Semiconductor Optoelectronics, *Vol. 41 No. 12 (2022), 1404-1419*
https://bdtgd.cn/

DESIGN & DEVELOPMENT OF A MULTI-FUNCTIONAL ROBOT (MOB) FOR MILITARY, MINING APPLICATIONS AND DISASTER RESCUE OPERATIONS IN THE COUNTRY – A PROTOTYPE

[1]Manoj Kumar J., [1]Arpitha N., [1]Darshan R., [1]Narendra Babu C.B.,
[2] Dr. Pavithra G., [3] Dr. T.C.Manjunath
[1] UG BE Final Year ECE Students, Dept of ECE,
Dayananda Sagar College of Engineering, Bangalore, Karnataka
[2] Associate Professor, ECE Dept., Dayananda Sagar College of Engineering, Bangalore, Karnataka
[3] Professor & HOD, ECE Dept., Dayananda Sagar College of Engineering, Bangalore, Karnataka
Email : tcmanju@iitbombay.org

Abstract—this paper gives the design & development of a multi-functional robot (MOB) for military, mining applications and disaster rescue operations in the country in the form of the development of a prototype. The country has invested a significant amount of money in the defence sector to implement high-security, rudimentary security measures and protect the border security forces from intruders in the modern day. In the defence sector, where robot efficiency is far higher than that of human forces, certain companies use robotics. Multi-operational Robots are essential in preventing human casualties and property damage during disasters, armed conflict, and mining. As a result, it will become more significant in the next era. The robot comprises of a mounted camera on a vehicle that takes pictures, then it sends the captured images to the base operating station through the cloud, it is also able to differentiate individuals using their body heat signatures along with gesture recognition. The robot can quietly enter into the enemy area, deep underground mining areas, disaster zones and send information via camera to the controller. The main motive of this paper is to make the Defence stronger by using robots, which will help soldiers during war and disaster times to safeguard human lives. This paper has proposed the system using the Arduino Raspberry pi, metal detectors, gas sensors, IR avoidance sensor, PIR sensor, ultrasonic sensor, Light detector sensor, GPS module which help the robot to do multi functionalities to do rescue operations. The work that is being presented here is the development of a multi-functional robot that we are doing for our final year undergraduate project in seventh & eight semester of our B.E. programme and as such we are trying to bring out some novelty & contributory issues so that it could be developed indigenously and used for military applications in our country.

Keywords—Robot, Bomb, Disposal, Security, Rescue, GPS location Tracking, Image Processing, Cloud Communication, metal detection, obstacle avoidance, distance measuring, trap indication, temperature sensing, Gesture recognizing, light sensing & detection.

I. INTRODUCTION REMARKS

Robots are mechanical machines that can carry out challenging and sophisticated activities both autonomously and in response to commands. As a result of the current era's rapid advancement in technology, it is acceptable to utilise robots rather than humans to carry out specific activities because they can carry out more difficult tasks, be transferred to locations where humans are unable to go, and carry out duties more effectively [1].

The country has invested a significant amount of money in the defence sector to implement low-tech, high-security measures in the current periodand safeguard the border security forces from trespassers. Some defence organizations utilize robotics in the defensee fields where the robot's efficiency is very high when compared to the human forces. Multi-operational robot plays a vital role in saving human losses and damages that occur during disasters, war, and mining. Thus, it will gain more importance in the upcoming era.

The robot consists of a vehicle which is mounted with a moving camera, which captures the images, Sends the captured images to the base operating station through the cloud, it is also able to differentiate individuals using facial recognition along with a laser defense mechanism. The robot can quietly enter the enemy area, deep underground mining areas, and disaster zones and send information thro' camera device to the controllers. The main motive of this project is to make the defence stronger by using robots, which will help soldiers during war and disaster times to safeguard human lives. The work presented in this paper has the design & development of a robotic system using the Arduino Raspberry pi, metal detectors, smoke level sensors, ultrasonic sensor, LDR with a flashlight, and GPS module which helps the robot to do multi functionalities to do rescue operations.

With multiple reported incidents of successful robot deployment in genuine crisis scenarios, disaster robotics has grown into its own research topic. Aerial, ground, and underwater robotic platforms are used in the majority of these catastrophe deployments. However, research on autonomous boats or Unmanned Surface Vehicles (USVs) for Disaster Management (DM) is now dispersed throughout various publications, with varying degrees of detail and focusing on multiple unmanned vehicles—usually under the banner of Unmanned Marine Vessels (UMV). As a result, the current significance of USVs in the DM process in its various phases remains unclear [28].

The rescue robots are the robots that are designed to assist with human search and rescue. They could help in rescue attempts by mapping, searching, removing rubbles, delivering the supplies, providing medical treatment, or evacuating victims.Despite mixed results, rescue robots were utilised in the after-math of the Sept'11 attacks, Fukushima Daiichi's nuclear disaster, and the 2016 Amatrice earthquake. Several programmes, including TRADR and SHERPA, are committed to improving rescue robot technology [2].

Every nation in the world has a strong advantage thanks to its defence system. One of the top priorities for maintaining the security of the nation's economy, assets, priceless treasures, and citizens' lives is to keep the country secure from enemies. Military robots are the most necessary and modern equipment in the defence sector. Military robots are now thought to represent the future of contemporary conflict. Military robotics, on the other hand, is thought to be a game-changing technology that could alter the organisation and employment of armed forces. The use of robots in the military is currently known to society. Military robots have become more prevalent on the battlefield during the past ten years. These robots are used by

the military for a variety of purposes, including transportation, enemy attack, disaster relief, and civil supply. Robots are now deployed in many nations' defence systems in an effort to gain superiority and move closer to the position of world supreme power [3].

