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THE DEVELOPMENT OF A PROTOTYPE ROBOTIC SYSTEM FOR RESCUE OPERATION BY GSM TECHNOLOGY

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Abstract- *This paper describes the development of a robotic system with GSM Based Communication. Here we included the control of the robot and taking information from the robot using DTMF technology. In this paper the limitation of long distance control is discussed and also discussed how we overcome it using GSM network. Here we show how video calling of 3G network can come in handy in a surveillance robot. It is remotely controlled by a mobile phone just pressing button of the phone. Another phone is mounted on the robot which receives a voice call and communication is started using DTMF technology. Here we get real time video by mounting a phone on the robot with the help of 3G video calling .The camera stand can rotate 180 degree and also give up and down view by some mechanical arrangement. This paper also focuses on robotic arm. The robot can pick up and hold objects by its extraction arm system. This paper introduces the steering mechanism which is engaged with front wheels of the robot which enhances its specialty. It can move 360 degree easily.*

Keywords: Mechatronics, Rescue robot, Teleoperated control, Extraction arm system, Video capturing.

1. INTRODUCTION

In the rescue operation, GSM based robots are presently developed assist in malignant and risky jobs during the operation. The corporation and robot can be manage by a remote coordinator ,who is located in a safe remote place outside of the disaster area[1].This robotics system is fitted with a Global System for Mobile Communication (GSM) so that position of a robot can be controlled. A video camera is inflicted with it to act as an eye for the robot. By using this appropriate perception equipment, the GSM based robot can localize itself and also sense a surrounding. A simple, light weight and efficient extraction system is included in this robot. The main functions of this robot are to monitor the specific area and to extract the malignant object. The software interface protocol of this robot is identical with embedded system on AVR Micro-controller. This robot is based on same control system using Dual Tone Multi Frequency system (DTMF).

2. DESCRIPTION OF GSM SYSTEM AND DTMF TECHNOLOGY

GSM (Global System for Mobile communication) is a digital mobile telephony system. GSM uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephony technologies (TDMA, GSM, and CDMA).GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot[2-4].

DTMF (dual tone multi frequency) is the signal that we generate when we press an ordinary telephone's touch keys. DTMF has generally replaced loop disconnect ("pulse") dialing. With DTMF, each key we press on your phone generates two tones of specific frequencies. So that a voice can't imitate the tones, one tone is generated from a high-frequency group of tones and the other from a low frequency group. This technology is conducted by the MT8870DE chip which is a complete DTMF receiver both the band split filter and digital decoder function. we also include HD74LS04P hex inverter which aids this technology[5].

3. SYSTEM DESCRIPTION

3.1 BASIC STRUCTURE

Figure 1 shows the photograph of robotic system. It consists of an extraction arm system where a pair of micro-servo SG90 conduct pair of rigid arms which are made by aluminum bar. These arms allow to essence different kind and size of objects which are may be malignant or non-malignant. The robotic system has a rotating camera stand for phone camera allocation. That's why 3G video calling of 3G network can come in handy in this system. Therewith, integration of drive system by using front wheel mechanism assists the

robotic system to rotate 360 degree in standing same position.

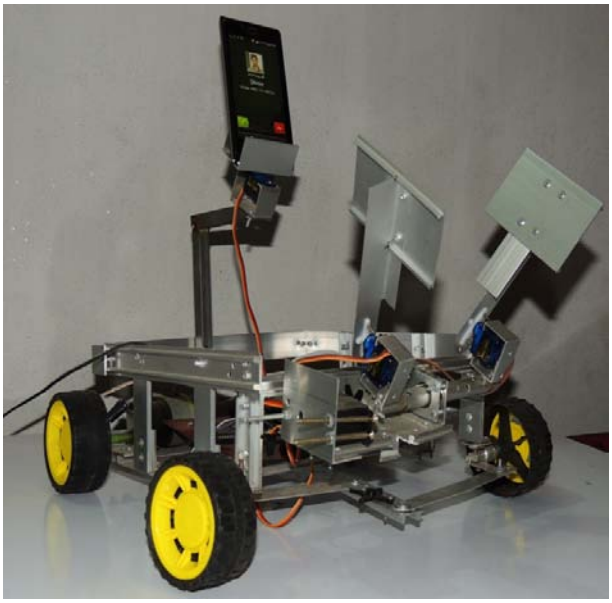

Fig 1: Robotic System for Rescue operation

3.2 OPERATION

The robot hardware system can be operated remotely without direct visual and auditory access to the hardware. Data and video originating from the robot during monitoring can be used to operate it. According to the signal from GSM module, the microcontroller operates the robot. And the motor drive runs by the signal of microcontroller. This robot is a wireless GSM based system which can be operated from any corner of the world where networking system available [7,8]. But it cannot run perfectly on rough surface and hence not water proof, so cannot work in water. It's also not efficient in dark environment.

