National Security Guard commando bot

A prototype of an anti-terrorist Robot

N.Sandeep Kumar Reddy[#1], Dr.B.AnuRadha[#2]

#1Instrumentation and Control Systems, Department of EEE,
S.V.University Collegeof Engineering,Tirupati, India.

#2 Professor, Department of ECE,
S.V.University College of Engineering, Tirupati, India

ABSTRACT:

Terrorism is an issue that plagues the world every minute of every day. Especially in a country like India, which is highly and densely populated with about 1.22 billion people, a terrorist attack may cost too much in the form of casualties. This was clearly seen in the 26/11 terrorists attack at Taj hotel in Mumbai where 101 people including nine foreigners and 14 police officers have lost their lives and about 300 people were injured. Therefore, there is an urgent need to go for comprehensive strategies and to adopt newer technologies to counter these types of inhuman acts. One step towards it is the designing of highly improvised robots which are made exclusively to tackle these types of attacks.The **National Security Guard commando bot** is designed to help the security authorities to complete the operations quickly when such attacks occur so that the casualties can be reduced.The robot consists of different systems, which serve in acquisition of data from the attacked place, help in rescuing the people inside the attacked place and attacking the terrorists, even killing them under extreme conditions. The Robot is a system operated, ZigBee controlled, self-powered, wheel based one having plain mobility system and with variable speed control mechanism. It consists of a wireless camera mounted on a 3-axis manipulator for flexibility, a 5-axis pick and place arm, faint gas sprayer, fire extinguisher, speaker for communication and high focus lights. The robot can detect bombs, live humans, and temperature of a remote place and alerts the operator with the help of voice messages. It is equipped with bomb/teargas activation circuit, a LASER gun which can be used to attack terrorists. It has the provision of recording live A/V signals and when situation demands, it can also act as a suicide bomber.

Key words: Anti-Terrorist Robot, National Security Guard (N.S.G), Armed Robotic Vehicle (ARV), Zigbee Transceiver, PIC microcontroller

INTRODUCTION:

Terrorismis an issue that plagues the world every minute of every day.It evolved from numerous attacks in the 20th century, to less frequent but more destructive assaults in the 21st century. Contemporary world is facing many immediate challenges, nations, cultures and people are being affected by various issues regarding the security, especially after 9/11 attacks over trade towers in New York USA. According to the observers on global terrorism, international terrorist groups mainly target and attack the civilians in third world countries. Such groups take

advantage on the weakness of security facilities, security preventive measures and insecure routes of the targeted developing countries. When these kinds of attacks take place government should respond quickly so as to save the lives of civilians. Especially in a country like India, which is highly and densely populated with about 1.22 billion people, a terrorist attack may cost too much in the form of casualties. This was clearly seen in the 26/11 terrorists attack at Taj hotel in Mumbai where 101 people including nine foreigners and 14 police officers have lost their lives and about 300 people were injured. So there is an urgent need to go for comprehensive strategies and to adopt newer technologies in order to counter these kinds of inhuman acts. One such step is the introduction of robots at the attacked place which are exclusively designed to tackle these types of attacks.

Robot definition and benefits:The acclaimed Czechoslovakian playwrightKarel Capek (1890-1938) made the first use of the word 'robot', from the Czech word which means "a forced labor" or "serf". The use of the word Robot was introduced into his play *R.U.R. (Rossum's Universal Robots)* which opened in Prague in January 1921[1].The robot theme was popularized by Isaac Asimov in science fiction in the late 1940's and the early 1950's, and subsequently by Hollywood movies. Basically, a robot comprises of motors, pulleys, gears, gearbox, levers, chains, and many more mechanical systems, enabling locomotion. Sensors present in robot help the robot collect information about its environment. There are microcontrollers powered by powerful software that help the robot make sense environmental data captured and tell it what to do next. Microphones, speakers, displays etc., help the robot to interact with human[1].Robotic systems offer numerous potential operational benefits to the security personnel: faster, cheaper, better mission accomplishment; longer range, greater persistence, longer endurance, higher precision; faster target engagement; and immunity to chemical and biological weapons, among their benefits. All of these can enhance mission effectiveness and serve as drivers for the ongoing deployment of these systems. Autonomous robotic systems offer numerous potential operational benefits to the military: faster, cheaper, better mission accomplishment; longer range, greater persistence, longer endurance, higher precision; faster target engagement; and immunity to chemical and biological weapons, among other benefits. All of these can enhance mission effectiveness and serve as drivers for the ongoing deployment of these systems.

RELATED WORKS:

The first deployed robots were in *structured environments* such as automobile assembly lines in the 1950's. At that time, computation and sensors were both very expensive, so the environments for robots were specially constructed so that robots could effectively operate with little sensing or computation. Today's manufacturing robots still follow this approach and so manufacturing robots are only used in industries where the overhead of building the necessary special environments can be absorbed. In space missions or for the exploration of Mars or similar planets where – due to the lack of atmosphere, plants, and animals - "rovers" face much less environmental complexity than on earth [2]. This restricts them to factories that produce very expensive objects such as automobiles or silicon wafers, or very high volumes of unchanging products over many years, such as disposable medical devices. The rise and continuous perfection of stationary semi-autonomous weapon systems are mainly dedicated to defensive operations: beginning with- The famous "Norden bombsight" in World war II which made calculations of height, speed, and trajectory too complex for a human alone when it came to

deciding when to drop a bomb [5]:- Tele-operated tanks of the German Wehrmacht used quite similarly as analogous vehicles in Iraq and Afghanistan today [3].