After the September 11 attacks in New York, rescue robots were utilised in the search for fatalities and survivors. Rescue robots were put to the test for the first time during the September 11 terrorist attacks. They were tasked with searching the rubble for survivors and bodies. The robots struggled to work in the World Trade Center wreckage, frequently becoming trapped or broken. Many new ideas concerning rescue robots have emerged since then. Engineers and scientists are attempting to transform the robots' forms, converting them from wheels to no wheels. If search and rescue robots are to be widely used in less than 14 years, strong government funding and support are required. This means that without government assistance, technology for various apps [4].

The suggested model makes use of many sensors, including metal detectors, gas sensors, IR sensors, ultrasonic sensors, PIR sensors, and IR sensors, for a variety of tasks because robots are quick and their abilities, strengths, and computations are extremely effective. With the advancement of technology, it is now possible to control robots wirelessly and from a distance. This reduces the risk of human casualties during military operations such as surgical strikes and defence. We were able to create a spy robot using the camouflage technique that could transmit the precise position and pictures of intruders. The current method has some flaws, such as noise in the channel of information transfer to the closest encampment which can be avoided through the process of image recognition [5][29].

II. LITERATURE REVIEW / WORK DONE BY VARIOUS AUTHORS

A number of authors have worked on various issues that are presented in this research topic. To name a few of them are presented here in chronological sequence [6][30].

- Prem Kumar. M. presented a study that used a low power X-bee wireless sensor network to offer a novel technique for locating trespassers. The robot then took action against trespassers that it discovered while it was being watched, reducing human error [7].
- AkashRavindran suggested a system that establishes Bluetooth communication between the controller and Android. This system was created using a Bluetooth module that was interfaced using the UART protocol. Through the use of an Android app, the robot may be controlled [8].
- Hymavathi suggested a paper for connecting the X-bee and the creation of a multifunctional robot using wireless technology; the model may be operated by using a personal computer (PC), and it navigates through disaster zones and identifies the enemy [9].
- YadnikaWarang put forth a study on how to use a smartphone connected by Bluetooth to create a robot with several functions and camouflage technologies. Additionally, it is centred on robot safety and artificial intelligence [10] [27].

The next study will reveal how many warriors lose their lives each year protecting their nation. The casualties were brought on by India's underdeveloped defence system. The Information Bureau of the Ministry of Defence, Government of India, is the sole source of information used in the study.

[11] [28]. Fig. 1 gives the different blocks that may be used for our proposed project work

along with a typical 2-legged biped used for rescue operations in Fig. 2. Table 1 gives the list of causalities.

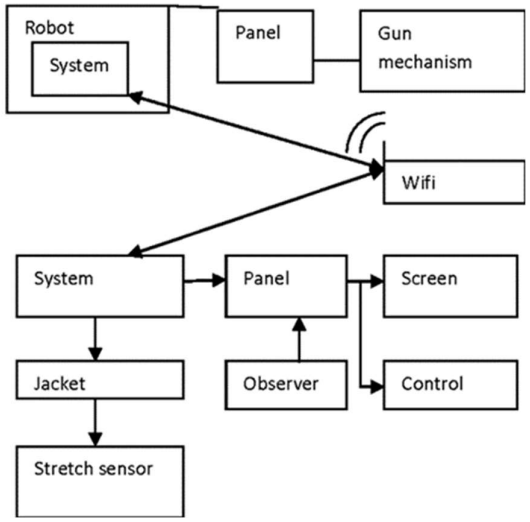

Fig. 1. Different blocks that may be used for our proposed project work [29]

Fig. 2. A typical 2-legged biped used for rescue operations

No	Year	Causalities
1	2010	1000+
2	2011	1100+
3	2012	1200+
4	2013	1300+
5	2014	1400+
6	2015	1500+
7	2016	1600+
8	2017	1700+
9	2018	1800+
10	2019	1900+
11	2020	2000+
12	2021	2500+

III. BLOCK DIAGRAM GOING TO BE UTILIZED

In this section, we present the block-diagram of the proposed technique that is going to be utilized for the design & development of the multi-functional robot that could be utilized for a host of military approaches, this is shown in the Fig. 1. Defense robots are service robots of the highest calibre that are used in times of conflict. They're typically created to enhance a soldier's

current skills while keeping them as safe as possible. The utilization of Defence robots by the military as a whole provides a tactical advantage.Military (defense) robots are mobile, autonomous, or remote controlled automatic machines that are employed for military tasks like attack, transportation, and search and rescue. Inspection, Security, Defense, and Surveillance - Inspection, Security, Defense Robots are far more durable than the hobby- or educational-grade versions of themselves. They are designed to withstand abuse and save lives by being exposed to difficult or dangerous conditions that people would want to avoid [12].

