IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Impact Factor 6.252
Volume 2, Issue 1, July 2022

Military Support and Rescue Robot

Dipak Ramesh Budhivant
Student, Department of MCA
Late Bhausaheb Hiray S S Trust's Hiray Institute of Computer Application, Mumbai, India

Abstract: *In this era of a politically unstable world, there is a growing demand for the use of military robots to aid the soldiers to perform perilous missions. This paper focuses on the design and build of a semi-autonomous, unmanned robotic system used for various military and rescue operations. Dangerous tasks such as bomb disposal, enemy territory surveillance, search and rescue can be efficiently carried out by the MSRR, Military Support and Rescue Robot. This reduces the risk of losing the lives of both soldiers and civilians. With the help of live feed from the wireless camera and data analysis of environmental composition by various sensors, of the area under surveillance, the soldiers can better prepare for their missions. Using Arduino and Zigbee technology, the above-mentioned tasks can be achieved. The different sensors and the robotic arm are connected to the Arduino mega which in turn is connected to the Zigbee. Data transmission and receiving are through Zigbee technology. This prototype design overcomes the weakness of the existing models and thus provides better support for military operations.*

Keywords Military robot, Semi-Autonomous, Search and Rescue, Pick and Place Arm, Arduino, Zigbee

I. INTRODUCTION

In today's technologically proficient world, technology plays an important role in drastically changing warfare tactics. More than advancement in weaponry, the advancement in technology gives a country superiority and the capability to counter an enemy attack in the most effective manner. Nowadays, robots are used in places which are dangerous for humans and thus, carry out the missions more effectively and obediently than human soldiers.

The military support and Rescue robot help to locate survivors in hazardous conditions unfavorable to human rescue teams. This reduces casualties and helps plan the rescue more effectively by using the data provided. The utilization of military robots for this very purpose is used by many countries around the world. The robots are robust, daring, obedient and have no fear of death. These robots may not be humanoids and need not carry lethal weapons, they are just machines instilled with advanced technology to aid the military.

The many advantages of military robots are driving all militaries around the world to opt for the use of robotic technology. *MarketsandMarkets* conducted an analysis which concludes that the military robot industry is expected to reach USD 30.83 billion by 2022, at a CAGR of 12.92% from 2017 to 2022 [1].

Military robots can be affected due to hardware and software malfunctions. Even though the military robots are built for adverse conditions the robotic system might face challenges due to adverse climate, software malfunction, components breakdown and much more. These types of robots are either fully human controlled, semi-autonomous or fully autonomous. Autonomous robots face more challenge under moral grounds for use in the military. A fully autonomous robot is considered as a killing machine under many country laws. The use of automated machines has a lot of restrictions due to the lack of human feelings and emotions. Hence, it is preferable to use semi-automated robots for certain safety precautions [2]. The *MSRR*, Military Support and Rescue Robot can be used for many different applications in the military. Among which a few are discussed in this paper, such as Intelligence, Surveillance and Reconnaissance (ISR), Search and Rescue, Mine Clearance and Bomb Disposal.

1.1 Intelligence, Surveillance and Reconnaissance

This is the most important task bestowed upon military robots. The robots used for surveillance and reconnaissance are usually small and invisible to the enemy. The robot takes pictures, records conversations and sends videos back to the ground stations from areas that are difficult to access for the soldiers.

1.2 Search and Rescue Robots

Another important role that is carried out by military robots is search and rescue. There are a lot of restrictions for a human to enter a rescue area after a calamity. Robots can rescue victims from radioactive, biological and chemical environments. Robots don't have limitations like humans and hence can help in reducing the response time by saving maximum lives. Usually, these robots are controlled by humans at base, but sometimes can work autonomously.

1.3 Explosive Ordnance Disposal (EOD)

Millions of lives of soldiers are lost while diffusing a bomb or disposing a mine, to avoid which, robots are used instead of humans to diffuse these explosives. The robots can be controlled from base or can be programmed to identify an explosive. This feature instilled in military robots has reduced the loss of lives of soldiers and civilians to a great extent [3].