In the U. S, Navy, such technological strands are vividly exemplified by the highly sophisticated "Aegis-system" introduced in the year 1980. When fully activated, it is capable of protecting the ship on which it is installed by observing the surrounding environment and by intercepting approaching torpedoes or missiles on the basis of autonomous decisions [7]. In the American Army, some very recent developments have resulted in locomotive devices that have far more resemblance to Asimov's imaginations. In the war against terrorism, the forces of good have an unexpected ally, iRobot's Packbot EOD (Explosive Ordnance Disposal.) The Packbot is an extremely ragged vehicle aiding US troops in IRAQ. About 500 Packbots have already been deployed assisting with a number of different tasks helping to save soldiers' lives. PackBot EOD can handle a full range of Improvised Explosive Device (IED) and conventional ordnance disposal challenges. Its lightweight, ruggedized Omni Reach Manipulator System can reach as far as 2 meters in any direction to safely disrupt difficult-to-access IEDs, military ordnance, land mines and other incendiary devices.

About the size of a lawn mower, the PackBot mounts all sorts of cameras and sensors, as well as a nimble arm with four joints. It moves using four "flippers." These are tiny treads that can also rotate on an axis, allowing the robot not only to roll forward and backward using the treads as a tank would, but also to flip its tracks up and down (almost like a seal moving) to climb stairs, rumble over rocks, squeeze down twisting tunnels, and even swim underwater. The cost to the United States of this "death" was $150,000 [5]. The recent emergence of „Predator" and „MQ-9 Reaper" drones capable of monitor ing suspicious territories for detecting potentially relevant changes, of attacking envisaged targets and of finding their way home without human assistance [6].Robots already have the ability to carry weapons and use lethal force under the direction of a human operator. Multiple unmanned robotic systems are already being developed or are in use that employ lethal force such as the Armed Robotic Vehicle (ARV), a component of the Future Combat System (FCS); Predator and Reaper unmanned aerial vehicles (UAVs) equipped with hellfire missiles, which have already been used in combat but under direct human supervision; and the development of an armed platform for use in the Korean Demilitarized Zone [8].

MATERIALS AND METHODS

Path of Implementation:

The path of implementation of the robot system is as shown in figure 1. The technology used for wireless communication between operator and robot is Zigbee wireless technology. A Zigbee transceiver is used at both the operator side and the robot side for wireless communication. All the controlling commands are sent from operator's laptop to robot via Zigbee transceiver present at the operator side. These signals are received by Zigbee transceiver present at the robot side and the corresponding commands are executed with the help of microcontroller. Controlling commands compose of the switching on/off of motors, devices etc. All signals from robot sensors are monitored and sent via Zigbee transceiver, in order to monitor audio and video signals, separate transmitters are used to send these A/V signals to the operator side.

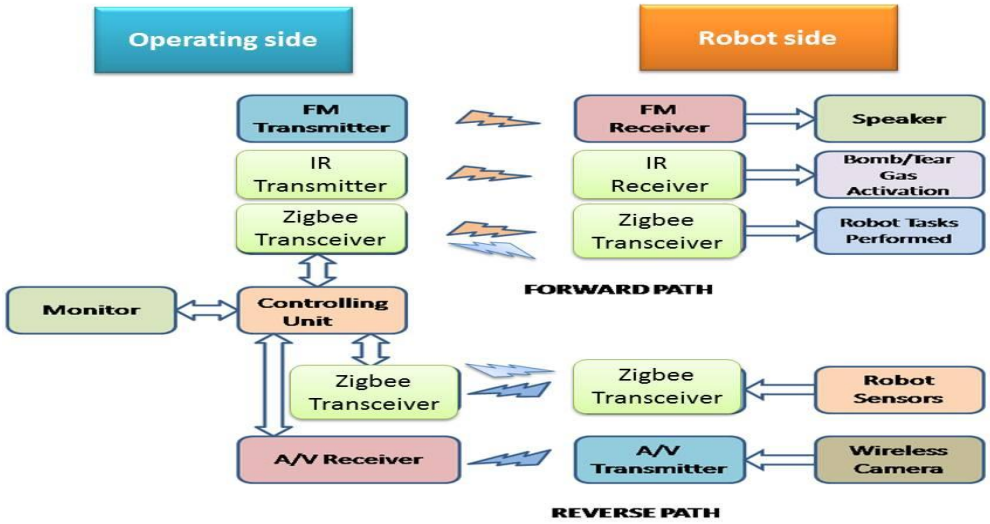

Figure 1: Path of Implementation of NSG Commando bot

The important blocks of the Transmitter section of NSG Commando Bot are Microcontroller (PIC16F73), ZigBee Transceiver Module, laptop, A/V Receiver of Camera, FM and IR Transmitters, LCD for Temperature Display and Regulated Power Supply. Block diagram of the Transmitter section of the robot is as shown in figure 2