Fig. 3. A typical military robot that could be used (similar in design) for defense purposes

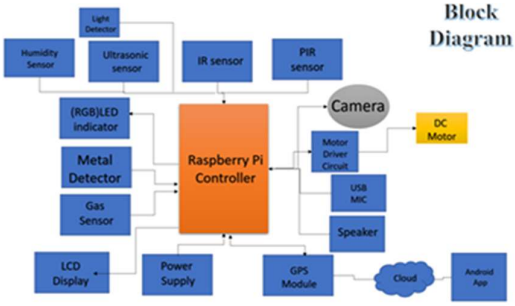

Fig. 4. Proposed block – diagram for the development using the multi function bot for military application

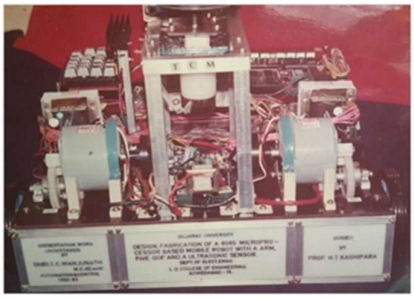

Fig. 5. One of the military robots that was designed by one of the authors of this paper, Dr. T.C.Manjunath

IV. HARDWARE & SOFTWARE THAT IS GOING TO BE USED

Fig. 3 gives a typical military robot that could be used (similar in design) for defense purposes. Fig. 4 gives the proposed block – diagram for the development using the multi-functional bot for military applications. Here, in this section, we present the different hardware components & the software that are going to be utilized for the design of the m-bot [13] [26]. Fig. 5 gives the pictorial view of one of the military robots that was designed by one of the authors of this paper, Dr. T.C.Manjunath, also which appeared in newspaper cuttings shown in the Figs. 6 &

7 respectively.

04 MULUNDPLUS

T C Manjunath (centre) with Amit, Deepali and the robot, OCTAGON

Robot to the rescue

IIT research scholar and VJTI techies develop an indigenous mobile robot 'Octagon' that promises to be a great help to the industry

Nisha Prabhakaran | Powai

Imagine a day in your life when you wake up in the morning and find a machine walking up to you and saying "GOOD MORNING Sir! Have a cup of tea." How would you respond to such a situation? Cool, isn't it?

With path-breaking success and progress in the fields of science, engineering and technology, this thought no longer remains just a dream in the age of automation. Keeping in pace with current technology, Powai resident T C Manjunath has helped design, fabricate and implement a mobile robotic unit (Octagon) along with Prof SA Patekar (VJTI) and students Deepali Trivedi and Amit Joshi (M E Computer Engineering, VJTI).

Speaking about their creation, Manjunath says, "OCTAGON is basically a moveable mobile trolley on which the articulated robotic manipulator arm is mounted to perform 'pick and place' (PNP) operations. One day, when I saw an octopus on television, I was influenced by its shape. While an octopus has eight legs, an Octagon has just four wheels as it is a mobile robot but the shape of the robotic body is that of an octagon."

And a design like this, he claims, will be of great use to the general public and the industry. "This can be a prototype for many industrial research purposes like removal of nuclear wastes in reactor zones, bomb disposal, and so on. This system is a prototype of an educational model for the students to understand the basic concepts of robots. If an institution wants to purchase a robot, it easily costs at least Rs 5 - 6 lakh as majority of the robots come from abroad," he cites.

"The total cost involved in the development of this robot including all the wastage, components costs, travelling costs, and so on. If a company manufactures this model on a larger scale with more sophistication, it could be used in the industry for 'picking and placing' manufactured parts in a container. The company can patent it and sell it in large numbers at a lower cost," he explains.

Elaborating on the working of the device, Manjunath explains, "In the 'Octagon', the mechanical system is coupled to the electronic system, which in turn is interfaced to the computer through its parallel port. The software module is designed for maximum robot control and working efficiency in a user-friendly JAVA environment. The user can easily manoeuvre the robot and make it traverse a path towards the object to be picked," he points out.

"If there are obstacles in the path, then the software initiates an alternative path ensuring that the robot reaches the desired destination. The user can teach the robot first using the teach mode software. The robot memorises all the instructions taught by storing it in its memory and plays it again and again," explains Manjunath.

"The group also had to battle several tense moments when things would go wrong or just stop working. But it was teamwork in their cohesive unit that saw them through. "Both Deepali and Amit would come to my place for consultation every week. It was very tough when it came to electronics interfacing of the mechanical hardware, as electronics sub-circuits wouldn't work on many occasions and we had to figure out where the fault had occurred. Programming in JAVA was also a tough task as all the control parameters like speed, pick and place position, velocity, acceleration, avoiding the obstacles, etc had to be taken into consideration," Manjunath points out.

"The creation of this device is all the more important in the present scenario, especially when robotics is becoming such an integral part of all sciences and research. In fact, 'Octagon' has been accepted as a full-fledged research paper on robotics in the prestigious 11th International Conference on Artificial Life and Robotics to be held in January 2006 in Japan.

"With increasing use of robotics in the industry, Manjunath feels that it is the right time to get into the field. "All the automobile car companies in the advanced countries are using robots to manufacture cars. Even in our country, Maruti, Hyundai, Tata Indica have assembly lines that are fully automated using robots. Advanced countries like US, Japan, USSR, Europe and UK have a lot of scope in this field," he concludes.

> This can be a prototype for many industrial research purposes like removal of nuclear wastes in reactor zones, bomb disposal, and so on
> - T C Manjunath

Fig. 6. One of the military robots that was designed by one of the authros of this paper, Dr. T.C.Manjunath that appeared in the Times of India newspaper

ROBOT TO THE RESCUE

An IIT research scholar and a few VJTI techies come together to develop an indigenous mobile robot that promises to be a great help to the industry. **Nisha Prabhakaran** reports

Fig. 7. One of the military robots that was designed by one of the authros of this paper, Dr. T.C.Manjunath that appeared in the Times of India newspaper

A. Hardware Used for the Protype Development :

- Raspberry Pi Controller
- Ultrasonic Sensor
- Wi-fi modem
- IR Sensor
- PIR Sensor
- Metal Detector
- LED Indicator
- Gas Sensor
- Motor Driver & wheels
- Night-vision Camera

- GPS Module
- Power Supply
- Battery level Indicator
- DC Motor
- Light detector sensor
- OLED display
- Mic & speaker

B. Software

- Embedded C
- Python
- MIT App Inventor
- Machine Learning

V. MAIN AIM OF THE RESEARCH PAPER

The main aim of this paper is to build Multi-operational Bot for information gathering in the Defence system of India [24][25].