MSRR is a semi-autonomous, unmanned ground vehicle developed with the most important features required for use in the military. The robot is instilled with a wireless camera used for reconnaissance and surveillance missions, a pick and place arm used for explosive disposal and a sensory circuit for data collection of the environmental gas composition of the area under inspection. The data collected by the sensory circuit and wireless camera are transmitted to the PC, Personal Computer at the base. The controls for the motion of the entire robot as well as the pick and place arm are given by the GUI, Graphical User Interphase on the PC. Arduino and Zigbee technology are used for data receiving and transmission. This paper has been organized into sections. Section 2 contains an elaborate background study on various topics related to the project. Section 3 is the methodology used for this project and Section 4 consists of the results and discussions of the *MSRR*. The paper is concluded in section 5.

II. LITERATURE REVIEW

This section illustrates the key factors needed for various applications from the literature:

2.1 Search and Rescue

Search and rescue in disaster scenes are extremely challenging due to the unstructured condition of the area. Robots are developed to assist by moving in extremely hazardous conditions like accessing collapsed structures which are unstable, moving into areas after a bombing hence being exposed to harmful gases and areas after radioactive disasters. Robots operate in situations which are dangerous for humans to be exposed.

Doroodgar and *Nejat* [4] suggested the use of semi- autonomous robots which can address the limitations of both teleoperated and fully autonomous robots. The aim of the prototype developed in this journal is for the robot to continuously learn from its experience and improve the overall performance in an exploration of the unknown disaster. The robot is tested in simulations and USAR, Urban Search and Rescue, like situations to improve the robustness. This robot performs tasks like navigation, exploration and victim identification.

The drawback of this semi-autonomous robot is that there is no way of finding if the environment is suitable for rescue workers to access. This robot could also scare off small kids and humans in distress as there is just a machine approaching and this can create panic.

Nourbakhsh and *Sycara* [5] tried to develop a set of autonomous robots for USAR purposes. This prototype uses victim detection by using thermal signatures, noise and motion. The research was unsuccessful since the group faced a lot of problem with coordinating a set of heterogeneous robots working together under one algorithm. The testing of the robots in USAR conditions was also difficult because of the visually confusing patterns of rubbles, glass and dust. The only successful prototype was the direct teleoperated algorithm but once the robot loses connection with the base it renders useless. The robot can only identify a human being but cannot help them without a rescue worker.

Niroui and *Zhang* [6] used a USAR abbreviate application to perform a very important task of exploring the uncluttered area and going to the aid of people. This model uses deep reinforcement machine learning that allows the robot to autonomously explore the unknown cluttered environment. The robot uses frontier-based exploration along with the memory of the places visited before and is known to cover more area at a given time than robots working only based on random exploration technique. The objective of this model is to maximize the information gained to allow the robot to find trapped victims as quickly as possible. The testing of the robot in USAR like situations allows the robot to have prior knowledge in situations which might help reduce the time taken at a real case scenario.

The robots which work autonomously may have to make their own decisions which may not be humanly acceptable at certain levels. Even with all the rules and inputs fed to the robot, there can be cases where they don't abide by the norms of the human world. The robot should have a level of human connection to work at situations of distress as it may scare off the victims instead of coming to their aid. This model cannot traverse varying cluttered terrain and climbable obstacles hence taking more time to reach a victim, sometimes even coming to a halt in mission. The disaster area will include rubble, dust and will be unstructured and a robot should be able to come to aid at such conditions and not just in areas of a structured environment.

BEAR, Battlefield Extraction Assist Robot is a military robot built by the VECNA solutions in the year 2013. *BEAR* has a hydraulic upper body which enables it to lift objects to 227 kgs. It is teleoperated, battery power and has track legs and versatile manipulator arms. *A*s the name suggests, *BEAR* aids the removal of wounded soldiers from the war fields or mission areas [7].

BEAR is currently fully operated from base and research is being carried out by the US Army research and materials development team to make it semi-autonomous. *BEAR* could be used in all fields like search and rescue being the main function, surveillance and reconnaissance, dealing with chemical and biological hazards, mine inspection, lifting wounded victims and warehouse automation. *BEAR* has a cute appearance to not scare of wounded victims while helping. The use of *BEAR* was also suggested at warehouses or industries to lit heavy objects, at hospitals to aid the doctors for lifting patients and for civil defense.