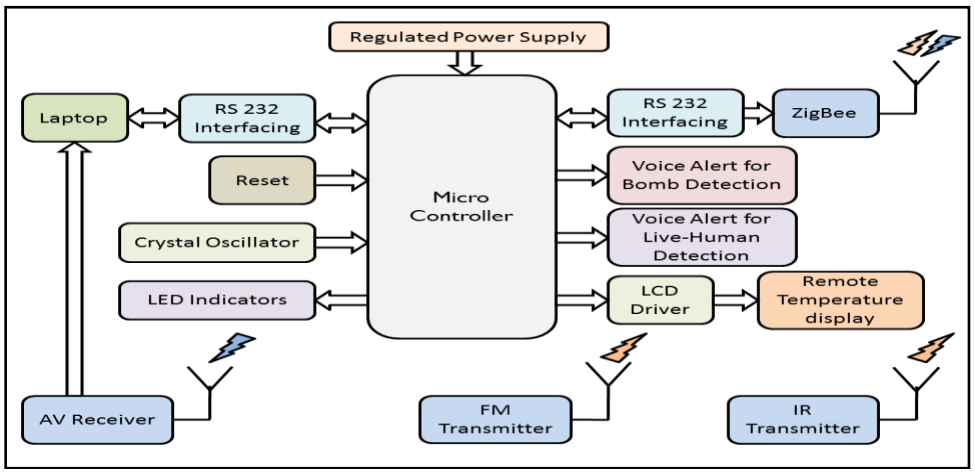

Figure 2: Block diagram of transmitter section of NSG Commando Bot

The Block DiagramReceiver section of NSG Commando Bot consists of Master and Slave Microcontrollers both of which are PIC16F877A microcontrollers. ZigBee transceiver is connected to Master controller and the two controllers communicate through RS 232 interfacing. FM receiver is connected to a speaker in order to reproduce the voice signals which are received from transmitter as input. IR transmitter is used to activate the circuit which can trigger a bomb/Tear gas shell. Camera will have dedicated transmitter which transmits Audio/Video signals. The Block Diagram of the Receiver section of the NSG Commando Bot is as shown in figure 3

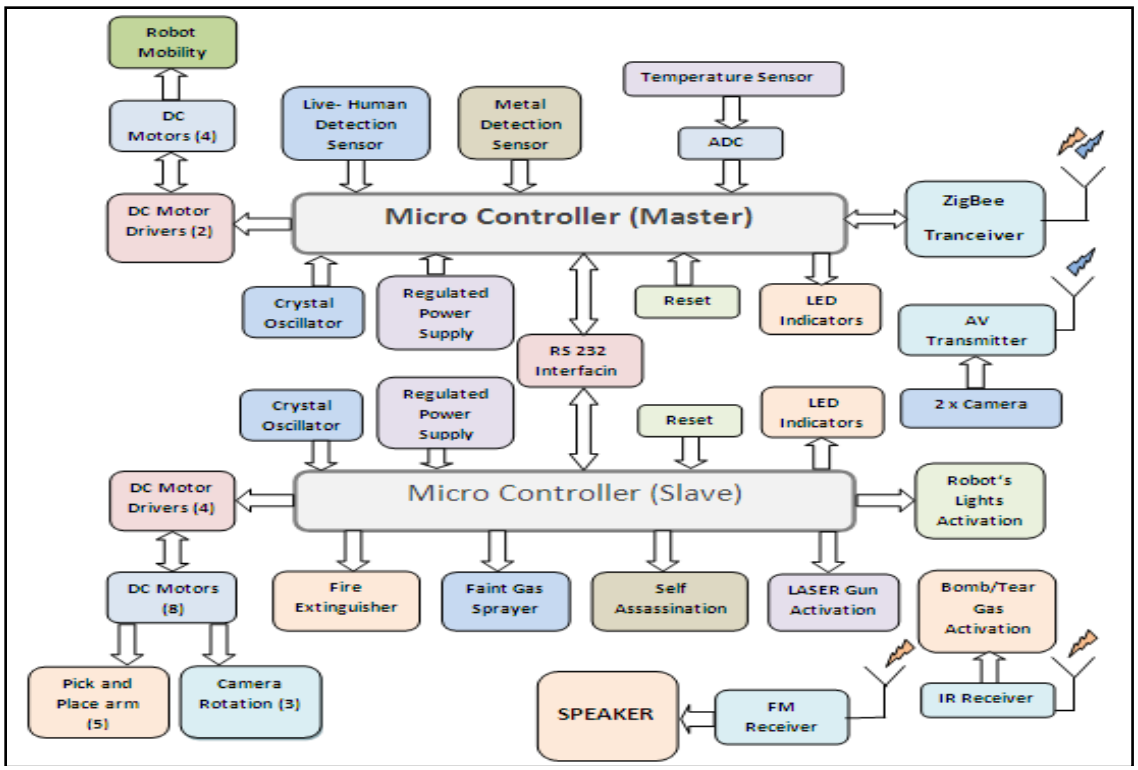

Figure 3: Block diagram of Receiver section of NSG Commando Bot

Hardware Implementation:

A. Robot mobility System:

The movements and locomotion of a robot can be implemented through DC motors. They are chosen according to the project requirements and motor's specifications. Generally, robotic movements need low rotations per minute (rpm) and high torque. This can be realized by attaching gearboxes to the motors which will increase their torque and reduce their rpm. This can also be achieved by using a "gear head motor" which is readily available in the market.Two 12v dc motors are used as base motors which help in providing mobility to the robot. The motion of the robot under these motors is as follow.