VI. RESEARCH OBJECTIVES

Here, we present the main objectives of the research paper that is going to be implemented as a part of our final year BE (ECE) project work.

- To Transverse a robot in the war field, to recognize classified people and capture images using a night vision camera and can transmit the status of the battle.
- To build a robot with the capability to perform missions remotely in the field without endangering human lives and to help majorly in a rescue operation.
- To develop a GPS in the robot to locate people in disaster areas and get them medical attention.
- To develop an image processing software & familiarize the system to recognize people's gestures and provide necessary first aid.
- To develop an android application to control the wireless multi-operational bot and find undiscovered places in mines where people cannot venture and gather information about those places.
- To design a model which intimates the soldiers about the obstacle, traps, and the distance from the location of the target.
- To build an alerting system in the robot to alert our soldiers from approaching hostile enemies through the multi-operational robot.

VII. RESEARCH OBJECTIVES

We're outlining a method of using an android device's Wi-Fi for robot control. The android application's controllers are made for controlling the robot's movements. The operation of these controllers is specified by embedded C and Python programmes that are loaded onto the Raspberry Pi and shown using a monitor connected to the Raspberry Pi. Switches, relays, transistors, or MOSFET circuits can be used to turn DC motors "On" or "Off," with "Multi-direction" control being the most basic type of motor control [14] [23].

The robot's location is determined using the GPS, which also transmits the coordinates of areas with metal, barriers, and gases. To move the robot, dc motors and sensors are also used as additional hardware components. Poisonous gas sensors, metal detectors, IR sensors for detecting obstructions, PIR sensors for detecting movement of people or animals, and gas

sensors for detecting toxic gases are all used.

Ultrasonic sensor is used to find the distance of the object or person in a certain proximity, a light detector is used to sense light and find paths, Mic for the rescuers to report about the casualty or wounded condition, Speaker to pass instructions to people in a dangerous situation, etc [15] [22].

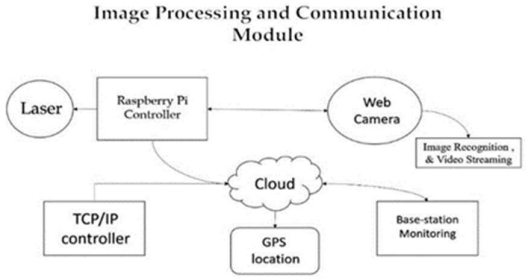

Fig. 8. Development of IP & communication module

We use a Night-vision Camera for the detection of people and recognition of the soldiers who are classified through masking of image and image processing through the cloud. The camera displays real-time data that the user can process or watch on a monitor or smartphone. As data is transmitted via the wi-fi module, it provides quick and precise data. It is extremely quick and trustworthy. The Model has a section where a first aid kit can be stored for use in an emergency. The monitor or a mobile phone can be used to control the robot's movement. The robot can move in any direction depending on the situation in order to locate any dangerous residues in the immediate area[16] [21].

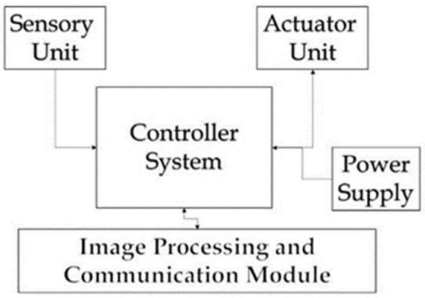

Fig. 9. Development of the image processing & the communication module

The proposed methodology that you are going to adopt here to solve the problem has to be presented in the form of a block-diagrammatic approach or the form of a flow chart or a proposed algorithm with some explanations. We are proposing a system used for controlling the robot using Wi-Fi via TCP/IP on the android device. The Android application's controllers are made for controlling the robot's movements. The Python programme that is loaded into the Raspberry Pi and shown on the monitor connected to the Raspberry Pi defines the operation in these controllers. DC motors can be turned "On" or "Off," with "multi-direction" control being the most basic type of motor control. The robot's location is determined using the GPS, which also transmits the coordinates of areas with metal, barriers, and gases. To move the robot, DC motors and sensors are also used as additional hardware components. Gas sensors are used to measure the levels of gas in the environment, anmetal detecting device is utilized for the sensing of the landmines and metal underground, an Ultrasonic sensor is used to find the distance of the object or person in a certain proximity, and an LDR is used to sense light which

turns on the light during the dark, Speaker to pass instructions to people in a dangerous situation, etc.

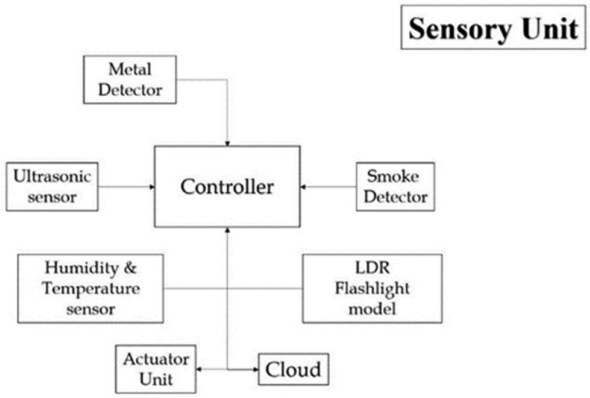

Fig. 10. Block diagarm for the sensing unit

We use a Webcam for the detection of people and recognition of the soldiers who are classified through image processing from the cloud. The user's monitor or mobile phone can analyse or display the real-time data that is displayed by the camera. If there is an unknown person detected it fires a laser at the unknown entity. As data is transmitted via the wi-fi module, it provides quick and precise data. It is highly dependable and quick.The Model is also provided with a compartment to keep a first aid kit for emergency treatment purposes.