2.2 Intelligence, Surveillance and Reconnaissance

Reconnaissance missions are carried out by both civil and military officers to aid in decision making to attain certain goals. Reconnaissance in earlier days was carried out by human spies endangering a lot of lives. In modern days robots which are flexible, small, efficient and infused with advanced technology is used for surveillance. These robots can record, save and send videos and pictures of the situation. *UGV* (unmanned ground vehicle),

UAV (unmanned Aerial vehicle), *UWV* (unmanned water vehicle) are all used to aid the military for surveillance, while *MSRR* is an unmanned ground vehicle built to eliminate the drawbacks of the existing models.

The literature-cited *UAV* swarm prototype is utilized for reconnaissance and surveillance [8]. The building of the model and selecting the optimal algorithm for the situation are the main issues, particularly when the mission is challenging. This prototype's three separate algorithms for quick convergence, random cross-over, and precise search are the foundation of its design. All three of the parameters are crucial, and this prototype is unable to produce an effective algorithm. One disadvantage of the swarm robots is that they are all autonomous and perform their tasks independently. *Qin* and *Dong* [9] alternative solution for reconnaissance involves programming a UAV with two separate algorithms. Later research revealed that the Heuristics method aids in lowering the maximum energy requirement for reconnaissance. This proposed prototype is fully automated without human supervision and is not acceptable by certain countries laws.

Manyam and *Casbeer* [10] propose a dual system model, a hybrid model containing both *UGV* and *UAV*. This hybrid system, in which the *UGV* serves as a launching platform for the UAV, operated on its own. The UGV is positioned close to the monitoring area, and the UAV would fly over it while taking photos and videos. Before its power ran out, the UAV would turn back toward the launch pad. The UGV in this prototype has no purpose, which would significantly impair efficiency, and it is stationary in one location, making it simple for the opponent to locate it.

As opposed to *Liu* and *Luo* [11], who suggested a model with a moving ground vehicle. In this concept, the ground vehicle (GV) has a dedicated surveillance mission. The disadvantage of this model is that there is a good likelihood that the opponent will be alerted when the UAV returns to charge power. In order for the GV to be effective, it must approach the adversary closer. Combining the two unmanned vehicles is a long shot, but it might be possible with advancements in technology.

A US-based corporation created the *Guardbot*, a spherical robot used for surveillance and reconnaissance. At security checkpoints and in airports, the *Guardbot* is employed for security purposes. It is remote controlled and equipped with an internal GPS for long distance navigation. *Guardbot* isn't particularly quick, but it can climb stairs and is equipped with high-definition night cameras for real-time data transfer [12].

A *Guardbot* looks like a stability ball from the gym, which aids in reconnaissance missions and makes it difficult for the enemy to find them. *Guardbot* can travel on both land and water, and because all of its components are contained inside a ball, the motion is incredibly quiet. All of the qualities facilitate covert surveillance. The US army is now researching the robotic ball, which will soon be put into use.

2.3 Pick and Place

Bomb disposal presents another problem in the modern world. The use of robots in the military and public sectors has significantly decreased the number of fatalities, according to statistics. When necessary, the MSRR Pick and Place arm can also be used to diffuse bombs and mines. It is used to move lightweight things into the robot's path.

An affordable bomb-disposal robot of a similar kind was proposed by *Zaman* and *Chowdary* [13] for use in developing nations. One such basic robot is the *Muktibot*, which features a dual arm, an Arduino, an IP camera, motors, and a transmitter and receiver. The robot operates in dangerous environments and sends information back to the base so that a soldier can diffuse a bomb from a safe distance while reviewing the current circumstances through the camera. Because of the model's poor pulse width modulation (PWM) resolution, the motors' efficiency suffers.

To control the operation of the various components of the robotic hand, numerous separate servo motors are present in the robotic arm. To receive the motion command, all of the various motors share a single receiver. One servo motor can only be operated at a time with this model; the other motors are in a standstill state.