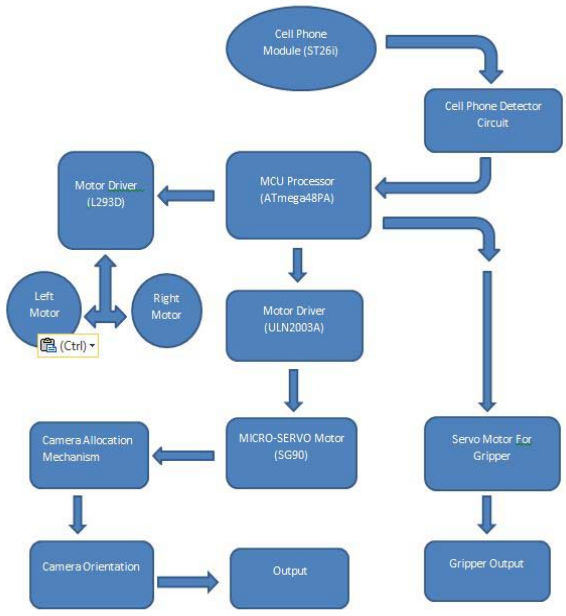

Fig 2: Operation Cycle of Robotic System

4. SYSTEM DESIGN AND ARCHITECTURE

The design procedure mainly focused to keep the robot simple so that the risk can be reduced and reliability can be increased. A simple design system is easy to implement. It is also helpful for having a good operational system. Since the team had multiple solutions for driving different subsystems, a preference list for solutions was made. Reduction through trial and error method is the basis for the solutions elimination process.

4.1 DESIGN MARGIN

Estimating the proper resource for the project was done in the initial phase of the design. Since the project was divided into different subgroups design margin for each subgroups were defined. Margins have been primarily established from an initial design. Design margin for the design consideration parameters are shown in the table 1 below:

Table 1: Design Consideration Parameters

Parameters	Expected Value	Margin
Weight	2kg	10%
Dimension	12*13*4.5 inches	15%
Torque	Motor-1>SG5010 Motor-2>SG90 Motor -3	11.00kg-cm 1.80kg-cm 20.00kg-cm
Control Functionality	Artificial intelligence	
Cost	150$	10%

4.2 KEY COMPONENET

Architecting the system is a major requirement for functional analysis and design process. System architecture gives the hierarchy of the system that helped to define deliverables for different subgroups. The GSM based robotic system is comprised of three main mechanical parts: the drive system, the extraction arm system and camera allocation system which are controlled remotely using control circuit through a GSM based communication.

.The robotic system can be divided into several subsystems which are built separately [9]. The following are the key components of the robotic system hardware:

1. Structural Frame
2. Drive Subsystem
3. Excavating Arms Subsystem
4. Camera allocation Subsystem
5. Controls Subsystem
6. Power Supply

4.2.1 STRUCTURE AND FRAME

The frame of the robot is made of aluminium bar almost. The (12*13*4.5) inches frame has a rectangular shape including a cage into it to hold the battery, circuitry, GSM receiver and a camera stand on the top of the cage which

is made by mild steel square bar and a steering system in the front of the cage. Also a hand gripper stand is built up which can hold the extraction system rigidly.