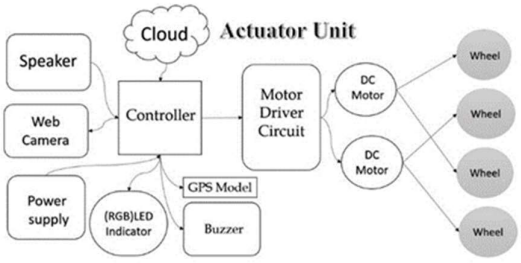

Fig. 11. Block-diagram for the actuator unit

A mobile phone or an autonomous system can control the robot's movement. The robot can move in any direction depending on the situation in order to locate any dangerous residues in the immediate area.

A. Flow chart for face recognition

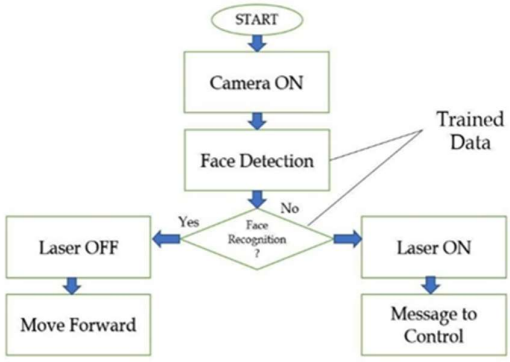

Fig. 12. Block diagarm from the face recognition unit

B. Text-to-speech conversion

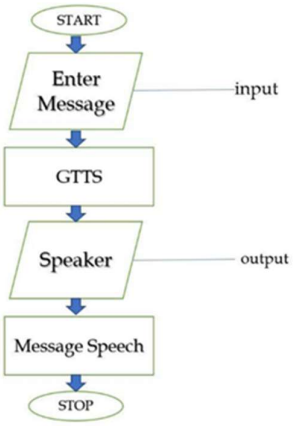

Fig. 13. Flow chart for the text to speech conversion

C. Automatic Movement

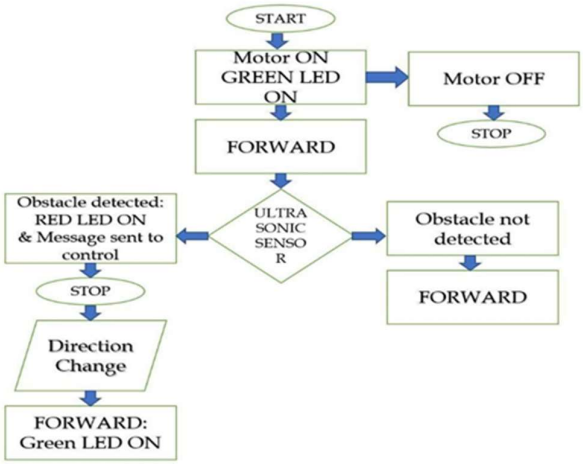

Fig. 14. Block diagarm for the automatic movements

D. Design of the Sensory Unit

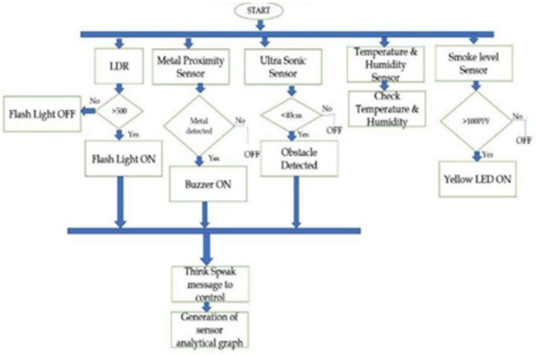

Fig. 15. Block diagram of the sensory unit

E. Developed prototype

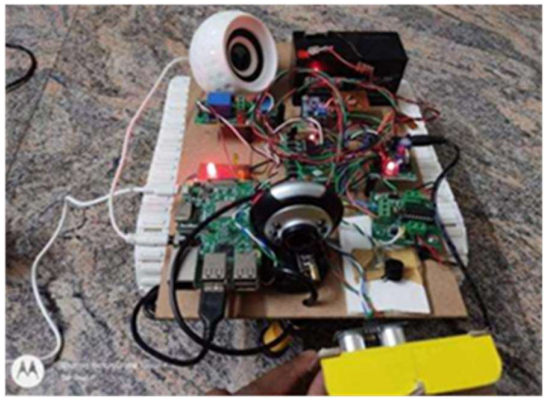

Fig. 16. Designed & developed protype as a part of the final year undergraduate project work in the 8th semester

The sensory unit should detect the traps, obstacles, or hostile targets approaching. The controller should obtain the data and process required operation from instructions of the human controller. The camera should identify the target and provide assistance based on the gesture of a comrade. The Mic and speaker should function like a walky - talky to provide further instructions to people in dangerous situations. GPS module should provide the location of the target, traps & obstacles around the prescribed area.

VIII. OUTCOME OF THE RESEARCH WORK

The sensory unit should detect the traps, obstacles, or hostile targets approaching. The controller should obtain the data and process required operation from instructions of the human controller. The camera should identify the target and provide assistance based on the gesture of a comrade.The Mic and speaker should function like a walky-talky to provide further instructions to people in dangerous situations. GPS module should provide the location of the target, traps & obstacles around the prescribed area [17] [20].