Daksh is a remote-controlled, battery-powered robot bomb defuser that was created by the Indian army's defence research and development agency. This robot's primary job is to locate, handle, and dispose improvised explosive devices in a secure manner. *Daksh* has a manipulator arm, several cameras, nuclear, biological, and chemical reconnaissance systems, IED handling gear, a manipulator arm, and an X-ray scanner, among other features [14]. To open any locked doors or to shoot any potential threats, *Daksh* has a shotgun. IEDs can be safely diffused using the water jet disrupter installed on the vehicle. The car has the ability to lift, pull, and tow suspicious items out of the way. The first batch of Dak sh robots was handed to the Indian army in 2011 after several years of testing and research, and since then they have performed their function in the bomb disposal team.

Jevit is a locally developed mine disposal robot that operates in Cambodia to find, unearth, transport, and destroy mines. Since the robots are remote-controlled and equipped with cameras, deminers may operate them without endangering people's lives. With between four and six million landmines and unexploded ordinances still lying about from the conflict that ended in 1979, Cambodia is one of the countries most plagued by landmines. *Jevit* has put an end to the numerous limb and life losses experienced by Cambodian deminers. According to estimates, all of Cambodia's landmines will have exploded by the year 2025 [15].

Less people died in Cambodia from landmine explosions following the release of Jevit for mine removal. According to a study issued on December 25 by the Cambodian Mine Action Centre (CMAC), the Jevit reportedly eliminated 36,000 mines and UXO in Cambodia in 2019. JEVIT the robot's slogan is "SAVE LANDS, LIMBS, AND LIVES."

III. METHODOLOGY

3.1 Proposed Robotic System

The semi-autonomous unmanned ground vehicle used in this paper is the military rescue and support robot. The military support robot presented in this paper has all the key qualities installed together with greater technology than the existing robots, which each have the aforementioned features in separate robots. This robot will assist the military by carrying out intelligence, surveillance, and reconnaissance tasks, as well as search and rescue operations and the defusing of bombs.

It is anticipated that this robot will lessen casualties and improve military productivity. This robot will assist the military by carrying out intelligence, surveillance, and reconnaissance tasks, as well as search and rescue operations and the defusing of bombs. It is anticipated that this robot will lessen casualties and improve military productivity.

With a pick-and-place arm, sensing circuits, servo motors, an Arduino mega, an LCD (liquid crystal display), a battery, a wireless camera, and Zigbee, the *MSRR* is a little robot that weighs between 10 and 15 kg. The site's environment, which is invisible to cameras, can be examined using the sensory circuit. Video and audio data from the wireless camera will be transferred via a TV tuner and seen on the base PC. The pick and place arm has two jobs: it moves obstructions in the robot's path and disarms bombs or mines, respectively. The prototype device is capable of lifting things weighing between 500 and 700 grammes.

The construction of the military assistance and rescue robot has been broken down into four stages. Each stage carries out a particular task for the robot. The robot is more effective since it can handle several duties at once. The *MSRR* is a battery-powered, semi-autonomous unmanned ground vehicle that the military use for a variety of tasks. The many tasks include tracking and reconnaissance, search and rescue, and handling explosives.

3.2 The Mechanical Body

The four DC (Direct Current) motors that power the various wheels are attached to the robot's steel bottom frame foundation. A rubber sprocket connects the wheels, allowing the robot to move over a variety of surfaces. Motor drivers, an intermediary between the batteries, microcontrollers, and the motor, are used to connect the motors. This robotic system is designed with sandy terrain in mind. The PC at the base uses Zigbee technology to direct the motion of the robotic wheels. The robotic base is where the remaining electronics is fixed. All of the other parts will be assembled into a single robotic system to form the robot's primary body. The rest of the robot's wiring, sensor wiring, pick-and-place arm, and other parts will be fixed to its base.

To secure all of the other components onto it, the base must be made hard and robust. The robot is somewhat autonomous but under human control. Some countries' legal systems might not allow a fully automated robot. Robots with a semi-autonomous nature save people time and effort on repetitive tasks. One person may manage numerous robots, which is more effective and saves time. The motors are powered by a 12V rechargeable battery that is positioned on the base beneath the acrylic. The microprocessor and the rest of the electronics require 5V.