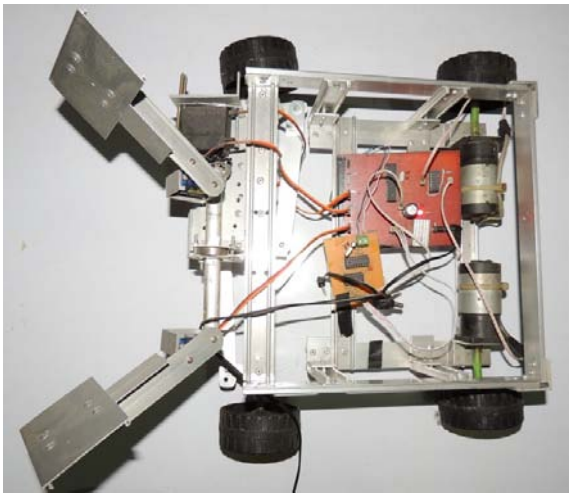

Fig 3: Structure and Frame of Robotic System

4.2.2 DRIVE SUBSYSTEM

The whole robot is driven by high efficient DC gear motor which is directly coupled with the rear wheel. There is no differential speed mechanism in this robot but we can run this robot at 360 degree by steering system which is driven by a high torque servo motor. We can easily move the robot in the back and forth direction by reversing the motor. We can also control the speed of the robot by increasing or decreasing the current flow through the DC gear motor.

4.2.3 EXTRACTION ARM SYSTEM

The extraction arm system consists of a pair of micro-servo SG90 conduct pair of rigid arms which are made by aluminum bar. These arms allow to essence different kind and size of objects which are may be malignant or nonmalignant. The pair of micro-servo aids the extraction arm system to grip the Object rigidly. And another servo (model-SG90) assists the extraction arm system for up and down movement. This servo (torque: 11 kg-cm) is high efficient to carry heavy weight safely.

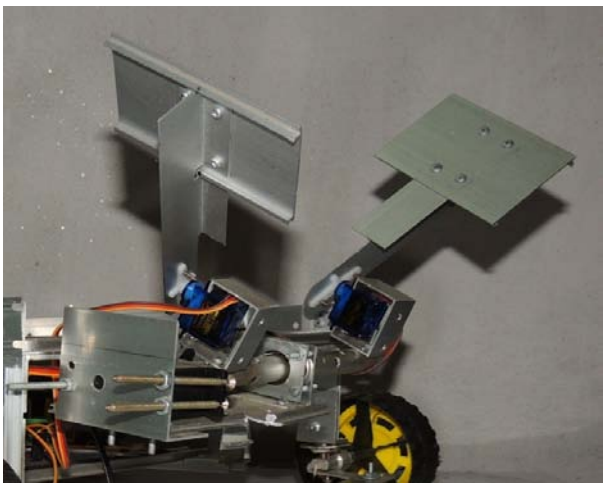

Fig 4: Extraction Arm System

4.2.4 CAMERA ALLOCATION SUBSYSTEM:

The camera allocation subsystem is built up on the camera stand which is made of mild steel and aluminium. There is a special arrangement on the stand so that the camera can monitor the lower front side and upper back side. That's why the camera stand is kept about an angle of 50 degree with the horizontal. The camera can rotate by the wish of operator when it is needed which is controlled by a servo motor.