Components	Quantity	Voltage in V	Current in mA	Power in mW
Raspberry Pi3Model B+	1	5	500	2500
Ultrasonic sensorHC- SR04	1	3.3	5	16.5
DHTT1 Temperature & Humidity Sensor	1	5	2.5	12.5
E18- D80NK metal sensor	1	5	2.5	12.5
LED’s	1	3.3	20	66
Relay module	1	3.3	20	66
Motor Driver	1	12	800	9600
Smoke sensor	1	5	2.5	12.5
LDR	1	3.3	0.5	1.65

Analog to Digital converter	1	5	5	25
LEDstrip	1	3.3	20	66
Buzzer	1	3.3	0.5	1.65

IX. ADVANTAGES & APPLICATIONS

In this section, the advantages and applications of the research work that is taken up in this paper is presented [18] [19].

A. Advantage

- Wireless controlling facility
- Surveillance module
- Navigation of the vehicle with the use of 4G tech
- It utilises mobile technology, which is practically ubiquitous
- It has no foundation of range and may be operated as far as a cell phone network.
- Safety and life-saving.
- Makes an activity safer and easier.

B. Applications

- A mission of military reconnaissance.
- Hotspot security and monitoring via wireless.
- Rescue and search efforts.
- Performing manoeuvres in a dangerous setting.
- Providing emergency treatment for people needing rescue.
- Identification of living souls during disasters.
- To have the ability to search through the external environment and identify fatalities, hazardous subjects, or material.

X. CONCLUSIONS & FUTURE SCOPE

In this hardware-software based paper that Multi-Operational Robot (MOB) can be used in Defence, Disaster Recovery, Hazardous environment, By using the cloud, we can transmit commands and information to the nearby camp bases that are known, and it also detects any gases that are present in the environment.It can provide emergency treatment to soldiers during war times. It can help to pass the information on the battlefield & other terrains.By outfitting and enhancing the sensors and their capabilities, as well as applying artificial intelligence and machine learning to provide higher precision, we can improve the system, we can also make the model gather aerial data by attaching Drone wings, we can also install self-charging batteries and also provide security of information gathered, etc.

Fig. 17. Receiving the best project award in the IEEE fest @ GSSIETW, receving the

certificate & prize from the principal of GSSIETW, Mysore

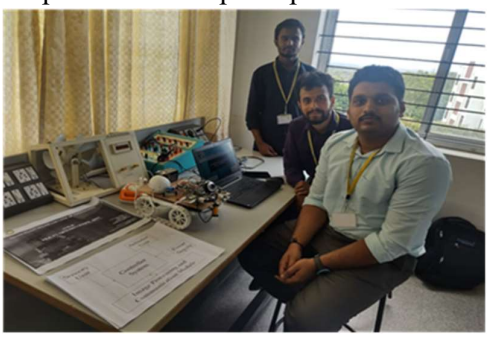

Fig. 18. Students with the developed module in the IEEE techfest

Fig. 19. Students with the developed module in the IEEE techfest

XI. ACKNOWLEDGEMENTS

The project team (Arpitha N.- 1DS18EC013, Darshan R.- 1DS19EC407, Manoj Kumar J.- 1DS19EC418, NarendraBabu C.B.- 1DS19EC419) got the best project award for the title, “M.O.B (Multi-Operational BOT) for military and mining applications” in the Sixth National Level IEEE Project Competition-2022 held at GSS Institute of Engg& Tech for Women (GSSIETW) in Mysore, Karnataka on 8th of June 2022 along with a cash prize of Rs. 1000, the Principal of GSSIETW – Dr. Shivakumar& the IEEE College Head – Dr. Parameshachari presented the certificate & the award.

Karnataka State Council for Science and Technology
(An autonomous organisation under the Dept. of Science & Technology, Govt. of Karnataka)
Indian Institute of Science Campus, Bengaluru – 560 012
Telephone: 080-23341652, 23348848, 23348849, 23348840
Email: office.kscst@iisc.ac.in, office@kscst.org.in • Website: www.kscst.iisc.ernet.in, www.kscst.org.in

KSCST

Mr. H. Hemanth Kumar
Executive Secretary

Ref: 7.1.01/SPP/91

11th May, 2022

The Principal,
Dayananda Sagar College of Engineering,
Shavige Malleshwara Hills,
Kumaraswamy Layout,
Bengaluru - 560 078.

Dear Sir/Madam,

Sub : Sanction of Student Project - 45th Series: Year 2021-2022

Project Proposal Reference No. : **45S_BE_2114**
Ref : Project Proposal entitled **M.O.B (MULTI-OPERATIONAL BOT) FOR MILITARY AND MINING APPLICATIONS**

We are pleased to inform that your student project proposal referred above, has been approved by the Council under "Student Project Programme - 45th Series". The project details are as below:

Student(s)	Mr. DARSHAN R Mr. MANOJ KUMAR J Ms. ARPITHA N Mr. NARENDRA BABU C B	**Department**	ELECTRONICS AND COMMUNICATION ENGINEERING
Guide(s)	Dr. PAVITHRA. G	**Sanctioned Amount (in Rs.)**	7,000.00

Instructions:
a) The project should be performed based on the objectives of the proposal submitted.
b) Any changes in the project title,objectives or students team is liable for rejection of the project and your institution shall return the sanctioned funds to KSCST.
c) Please quote your project reference number printed above in all your future correspondences.
d) After completing the project, 2 to 3 page write-up (synopsis) needs to be uploaded on to the following Google Forms link https://forms.gle/YMn9X7XETuS6tBXbA. The synopsis should include following:
1) Project Reference Number
2) Title of the project
3) Name of the College & Department
4) Name of the students & Guide(s)
5) Keywords
6) Introduction / background (with specific reference to the project, work done earlier, etc) - about 20 lines
7) Objectives (about 10 lines)

Fig. 20. KSCST project grant obtained certificate for Rs. 7,000

REFERENCES

[1] Prem Kumar. M "Unmanned Multi-Functional Robot Using Zigbee Adopter Network for Defence Application" International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 2, Issue 1, January 2013.