3.3 Sensory Circuitry

The sensors circuit is used to gather environmental information about the region being examined and to record information that the human eye would miss. The information is shown on the robot's LCD and relayed back to the base via Zigbee for use in next planning. A few sensors aboard the robot include temperature, humidity, air/velocity, gas sensors (MQ2, MQ8, MQ9, and MQ135), and gas sensors (MQ2, MQ8, MQ9, and MQ135).

To ensure that the soldiers are better equipped for the circumstances they confront, such a circuit is used. Because it offers a substantial number of analogue input and output ports, the Arduino mega board was chosen. Since the coverage area is appropriate for the Zigbee application, Zigbee is employed as the communication method.

The Arduino's analogue inputs are connected to five sensors in the sensor circuit, and the Arduino's output is coupled to an LCD and Zigbee. The background lighting can be controlled using a potentiometer that is connected to the 20*4 LCD panel. The Arduino is linked to the Zigbee, which communicates information to the Zigbee at the base. The PC at the base displays the sent data. Soldiers operating close by will be able to see the atmospheric composition of dangerous gases thanks to the LCD on the robot. The sensors are mounted on an acrylic board that is set on the robotic base, together with the motor drivers and other parts like the camera, LCD, etc.

3.4 Camera

The PC at the base receives live data from the place being inspected through the camera and a TV tuner. Audio and video are transmitted to the base using wireless data transfer. The camera is necessary for search and rescue operations, for pick-and-place actions to detonate bombs or mines or carry objects when necessary, for reconnaissance and surveillance of the area under inspection, for viewing the objects in front of the robot to help navigate through rubble, and for other purposes. A 5V battery for the wireless camera is mounted to it on the acrylic board in the most advantageous location.

3.5 Pick and Place Robotic Arm

The robot has a robotic arm that is operated by the computer using Zigbee. The arm is used to destroy mines, diffuse bombs, and move any lightweight objects out of the robot's way. The practical version of the robotic prototype can be used to move a person out of harm's way and can only move objects weighing between 300 and 500 grammes. With the assistance of a camera for live feed and human supervision, the robotic arm is used to disarm bombs and destroy mines. The number of deaths among officers of civil and military defence has significantly decreased as a result of the employment of robotic technology.

IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

Impact Factor 6.252

Volume 2, Issue 1, July 2022

The arm, elbow, wrist, and grasping motions of the robotic arm are all controlled by four servo motors. The visual studio GUI on the base PC controls the pick and place arm servos. More motors will allow for more movement and improved performance. The employment of this kind of arm boosts productivity.

3.6 Graphical User Interphase

The data gathered by the sensor circuit is shown on a GUI created in Visual Studio, and the GUI's control buttons allow the motors on the robotic system to move. Wireless data transfer and Zigbee technologies are used for data transmission and reception. Utilizing the TV USB stick to link the wireless camera to the PC, the camera data is played on Media Player.

Using Visual Basic, the data from the Arduino is shown. Each sensor reading will be shown on the GUI in a specific text box, and the same information will also be shown on the robot's LCD.

- The computer will display data from the wireless camera. Wireless data transfer will be used to send audio and video data.
- The PC will be utilised to control the Pick and Place sensor, which will be used to pick up and place obstacles in the robot's route as well as detonate explosives. On the GUI, there will be a separate control button for each motor.
- The control buttons on the PC at base will also be used to direct the robot's movement using DC motors attached to the wheels.

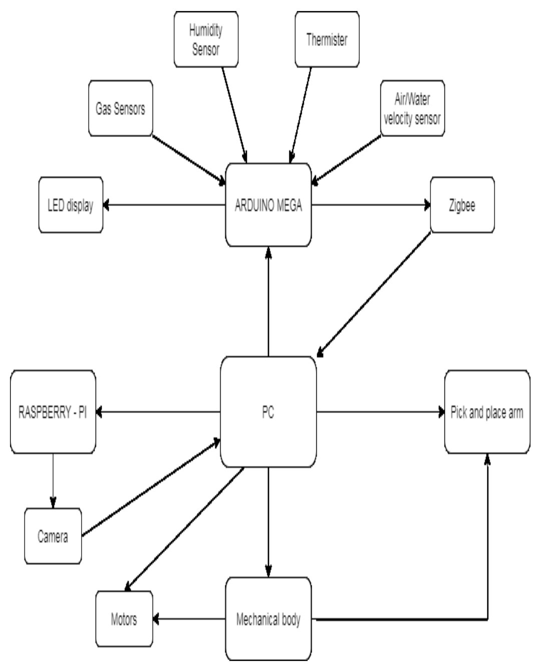

Fig. 1. Block diagram of the robotic system.