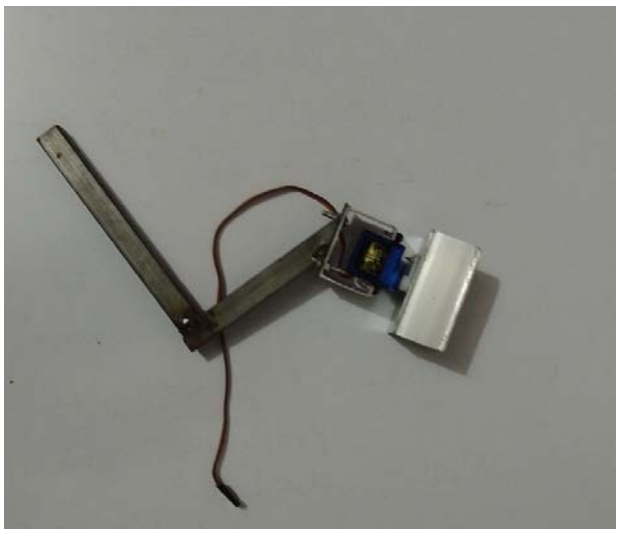

Fig 5: Camera Allocation System

4.2.5. CONTROL SUBSYSTEM:

The control subsystem consists of different components. The main components are system control circuit and communication control circuit. The main functionalities of system control circuit (SCC) include wheel-extraction arm–camera allocation driving circuit, GSM based communication module, power calculation module, data feedback system, emergency stop button etc. Microcontroller ATMEGA48PA used in this control system. In this system a phone which support 3G video calling is allocated in the robot and another phone is used for calling. When two phones are connected by calling then by means of DTMF technology we get signal in the communication circuit .Here MT-8870 is a DTMF Receiver is integrated .That integrates both band split filter and decoder functions into a single 18-pin DIP or SOIC package. Its filter section uses switched capacitor technology for both the high and low group filters and for dial tone rejection. Its decoder uses digital counting techniques to detect and decode all 16 DTMF tone pairs into a 4-bit code. External component count is minimized by provision of an on-chip differential input amplifier, clock generator, and latched tri-state interface bus. Minimal external components required includes a low-cost 3.579545 MHz color burst crystal, a timing resistor, and a timing capacitor. The filter section is used for separation of the low-group and high group tones and it is achieved by applying the DTMF signal to the inputs of two sixth order switched capacitor band pass filters, the bandwidths of which corresponds to the low and high group frequencies. This is converted with voltage. And

this voltage act as a input signal for system control circuit .By help of algorithms the robotic system can get different movement[6].

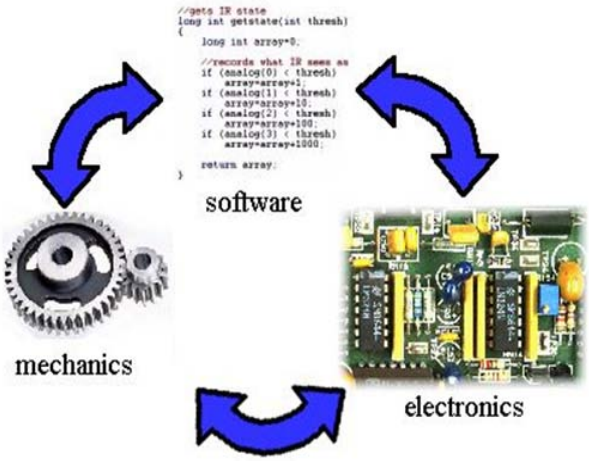

Fig 6: Control System of Robotic System

4.2.6. POWER SYSTEM:

The power supply is to support 9 high torque12 V DC motor and 1 high torque 24 V HUB motor. The 9 high torque motors require almost 12A of current in full load. Two batteries of 12V which can supply maximum of 18A are used in series connection. The SCC and KINECT powering module has been made using different battery because of the noise occurred by the high torque DC motors which can damage the control circuit.

5. SOFTWARE INTERFACE AND CIRCUIT DIAGRAM

WinAVR AVR-GCC has been used for programming language writing .the simulation software named Proteus 7 professional has been used On basis of our required algorithm. Finally the code is burned by AvrPal.Net software. The circuit which is made by simulation software is given below:

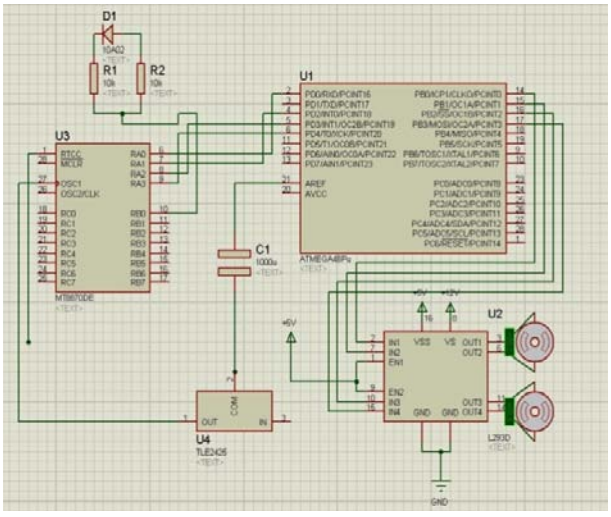

Fig 6: Circuit Diagram of Robotic System

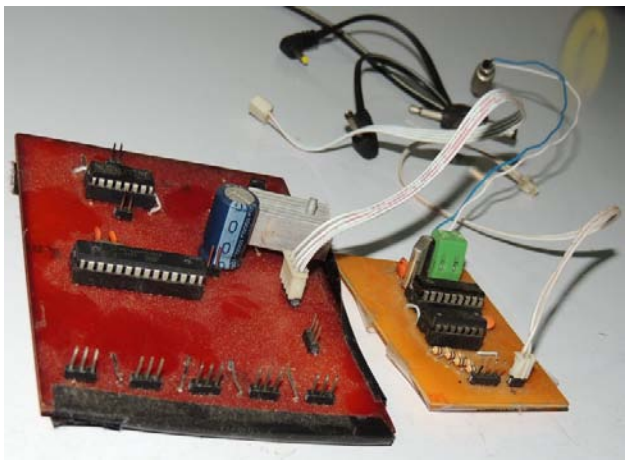

Fig 7: Electronics Hardware of Robotic System

6. TESTING, VALIDATION AND VERIFICATION

During the design implementation process each subsystem has been verified multiple times to make sure the implemented design is correct and the developed system. Dimensions and weights of the different components have been noted down during the development process so that the total system does not exceed the maximum allowable weight or dimension. Among other requirements that have been verified after the integration of the total system includes:

- The control circuit is equipped with the emergency stop button so that all the power can be turned off instantly;
- The communication method follows the system does not employ any physical process.
- Extraction arm system works perfectly but a suspension could make the system more efficient;
- The drive system works perfectly. It can move 360 degree easily
- Video calling of 3G network can come in handy

7. CONCLUSION

This paper presents the GSM based robotic system used in rescue operations. The robots have functionalities for searching victims, investigating dangerous area and extracting malignant objet. We hope, within a limited low-cost budget and available technology using, its effectiveness will match the research goals. Currently some works are going on for making it more affordable to the local agencies in Bangladesh in case of emergency rescue works. . It is true that sometimes mass production can make anything available with low-cost, but the researchers at least tried to meet the need of rescue works by robotic effort within a low-budget in Bangladesh. In future, this current rescue version of robot in Bangladesh will get more rescue capability and preciseness.

8. ACKNOWLEDGEMENT

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9. REFERENCES

[1] F. Driewer, H. Baier, K. Schilling, J. Pavlicek, L. Preucil, M. Kulich, N. Ruangpayoongsak, H. Roth, J. Saarinen, J. Suomela, A. Halme, *"Hybrid Telematic Teams for Search and Rescue Operations*", Proceedings of the SSRR'04, IEEE International Workshop on Safety,Security, and Rescue Robotics, Bonn, Germany, ISBN: 3-8167-6556-4, May 2004. (for introduction)

[2] EU Seeks To End Mandatory GSM for 900Mhz - Source

[3]. Jump up ^ Leader (7 September 2007). "Happy 20th Birthday, GSM". *zdnet.co.uk*. CBS Interactive. Archived from the original on 5 May 2011. Retrieved 5 May 2011. "*Before GSM, Europe had a disastrous mishmash of national analogue standards in phones and TV, designed to protect national industries but instead creating fragmented markets vulnerable to big guns from abroad*."

[4]. Jump up to: *a b* "GSM". *etsi.org*. European Telecommunications Standards Institute. 2011. Archived from the original on 5 May 2011. Retrieved 5 May 2011. "*GSM was designed principally for voice telephony, but a range of bearer services was defined...allowing circuit-switched data connections at up to 9600 bits/s*."

[5] Dodd, Annabel Z. *The essential guide to telecommunications*. Prentice Hall PTR, 2002, p. 183

[6] http://www.societyofrobots.com/robottheory.shtml

[7] J. Kuhle, H. Roth, and N. Ruangpayoongsak, "*MOBILE ROBOTS and airships in a multi-robot team*," The 1st IFAC Symposium on Telematics Applications in Automation and Robotics , Helsinki University of Technology, Finland, pp. 67-72, June 2004

[8] M. Kulich, J. Pavlí þek, J. Chudoba, R. Mázl, L. PĜeu þil, "Hybrid Telematic Systems for Rescue Missions," Cybernetics and Systems 2004, Vienna: Austrian Society for Cybernetics Studies, 2004, vol. 1,2, p. 731-736. ISBN 3-85206-169-5

[9] http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=6509787&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D6509787