[2] Akash Ravindran and Akshay Prem Kumar "Camouflage Technology" International Journal of Emerging Technology in Computer Science & Electronics (IJETCSE)ISSN:09761353 Volume8Issue1–April 2014.

[3] P. Hymavathi, T. Jyothi "Surveillance Alive Human Detection Robot using X-bee Technology" SSRG International Journal of Electronics and Communication Engineering (SSRG-IJECE) – volume issue 4, June 2014.

[4] Dipak Patil, Himali Patil, Abhijeet Patil, Sunil Kalal "Camouflage Technique Based Multifunctional Army Robot" International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE) Volume 4, Issue 2, February 2015.

[5] Yadnika Warang, Tejali Mahadik, Supriya Ojha, Asha Rawath "Camouflage Robot-A Colour Changing Spy Robot" IJARIIE-ISSN (O) - 2395- 4396, Vol-3 Issue-2,2017.

[6] Tarun Preet Kaur, Dilip Kumar, "Wireless Multifunctional Robot for Military Applications" Proceedings of 2015 RAECS UIET Panjab University Chandigarh 21-22nd December 2015: 978-1-4673-8253-3/15 ©2015IEEE

[7] Kunal Borker1, Rohan Gaikwad2, Ajay Singh Rajput3, "Wireless Controlled Surveillance Robot" International Journal of Advanced Research in Computer Science and Management Studies. ISSN: 2321- 7782,Volume.2,Issue.2,February2014.

[8] Pooventhan K, Achutha Perumal R, Kowshik S3 Manoj Balajee C "Surveillance Robot Using Multi-Sensor Network". International journal of innovative research in electrical, electronics, instrumentation and control engineering Vol. 3, Issue 2, February 2015 ISSN (Online) 2321- 2004

[9] Yu Jun, Yang Wuxia, Hu Zhiyi, Chen Hongshu. Research of Digital Camouflage Generation Algorithm[J]. Opto-Electronic Engineering, 2010,37(7):110-114

[10] Dr. Shantanu K. Dixit, "Design and Implementation of e-surveillance Robot for Video Monitoring and Living Body Detection", International Journal of Scientific and Research Publication, Volume 4, issue 4, April 2014 ISSN2250-3153.

[11] Robert T. Collins, Alan J. Lipton, and Takeo Kanade, Introduction to the Special Section on Video Surveillance, IEEE Transaction on Pattern Analysis and Machine Intelligence, Vol. 22, No. 8, August 2000.

[12] Balaji.M, Karthick.S, Manikandan.V, Benedict Ebinesar.J, Vijay Nagaraj "Survillance and Target Engagement using Robots" IOSR Journal of Electronics and Communication Engineering 2017, pp.01-06.

[13] S. A Joshi, Aparna Tondarkar, Krishna Solanke, Rohit Jagtap, " Surveillance Robot for Military Application", International Journal Of Engineering And Computer Science ISSN:2319-7242, Volume.7 Issue.5 May2018,PageNo.23939-23944

[14] T Kaur and Dilip Kumar, "Design of Cell Phone Operated Multipurpose Security Robot for Military Applications using Solar Panel", International Conference.

[15] Dr. T.C.Manjunath, Pavithra G., R. Jagadisha, "Design & development of an efficient path planning mechanism for a Micro-Robot", IEAE's International Journal of Emerging Research & Management (IJERMT), ISSN : 2278-9359, DOI : 10.23956/ijermt, Vol. 6, Issue