The schematic for the entire robot is represented by the block diagram, as seen above. The principal elements and the different links between them are all mentioned. The primary goal of this graphic is to convey a straightforward and understandable image of the project. The PC is the primary source of control from the base station, and the schematic shows that all the major components are connected to or from it.

IV. RESULTS

4.1 Mechanical Body

DC motors are used to construct the robot's framework. The robot can move through challenging terrain since the motors are coupled to a rubber sprocket. Using the camera to see the path in front of the robot, the PC uses Zigbee connectivity to control the motors. Zigbee at the base sends the command from the GUI to Zigbee on location. Over the base is where the MSRR's remaining circuitry is located.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Impact Factor 6.252
Volume 2, Issue 1, July 2022

In Fig. 2, the present base model is displayed.

Fig. 2. Mechanical base of the robot with motors

4.2 Sensor Circuitry

The military robot's sensor circuitry aids in determining the air's ambient makeup. Gas sensors, humidity sensors, air/water velocity sensors, temperature sensors, an Arduino, a 20*4 LCD display, a potentiometer, and Zigbee make up the sensor circuitry. The sensor data is coded so that it may be shown on the LCD and the GUI on the base PC. The Arduino Mega receives the data and codes it so that it can be shown on the LCD and PC.

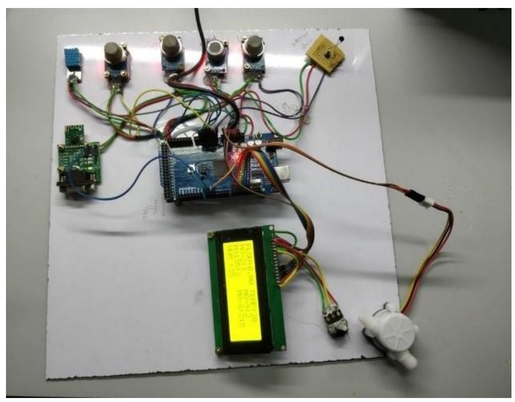

Fig. 3. Sensory circuit for the robot.

The list of sensors used in circuitry are

- MQ 2 – Detects methane, butane, LPG and smoke.
- MQ 8 – Detects hydrogen gas.
- MQ9 – Detects carbon monoxide, and flammable gases.
- MQ135 – Detects NH_3, NO_x, alcohol, benzene, smoke and CO_2.
- Humidity sensor – Detects the level of humidity in the atmosphere
- Air/water velocity sensor – Identifies the speed of wind or water.
- Temperature sensor – Detects the atmospheric temperature.

The sensor circuitry gathers the data for the LCD that is located on the robot's body and delivers it via Zigbee communication to the PC at base.

The data is gathered by the Arduino Mega, which is then programmed to show the data on the LCD and GUI. This code will cause the LCD display to show the analogue values acquired from the sensors. Fig. 4 displays the code segment with comments.

IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

IJARSCT
Impact Factor 6.252

Volume 2, Issue 1, July 2022

```
int flowPin = 2;    // velocity sensor is connected to pin 2 on the arduino board
double flowRate;
volatile int count,GAS;

void setup()
{

  lcd.begin(20, 4); // the LCD display used is a 20*4 display
  pinMode(flowPin, INPUT);
  attachInterrupt(0, Flow, RISING);
  Serial.begin(9600); // the baud rate is 9600 for this communication
}
```

Fig. 4. LCD display code part 1/2

```
#include <LiquidCrystal.h>
const int rs = 8, en = 9, d4 = 10, d5 = 11, d6 = 12, d7 = 13; //LCD pins connection to arduino mega
LiquidCrystal lcd(rs, en, d4, d5, d6, d7); // the LCD pins used
int Temp=A0; // temperature sensor is connected to the analogue input pin A0
int GAS1=A1;// Gas sensor MQ2 is connected to analogue input pin A1
int GAS2=A2; // Gas sensor MQ9 is connected to analogue input pin A2
int GAS3=A3; // Gas sensor MQ135 is connected to analogue input pin A3
int GAS4=A4; // Gas sensor MQ8 is connected to analogue input pin A4
int HUMTIY=A5; // Humidity sensor is connected to the analogue input pin A5
int flowPin = 2;    // velocity sensor is connected to pin 2 on the arduino board
double flowRate;
volatile int count,GAS;
```

