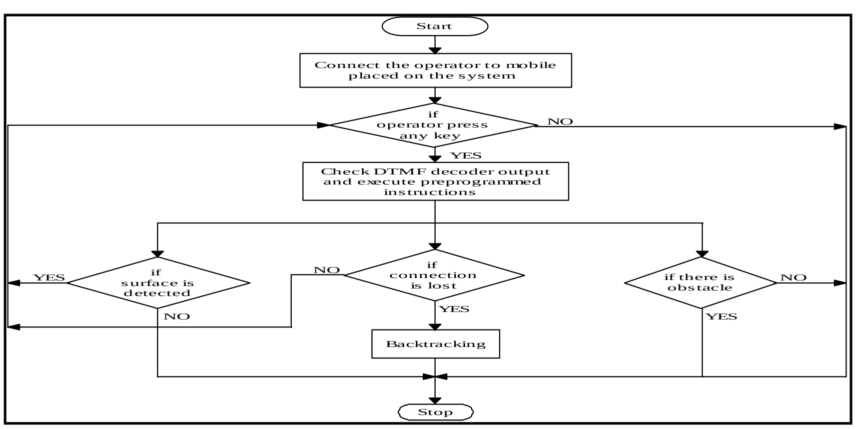

Figure 3:Flowchart of system operation

When the remote operator will make a call to the mobile placed on the system, either by telephone or a mobile, connection will be established between system and operator. The DTMF decoder IC will decode mobile signals. The microcontroller will control these tasks through decoded signals of DTMF IC. The different tasks will be performed by system as per key assignments. The respective signals will control the motors by assigning values to their drivers. The use of wireless camera will give video feedback. Transmitter section will provide continuous supply to both LEDs. But if the connection between system and operator is lost then system goes into backtracking mode.

The system performance is evaluated by comparing parameters with other systems (Daksh and Takshak [6]). The evaluation parameters includes vision, mobility, distance of operation etc.

Parameter	**Daksh**	**Takshak**	**Proposed system**
Category	ROV/GMR	ROV	ROV
Developer	DRDO	DRDO'S R&D(E) at Dighi	PG student of G.C.O.E. Jalgaon
Status	Developed	Under development	Under development
Control unit	256-node cluster with 2 quad-core CPUs	---	AT89C51 Microcontroller
Distance of operation	500m	200m	0-10km (Depend upon coverage of the network)
Vision	Four cameras with X-ray scanning capabilities	Three cameras	One wireless camera mounding
Mobility	Limited but can be deployed on cross country terrain	Good	Higher mobility due to compact size.

Table 1: System performance analysis

Though capabilities seem to be less than Daksh like ROV'S the proposed system serves the purpose of surveillance. The proposed system can be further summarized as follows

Parameter	Value
Backup time	8.458hrs
Weight	2.598Kg
Coding density	5.322
Failure rate	$20.14X10^{-6}$/hr
MTBF	5.2246hrs
Obstacle detection range	45cm(stationary)

Table 2: Summary of system

Backup time defines the time for which the system would after complete charging. The inverse relation exists between weight and backup time of the system. The weight mentioned here is of ‘without load’ condition. The coding density defines how efficient the coding is in terms of free memory space and functionalities embedded into the system. The failure rate of system components and mean time between failures (MTBF) impacts the overall reliability. Failure rate is ‘the number of failures per number of components hours over the useful life of the component’. ‘A prediction of the average time that system will run before failing is MTBF’. For prediction of reliability we are using typical failure rate of electronic components.

5.Future scope

This system is designed for slow or moderate speed. The research is required to improve functionalities of high speed vehicles and autonomous vehicles. In case of failure of any component or module every system needs a technician. The requirement of human on the battlefield is dangerous. Thus Health Maintenance of robots should be the hot research filed.

Packaging of the final product is to be designed carefully such that it can withstand thermal, mechanical, electromagnetic and electrostatic discharge stresses. To improve working of ability and speed of the system multiprocessor system and advanced software implementation can be the solution. The provision of storing the footage of border area can be added for security point of view.

In the nutshell it can be said that the system proposed is reliable, robust and having greater mobility. It can be deployed as an assistant to the ROV or GMRs.

6.Reference

1. McComb G., Predko M., ‘Robot Builders Bonanza’, McGraw-Hill publication, 3rd edition, chapter 17 and 20, 2006
2. Nair Binoy B., T. Keerthana, ‘A GSM-based Versatile Unmanned Ground Vehicle’, Intelligent Systems Issue by IEEE Computer Society, page no. 978-982, 2010
3. Naskar Saradindu, Das Soumik, ‘Application of Radio Frequency Controlled Intelligent Military Robot in Defense’, International Conference on Communication Systems and Network Technologies, page no. 396- 401, 2011
4. Pietikäinen Aku, et al., ‘Design of The Mechanics And Sensor System of An Autonomous All-Terrain Robot Platform’, International Conference on Robotics and Automation, page no. 2325-2330, May 19 – 23, Pasadena, California, 2008
5. Raj Kamal, ‘Embedded systems: systems, architecture, programming and design’, second edition, TMH, 2004
6. Sakaal times, E-paper, (a) details of Takshak, www.sakaaltimes.com/20100702/5121166480420301.htm, July 2, 2010,
   (b) features of Daksh,
   www.sakaaltimes.com/20101102/5511568363763507017.htm, Nov 2, 2010
7. Khandpur R. S., ‘Printed Circuit Boards: Design, Fabrication and Assembly’, McGraw-Hill publication, chapter 1, page no. 1-24, 2005
8. Khandpur R. S., ‘Troubleshooting Electronic Equipment: Includes Repair and Maintenance’, McGraw-Hill publication, second edition, chapter 1, page no. 7-13, 2003