- For forward motion, data must be sent such that it make the two motors move forward.
- For backward motion, the two motors are made to move backward.
- For turning right, two options are available. The first is to stop the left DC motor and move the right DC motor forward and the second is to move the left DC motor backward and move the right DC motor forward. The first method turn the robot right but it takes large area to move around. The second method is the best way as it turns the robot around itself.
- In the same way to turn the robot left, move the left DC motor forward and the right DC motor backward.

The robot has two DC motors, 6 wheels (2 forward wheels, 2 backward wheels and 2 wheels in the center of the robot). The two base motors are connected to two wheels which are in the backward of the robot. One of the motors is connected to the right wheel and the other connected to left wheel. Robot base is one of the vital considerations while constructing a robot as it has to withstand major weight acting upon it. For this reason Cast acrylic sheet is chosen for building the base of the robot.

B. Pick and place arm:

It serves in picking and placing of objects present on the robot at desired location. Especially it is helpful in placing bombs/tear gas shells at the desired place. Then the bombs/teargas shells can be activated by the operator at the command centre. It is also useful in placing first aid boxes inside the attacked place so that they can be used by the casualties and also in collecting things (like bullets used by terrorists etc.,) from the attacked place. The Robotic Arm has five degrees of freedom which is achieved by using five 3V motors each coupled with a gearbox. The five motors with gearboxes enable the opening and closing of the gripper (0-4.5cm), a radial wrist movement of 120 degrees, an elbow movement of 320 degrees, a shoulder motion of 180 degrees and a base rotation of 360 degrees. The arm is having a lifting capacity of about 200 g. It can reach vertical and horizontal distances of 15 inches and 12.6 inches respectively. When any of the gearboxes encounters excessive resistance to motion, the gearbox will make a noise that alertsindicating to stop the arm's motion in that direction. This feature helps in preventing any potential injury or gear breakage during operation. A white LED is mounted on the "hand" of the arm which serves as a search light illuminating whatever the gripper is holding.

C. Robot vision System:

The camera used in the project is JMK WS 309 AS which is useful in monitoring the happenings inside the attacked place. The main purpose of this camera is to transmit audio/video signals in a manner that suits the transmission over a wireless connection to a computer port, giving the ability to receive and display this video signal using a software program. The circuit used in this process is video transmitter used to convert audio and video signals into TV band in order to be transmitted andthen received by TV tuner. The wireless video transmitter combines audio and video signals, and transmits the resulting signal up to 300 feet. The circuit can be powered from a 9-volt battery to insure maximum transmission range and best possible picture.

D. Camera Rotation and Live Audio/Video Recording:

A 3-Axis manipulator is used to increase the flexibility of the usage of camera. Camera is mounted on a manipulator having three degrees of freedom. To see any object around the robot, there is no need to turn around the robot we can just turn the camera as the 3-axis manipulator has 300*180*360 degrees of rotation. This feature is very handy in continuous monitoring of the terrorists movements inside the attacked place. The live video and audio signals from the wireless camera can be recorded at the control room by using a A/V recording software. It is useful to the security authorities for analysing terrorist's movements and in future investigation purposes.

E. Bomb/Tear Gas Shell Triggering System:

This is just an activation circuit that can trigger a bomb or tear gas shell whichever is connected to it, from the operators end. If the terrorist has to be killed, the bomb can be triggered and if the terrorist has to be caught alive, tear gas shell can be triggered. This activation circuit is an individual unit and it is placed in the robot. It can be placed at desired location with the help of pick and place arm. The triggering circuit can be implemented by using an IR switch. IR transmitter and Receiver pair is used to realize the triggering function. The Range of the IR remote is about 5 meters. To double the range from 5 meters to 10 meters transmitted powerneed to beincreased. For increasing the circuit efficiency, the switching function a MOSFET has been used and thus reduces the power loss.

F. Laser Gun:

Laser Gun is used to kill the terrorists .As the robot is a proto type laser with low intensity beam is used for demonstration. It can be activated from the operators end with a dedicated key. The output of the microcontroller is connected to laser which can be switched on/off.

G. Faint Gas Sprayer:

The main objective behind the using of a faint gas sprayer is to catch the terrorists alive by making them unconscious. When a terrorist is hiding in a room or comes close to the robot, it is activated and the sprayer present in the robot sprays the gas. This is realised with the help of a gear motor that can be controlled by microcontroller. The gear motor when activated pushes the sprayer head with the help of a mechanical linkage and the gas is released. The motor can be turned on and off and the sprayer sprays the faint gas until it is turned off by the user. Low dosages of several gases can be used as a faint gas for making the terrorists unconscious. For example chloroform, Formyltrichloride, ether, nitrous oxide, Methane trichloride, Methyl trichloride, Methenyltrichloride, TCM, Freon 20, R-20, UN 1888 etc,..If any one of these in the gaseous form is filled in the sprayer, the purpose can be served. Other examples are methane (mine gas) , cyclohexane, and nitric oxide (laughing gas), sulphur derivatives and fumes from cyanide sulphate (death cell gas).These gases can even kill terrorists when high concentrations are used.