Fig. 5. LCD display code part 2/2

The code Figs. that are shown above are the crucial components of the LCD coding that require explanation. For easier understanding, the codes are provided with comments.

4.3 Graphical User Interphase

The GUI at the bottom of the screen contains the controls for moving the MSRR and the pick and place arm. According to Fig. 6 below, the GUI additionally displays the environmental component's data. Zigbee technology is used for the control commands.

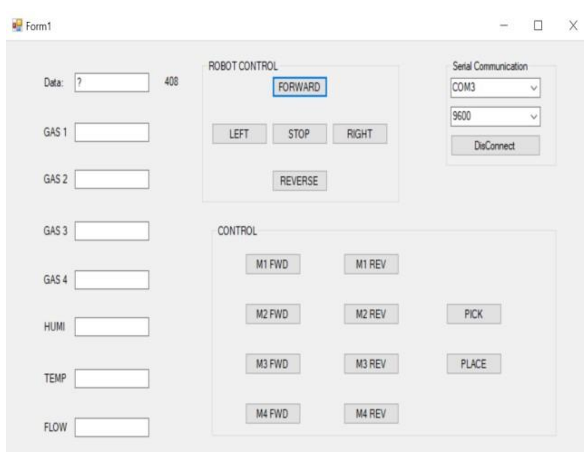

Fig. 6. GUI developed on the PC.

4.4 Prototype

The completed prototype is depicted in Fig. 7. The sensing circuit with LCD and motor drivers are displayed on the acrylic. In the front of the MSRR, the robotic arm can be seen. On the acrylic, you can also see the Arduino Mega and Zigbee.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Impact Factor 6.252
Volume 2, Issue 1, July 2022

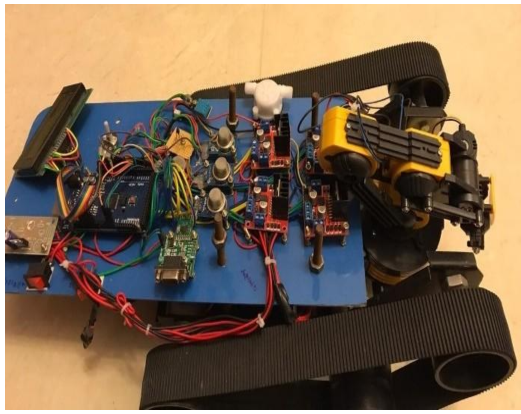

Fig. 7. Military Support and Rescue Robot prototype.

V. CONCLUSION

The construction of the Military Support and Rescue Robot will be done in four stages. The sensing circuit is the first stage of the robots. The sensors are used to examine the atmospheric makeup and determine whether it is appropriate for human contact. An analogue signal is emitted by the sensors, which the Arduino picks up to display on the LCD and communicate over Zigbee to the main PC.

The Pick and Place arm, which is used in the second phase, is programmed to be managed by the control buttons visible on the PC. The robotic arm is designed to both shift obstacles in the robot's path and detonate explosives. Phase three involves wireless data transmission from the site to the PC and TV tuner control of the camera. The last stage involves integrating all the previous ones into a single PC software that creates the GUI

The prototype is a battery-powered, semi-autonomous military support and rescue robot that was created to address all of the major flaws in the existing models and create an all-in-one robot designed to operate as efficiently as possible. According to the findings and discussion, the suggested system outperforms the shortcomings of the current systems and supports military activities more effectively.