5, pp. 727-733, Impact Factor: 3.969, IF by ISRA 1.492, UGC Approved Journal, May 2017.
[16] Dr. T.C.Manjunath, Dr. Vaibhav Meshram, Pavithra G., "Dynamic modelling of a robot arm", Journal of Applied Engineering and Technologies (JAET), ISSN-2278-1722, Paper id AET-012, Vol. 2, Issue 1, pp. 47 - 53, April 2013, India.
[17] Dr. T.C.Manjunath, Arunkumar G., Pavithra G., "Development of swarm intelligence in mobile robotic systems", Journal of Applied Engg. & Technologies (AET-2014), ISSN : 2278 – 1722, Vol. 3, Issue 1, Apr. 2014, pp. 109-112, Vidyalankar Inst. of Tech., Mumbai, Maharashtra, India
[18] Dr. T.C. Manjunath, Pavithra G., Dr. B.G. Nagaraj, "Design & simulation of the workspace for a stationary robot system", Proc. of the IEEE Region 10 Humanitarian Technological Conference (IEEE R10 HTC-2016), Dayalbagh Educational Institute, Dayal Bagh Rd, Dayal Bagh, Agra, Uttar Pradesh- 282005, India, IEEE Conference ID 39702, paper id 119, Session 2C on 21st Dec. 2016 at 09:30 hrs, Electronic ISBN: 978-1-5090-4177-0, Print on Demand (PoD) ISBN: 978-1-5090-4178-7, INSPEC Accession Number: 16837058, DOI: 10.1109/R10-HTC.2016.7906828, Dec. 21-23, 2016
[19] Dr. T.C.Manjunath, Pavithra G., Satvik M. Kuagur, "Recent advances in the development of nanotechnology for bio-medical robots", Proc. of the IFERP's Int. Conf. on Chip, Circuitry, Current, Coding, Combustion & Composites (i7c-2016), paper id 80, pg. 85-86, ISBN 9788192958026, organized by IFERP & Shirdi Sai College of Engg., Bangalore, Karnataka, India, & associated with Technocrate Group (Technocrate Research & Development Association), Conference Alerts, ECA, IERD, ISER, IIAR, pp. 85-86, (abstract booklet), 10-11 Nov. 2016.
[20] Dr. T.C.Manjunath, Pavithra G., "A review of the glaucoma detection using hardware based implementation using embedded systems", 2017 IEEE Int. Conf. on Intelligent Computing & Control (I2C2-2017), Sponsored by IEEE Madras Section, IEEE Robotics & Automation Society, Karpagam College of Engg., Karpagam University, Coimbatore, Tamil Nadu, India, paper id IC038, IEEE Xplore ISBN : 978-1-5386-0373-4, Vol. 1, Sl. No. 14, pp. 75-83, 23-24 Jun. 2017.
[21] Dr. T.C.Manjunath, Pavithra G., Rashmi Jagadisha, "Design & development of an efficient path planning mechanism for a Micro-Robot", IEAE's International Conference on Emerging Trends in Science & Engineering (ICETSE-2017), Paper id ICETSE-219, Associated by Institute for Exploring Advances in Engg. (IEAE), Coorg Institute of Technology, Ponnampet, S. Kodagu, Coorg, Karnataka, India, Proceedings in Vol. 2, Electrical, Electronics & Communication Engg., ISBN : 978-93-84698-42-3, Publisher : IEAE Publishing House, Karnataka, India, Sl. No. 42, pp. 227-234, 11-12 May 2017.
[22] Dr. Arunkumar G., Dr. T.C. Manjunath, Pavithra G., "4-point minimal pick & place trajectory design in robotics", Int. Conf. on Innovations In Communication Computing & Sciences, ICCS-2019, Dept. of ECE, Chandigarh Group of Colleges, Kharar, Banur Hwy, Sector 112, Sahibzada Ajit Singh Nagar, Landran, Mohali, Punjab-140307, Paper id ICCS-011, pp. 145-150, 26-27 Jul. 2019.
[23] Dr. Pavithra G., Mahesh B. Neelagar, Dr. T.C.Manjunath, "Development of a robotic part fixture mechanism for a conveyer belt problem for doing PNP operation in an industrial scenario using a fixed robot", 5th IEEE International Conference on Communication and Electronics Systems (ICCES 2020), PPG Institute of Technology, Coimbatore, TN, 10-12, June

2020.

[24] Dr. T.C.Manjunath, Dr. Chandrakumar K., Pavithra G., "Novel design & development of a medical nano-robot", Nat. Conf. on Emerging Trends in Nano Applications (NCETN-2015), Paper id p003 (OP-02), BMS Inst. of Tech (BMSIT), Bangalore, Karnataka, Organized by Dept. of Physics, Chemistry & ECE of BMSIT, ISBN No.:978-81-928203-8-5, pp. 16-18, 27-28 Mar. 2015. ©

[25] Dr. T.C. Manjunath, Pavithra G., Kavitha S. Guddad, "An overview of the design & development of safety features in robots in the industrial sector", 3rd Nat. Conf. on Recent Trends in Electronics & Communications (NCRTEC-2017), Organized by Dept. of ECE, IETE, Gate Forum, Paper id RTEC116, Global Academy of Tech. (GAT), Bangalore, Karnataka, India, pp. 1-5, 12 May 2017.

[26] Dr. T.C.Manjunath, Pavithra G., Rajasekar Koyyeda, "Mathematical formulation of a 2D path in the work space of the robot from the source to the destination", 2nd Nat. Conf. on Recent Advances in Engg. & Tech. (NCRAET-2017), Dept. of ECE, Basavakalyan Engg. College, NH-9, Bidar-585327, Bidar Dist., Karnataka, India, ISBN: 978-81-931739-4-7, ISSN (On-line) : 2320-9801, ISSN (Print) : 2320-9798, Certificate No. V5SI4C140, Paper id EC112, pp. 7 (abstract booklet), 27-28 May 2017.

[27] Pavithra G., Dr. T.C.Manjunath, Rajanish N., "Design & Development of a novel 4-point minimal pick & place trajectory in robotics", 10th Annual KSTA National Conference, Decennial Celebration of Science & Technology for future of Humanity (Sponsored by IIA, DRSC, ISRO, KSCST, Start up Karnataka, KSTePS) Decennial Celebration of Science & Technology for future of Humanity, Dept. of Science & Technology, Govt. of Karnataka, Reva University, Kattigenahalli, Bangalore-64, Karnataka, ISBN 978-81-936187-4-5, Paper id ES-12, Sl. No. 235, pg. 149, 18-19 Jan. 2018.

[28] Jorge, Vitor A M et al. "A Survey on Unmanned Surface Vehicles for Disaster Robotics: Main Challenges and Directions." Sensors (Basel, Switzerland) vol. 19,3 702. 8 Feb. 2019, doi:10.3390/s19030702.

[29] Bhawana D. Parate , Jagruti J. Shah, "Design and Development of Multifunctional Robot for Military Purpose Applications", International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622, International Conference on Industrial Automation and Computing (ICIAC- 12-13 th April 2014)

[30] Dr. T.C.Manjunath, "Fundamentals of Robotics", Nandu Publishers, 5th Edition, Mumbai, 2007.