H. Fire Extinguisher:

The robot is equipped with a fire extinguisher which can be used to put off small fires inside the attacked place. So the robot can also act as a fire fighter. Small fires can be put off by just triggering the fire extinguisher present on the robot from the operating side. For implementing a fire extinguisher mechanism automatic air freshener is used. The gear motor present in it when activated pushes the sprayer head with the help of a mechanical linkages and the gas is released. One of the outputs of microcontroller is connected to the motor. It can be turned on/off from the operating end. When the motor is turned on, the sprayer sprays the CO2 gas until it is turned off by the operator.

I. Remote Temperature Sensing:

Remote temperature sensing is helpful in knowing the temperature of a remote place inside the attacked place and alerting the security personnel if the temperature is very high. This can avoid serious burns to them. The temperature of the remote place where robot is operating can be found out by using a temperature sensor. LM 35 temperature sensor is installed on the robot for this purpose.

J. Live Human and Bomb Detection:

The task of identifying human being is difficult for the robotic agent but it is simple for the human agent. In order to detect a human body, a robot must be equipped with a specific set of sensors that provide information about the presence of a person in the environment around. The system uses a PIR sensor in order to detect the existence of living humans. This feature is provided for the robot in order to detect any bomb placed by terrorists in the attacked place. Metal Detector is used as a bomb detector in the project.

K. Microphone and Speaker system:

Sound in the audible spectrum is another human characteristic that we can detect and measure. However, to find a survivor, the rescue people sometimes stop all activity to listen to a shouting person. It is possible to hear some people in this condition. Microphones are also a low cost sensor but not very easy to interface to process its data. Microphone is inbuilt in the camera used in the project.The speaker system is used to communicate with the people inside the attacked place. It is helpful in giving directions to the people and aware them about the movements of the terrorists in the attacked place. As the camera installed in the robot continuously monitors its surroundings, any useful information can be given to the people inside the attacked place so that they can take any precautions to avoid terrorists strike. For this purpose FM transmitter and receiver pair is used in the project so that operator can communicate with the people from the operating side itself since its range is about 2 km distance.

L. Robot Lights:

The robot is also equipped with high focus search lights, installed at the front end, which are used for night mode or where visibility is low. A control signal is generated by the application, which is sent to the microcontroller to switch the light on and off. This feature helps the operator to perform search and rescue operations during night times also.

M. Self-assassination:

This is a special system present in the robot which when activated can make the robot as a suicide bomber. When the situation is out of control and terrorists are to be killed immediately, this system is activated. A dedicated key is present in the operators end to activate this system. Output of the microcontroller is connected to the circuit for activation.

Schematic Diagram of the transmitter section:

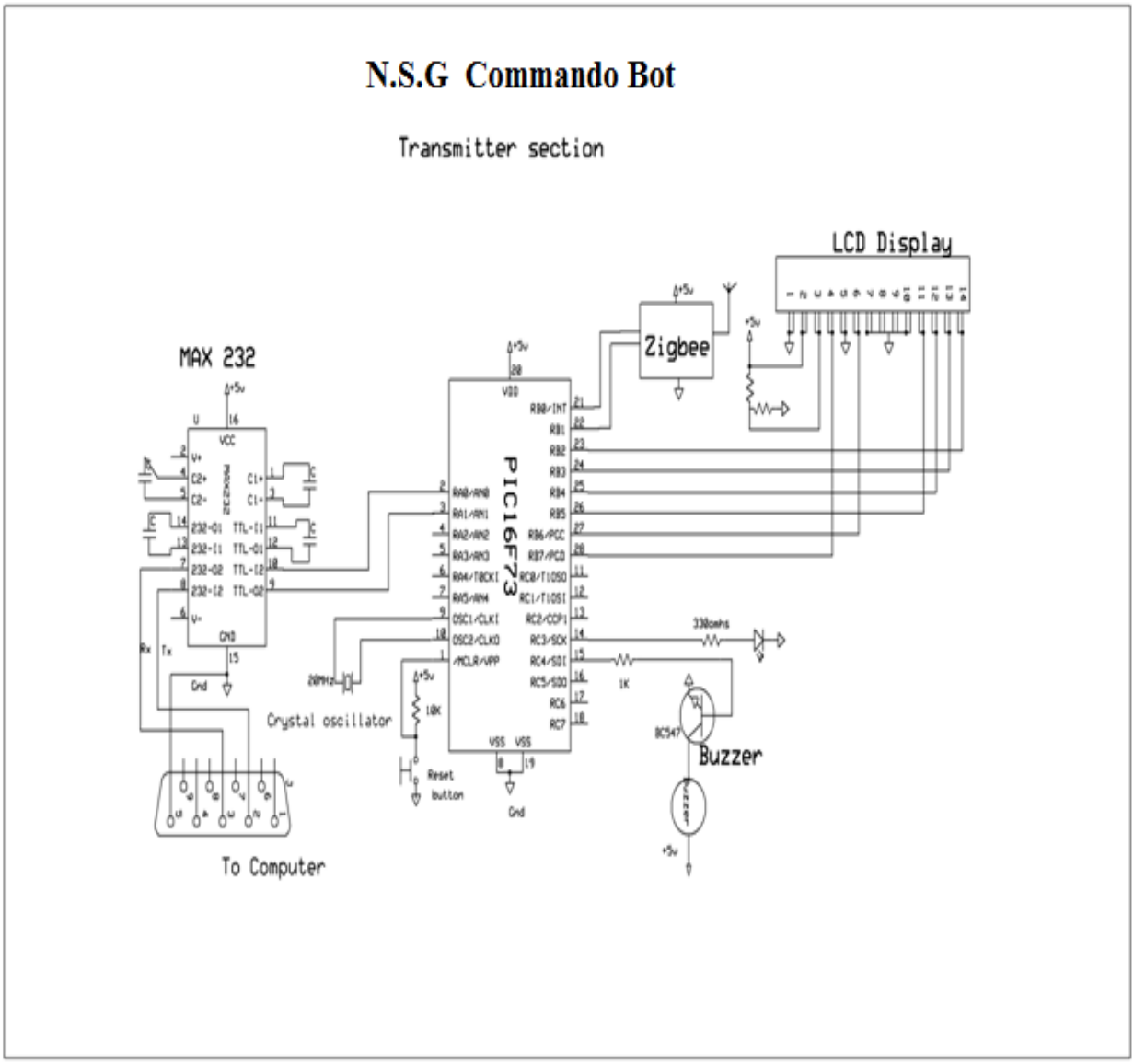

Figure 4: Schematic diagram of Transmitter section of NSG Commando Bot

Transmitter section Schematic diagram explanation:

1. The transmitter section has PIC16F73 microcontroller to which Crystal Oscillator is connected to 9th and 10th pins and reset button is connected to 1st pin. Zigbee module is connected to PORT B (B0, B1).
2. The MAX232 IC is connected to PORT A (A0, A1).
3. LCD module is connected to PORT B (B2, B3, B4, B5, B6, and B7).
4. LED is connected to PORTC (C3). Buzzers are connected to PORT C (C5, C6).

Schematic Diagram of the Receiver Section-1:

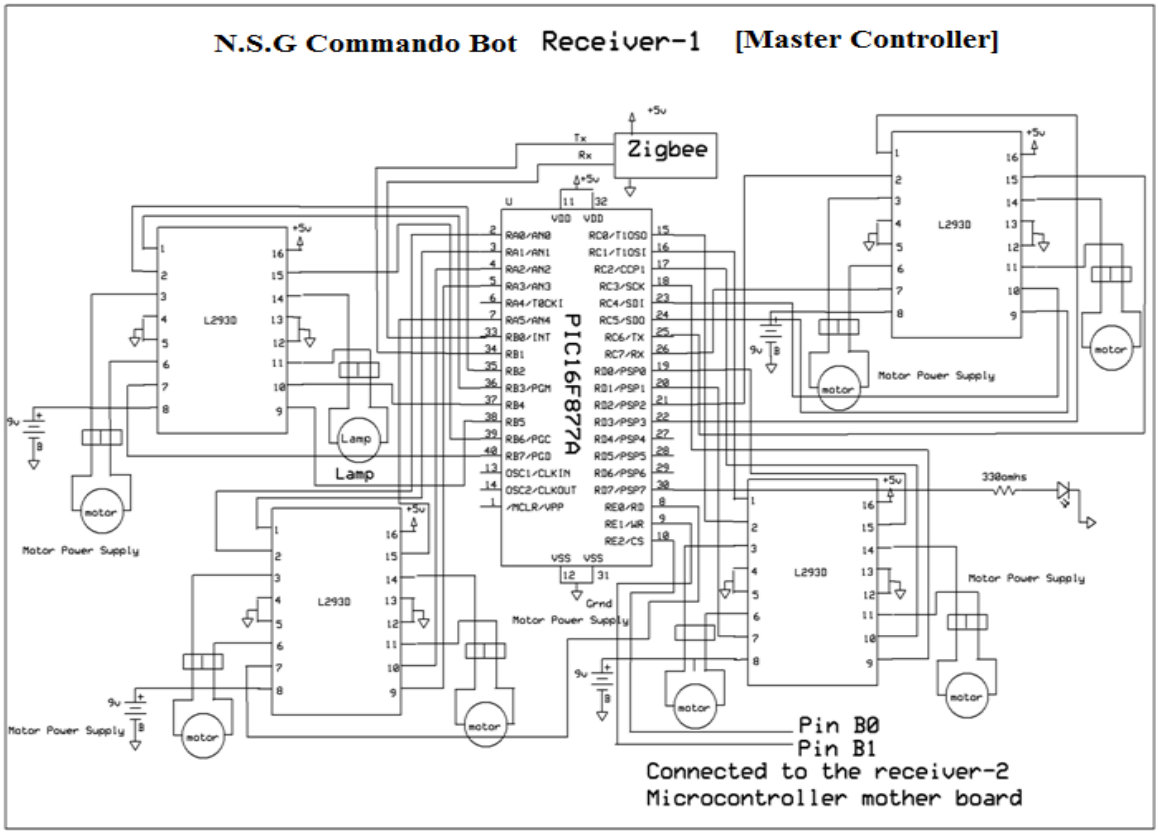

Figure 5: Schematic diagram of Receiver section -1 of NSG Commando Bot

Receiver Section-1 Schematic diagram explanation:

1. *T*he receiver section-1 has PIC 16F877A microcontroller to which crystal oscillator is connected to 13th and 14th pins and reset button is connected to 1st pin.
2. Zigbee module is connected to PORT B (B0, B1).
3. First L293D IC with two motors are connected to microcontroller PORT A(A0,A1,A2,A3,A5)
4. Second L293D IC with two motors is connected to microcontroller PORT B and E (B4, B5, B6, B7, and E0).
5. Third L293D IC with two motors is connected to microcontroller PORT C (C0, C1, C2, C3, and C7).
6. Fourth L293D IC with two motors is connected to microcontroller PORT C and D (C4, C5, C6, D0, and D1).
7. The microcontroller is interlinked with the other microcontroller which is at receiver-2 is connected from PORT E (E1, E2).

Schematic Diagram of the Receiver Section-2:

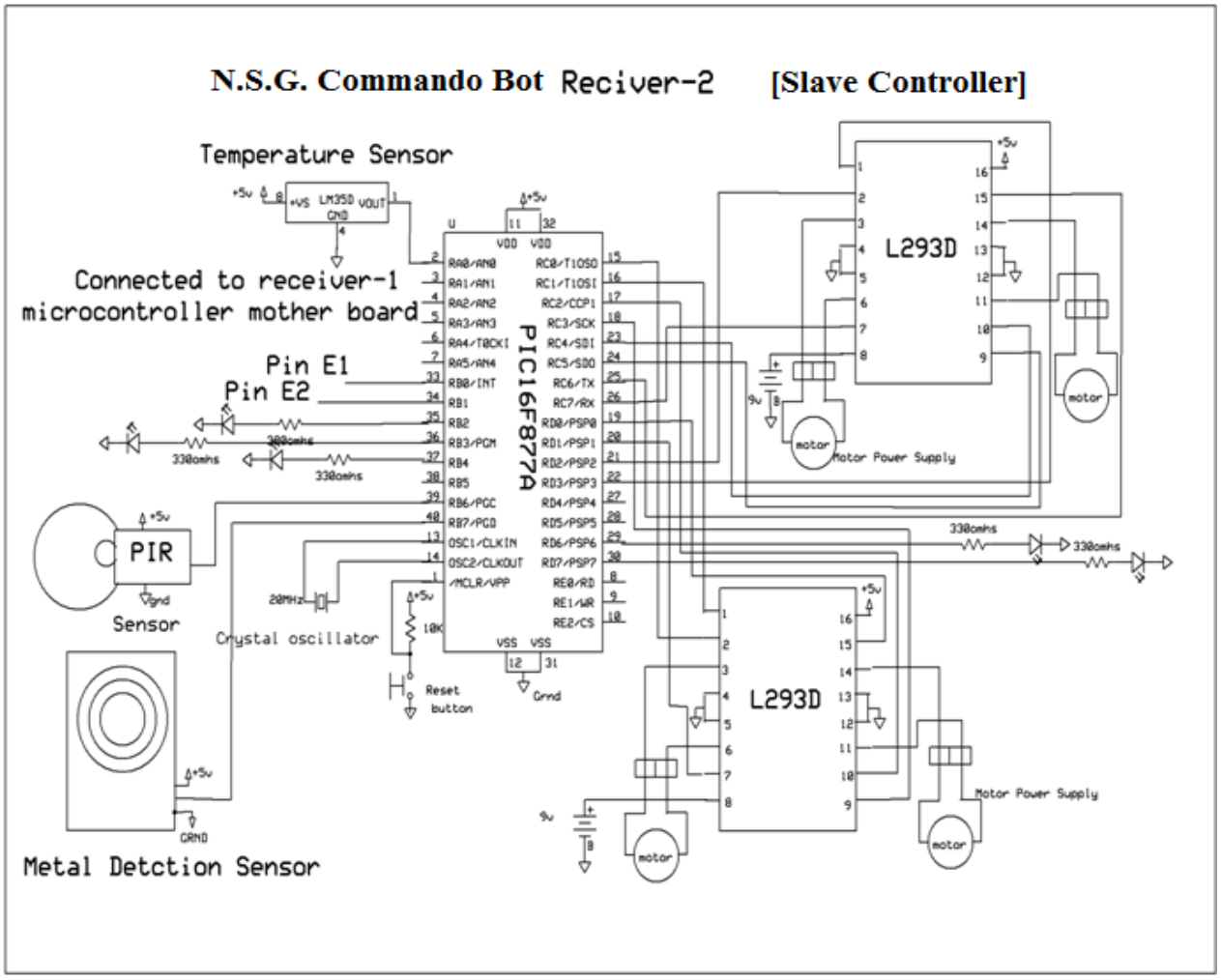

Figure 6: Schematic diagram of Receiver section 2 of NSG Commando Bot

Receiver Section-2 Circuit diagram explanation:

1. The receiver section-2 has PIC 16F877A microcontroller to which crystal oscillator is connected to 13th and 14th pins and reset button is connected to 1st pin.
2. The temperature sensor is connected to microcontroller PORT A (A0).
3. The PIR sensor is connected to microcontroller PORT B (B6).
4. The metal detection sensor is connected to microcontroller PORT B (B7).
5. Fifth L293D IC with two motors is connected to microcontroller PORT C (C0, C1, C2, C3, and C7).
6. Sixth L293D IC with two motors is connected to microcontroller PORT C and D (C4, C5, C6, D0, and D1).
7. The microcontroller is interlinked with the other microcontroller which is at receiver-1 is connected from PORT B (B0, B1).
8. LED's are connected to microcontroller PORT B and D to pins (B2, B3, B4, D6, and D7).

Software Implementation:

The project has been implemented by using the following software:

- Express PCB and Express SCH for designing circuit diagrams
- Smart Draw and Diagram Studio for designing block diagrams
- PIC C compiler for the compilation part
- Proteus 7 for the simulation part
- Hyper Terminal for giving system commands

A. Advantages:

- The robot is fast, robust, self-powered and the response time is very less as ZigBee communication is used.
- Speed of the robot can be varied according to the requirements of the operator.
- The robot is replacing security personnel, which results in minimizing the security personnel casualties.
- When terrorists are hiding inside a building, this robot can fight with them effectively.
- This is useful in rescuing the people inside the attacked place by giving security tips and guidelines to them with the help of a speaker.
- The operations can be performed during night times with the help of high focus lights enabling continuous command over the attacked place.
- In order to capture the terrorists alive, faint gas can be sprayed and make them faint and then take them into custody. Fire extinguisher can put off small fires inside the attacked place.
- Camera can be used for robot navigation and continuous monitoring of its surroundings.
- Pick and place arm helps in placing first aid kits and bombs/tear gas shells, at the place of attack.
- Helps in detecting bombs, live humans and temperature of a remote place and alerts the operator automatically.
- Can act as a suicide bomber when the situations are out of control.
- The main advantage is that the features of the robot can be altered to suit the needs of the operations.

B. Disadvantages:

- Since it is a wheel based robot its mobility may not be as good as a tread based robot in terrain environment.
- The robot can be operated only within a limited range.
- PIR sensor takes delay of some time to sense the presence of a person, when switched on and it doesn't respond, if the person is in standby condition (no movement).
- The robot is not autonomous since it doesn't have any artificial intelligence.
- It doesn't have explosives disposal mechanism.
- As the robot consists of many systems, it may consume more power.

C. Applications:

- Plays a vital role in other military applications like spying, detecting explosives etc.,
- It can be deployed at the country's borders for continuous surveillances and command.
- In case of nuclear disasters, this robot can be sent to hazardous areas and can acquire necessary data.
- This robot can be helpful in times of war in defending our country by attacking enemies.
- It can be used in mining industries in rescuing and accessing the conditions inside.
- It can be used in nuclear power plants, research centers and for other security purposes.

CONCLUSION

The ever developing technologies are helping the man to solve his problems, bringing a new preamble to his life. The rise of terrorism is one of the burning problems, the world is facing today. For our country, in fact, it is challenging the security and integrity of the nation. The deployment of robotic systems enables the security authorities to upgrade offensive and defensive potentials and avoid human casualties. After all, human life is more precious than lives of millions of robots and the deployment of robotic systems also helps in demotivating the enemies because they don't find any human targets. Our country desperately needs combat robot systems in order to strengthen the defence capabilities and able to tackle terrorists' attacks in future. "Better robots for better living" should be the objective for making this world "a beautiful place to live".

REFERENCES

[1] Abhinav Kumar Singh, NilayaMitashShanker&AnandPrakashYadav, "*RF Controlled Terrorist Fighting Robot"*, International Journal of Computer Science & Communication, Vol. 1, No. 1, January-June 2010, pp. 109-112
[2] Bares, Ambler, "*an Autonomous Rover for Planetary Exploration*", IEEE Computer,Vol. 22, No. 6, June, 1989, pp. 18-26.
[3] Donnelly, S.B. "*Long-Distance Warriors*", Time.com, Dec. 4, 2005.
[4] Carafano, James Jay &Gudgel Andrew, "*The Pentagon's Robots: Arming the Future*", Background No 2093, December 2007
[5] Singer, P. W. "*Robots at War: The New Battlefield*". The Wilson Quarterly,Winter,pp.30-48. 2009
[6] Axe David, "*A man and his drones: on the front line of robotic warfare*.", December 2009
[7] Sullins John P, "*RoboWarfare: can robots be more ethical than humans on the battlefield"*, Journal of Ethics and Information Technology 12:3, 263-275. 2010
[8] Geser Hans, "*Modest Prospectives for Military Robots in Today's Asymmetric Wars*". Prof. Hans Geser: World, Society and International Relations.Online Publications. Zuerich,January 2011.