REFERENCES

[1]. Market, M. (2020). Military Robots Market | Size, Share, and Global Market Forecast to 2022 | MarketsandMarkets™. [online] Marketsandmarkets.com. Online soure available at: https://www.marketsandmarkets.com/Market-Reports/military-robots- market-245516013.html [Accessed 11 Jan. 2020]:

[2]. Armyupress.army.mil. (2020). Pros and Cons of Autonomous Weapons Systems. [online] Available at:

[3]. https://www.armyupress.army.mil/Journals/Military-Review/English- Edition-Archives/May-June-2017/Pros-and-Cons-of-Autonomous- Weapons-Systems/ [Accessed 23 Feb. 2020].

[4]. Kumari, A. (2020). Military Robots Play a Pivotal Role as a Tactical and Operational T ool for Armed Forces. [online] Blog.marketresearch.com. Available at: https://blog.marketresearch.com/military-robots-play-a-pivotal-role-as-a-tactical-and-operational-tool-for-armed-forces [Accessed 11 Jan. 2020].

[5]. Doroodgar, B., Yugang Liu and Nejat, G. (2014). A Learning-Based Semi-Autonomous Controller for Robotic Exploration of Unknown Disaster Scenes While Searching for Victims. IEEE Transactions on Cybernetics, 44(12), pp.2719-2732.

[6]. Nourbakhsh, I., Sycara, K., Koes, M., Yong, M., Lewis, M. and Burion,

[7]. S. (2005). Human-Robot Teaming for Search and Rescue. IEEE Pervasive Computing, 4(1), pp.72-78.

[8]. Niroui, F., Zhang, K., Kashino, Z. and Nejat, G. (2019). Deep Reinforcement Learning Robot for Search and Rescue Applications:

[9]. Exploration in Unknown Cluttered Environments. IEEE Robotics and Automation Letters, 4(2), pp.610-617.

[10]. Robots.ieee.org. (2020). BEAR - ROBOTS: Your Guide to the World of Robotics. [online] Available at: https://robots.ieee.org/robots/bear/ [Accessed 14 Jan. 2020].

[11]. Wang, Y., Bai, P., Liang, X., Wang, W., Zhang, J. and Fu, Q. (2019). Reconnaissance Mission Conducted by *UAV* Swarms Based on Distributed PSO Path Planning Algorithms. IEEE Access, 7, pp.105086- 105099.

[12]. Qin, Z., Dong, C., Li, A., Dai, H., Wu, Q. and Xu, A. (2019). Trajectory Planning for Reconnaissance Mission Based on Fair-Energy *UAV*s Cooperation. IEEE Access, 7, pp.91120 -91133.

[13]. S. G. Manyam, D. W. Casbeer, and K. Sundar, ''Path planning for cooperative routing of air-ground vehicles,'' in Proc. Amer. Control Conf. (ACC), Jul. 2016, pp. 4630–4635.

[14]. Liu, Y., Luo, Z., Liu, Z., Shi, J. and Cheng, G. (2019). Cooperative Routing Problem for Ground Vehicle and Unmanned Aerial Vehicle: The Application on Intelligence, Surveillance, and Reconnaissance Missions. IEEE Access, 7, pp.63504-63518.

[15]. IFLScience. (2020). Military Test Amphibious Robot Guard Balls. [online] Available at: https://www.iflscience.com/technology/meet - guardbot-spherical-amphibious-robot/ [Accessed 15 Jan. 2020].

[16]. U.Zaman, H., Chowdhury, B. and Rezwan, U. (2016). Design, control & performance analysis of Muktibot. In: 2016 IEEE 7th An nual Information Technology, Electronics and Mobile Communication Conference (IEMCON). [online] Available at: https://ieeexplore-ieee- org.ezproxy1.hw.ac.uk/document/7746321 [Accessed 14 Jan. 2020].

[17]. KNOWLEDGE, G., GK, C. and Singh, H. (2020). Daksha: Country's first Anti-Terror Robot. [online] Jagranjosh.com. Available at: https://www.jagranjosh.com/general-knowledge/daksha-countrys-first - anti-terror-robot-1574428779-1 [Accessed 15 Jan. 2020].

[18]. Uy, J. (2020). The Jevit: home-grown Cambodian demining robot saves time and.... [online] AEC News T oday. Available at: https://aecnewstoday.com/2019/the-jevit-home-grown-cambodian- demining-robot-saves-time-and-limbs/ [Accessed 15 Jan. 2020]