Unmanned Autonomous Vehicle

Mohit Mahajan[1], Sarthak Dalal[1], Sarthak Mistry[1], Shikha Punjabi[1], Smit Chheda[1], Urvashi Maheshwari[1], Yash Dange[1], Amit A. Deshmukh[2]

[1] U. G. Student, Department of Electronics and Telecommunication, D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

[2] Professor &Head,Electronics and Telecommunication Department D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

E-mail: [1]mohitmahajan530@gmail.com, [1]sarthak.dalal@gmail.com, [1]sarthakmistry44@gmail.com, [1]shikhaspunjabi@gmail.com, [1]smitchheda22@gmail.com, [1]urvashijan6@gmail.com, [1]yashdange.yd@gmail.com, [2]amit.deshmukh@djsce.ac.in

***Abstract-* Advances in technology have revolutionized the medical field and changed the way healthcare is delivered. Unmanned aerial vehicles are the next wave of technological advancements that have the potential to make a huge splash in clinical medicine. UAVs, originally developed for military use, are making their way into the public and private sectors. Because they can be flown autonomously and can reach almost any geographical location, the significance of UAVs is becoming increasingly apparent in the medical field. In these immensely difficult times, when a global pandemic has endangered the world and all the people living in it, delivering food and medical supplies to the quarantine centers has been excruciating and extremely dangerous. It involves doctors risking their lives and their family's safety, to treat sick patients. To tackle this situation efficiently with minimal human contact which in turn would minimize the spread of the Coronavirus, our unmanned autonomous vehicle would be of immense use. Over the past decade, enormous improvements have been made in the capabilities, performance, and applications of unmanned autonomous vehicle (UAV) systems (airborne, marine, and terrestrial). Although unmanned underwater vehicle systems are used extensively in the oil and gas industry and have been around for decades, the advent of unmanned aircraft systems (UAS), popularly referred to as drones, is relatively new. Previously the exclusive purview of military and high-tech civilian agencies, small unmanned aircraft systems (sUAS) are widely available today and are used increasingly in the public and commercial sectors. The price tag for a capable UAS system now ranges from less than USD 5000 to more than USD 1 million, with sustained flight times (endurance) ranging from about 20 minutes to five hours.**

Keywords- Arduino UNO, OpenCV, Rpi Cam - Raspberry pi camera,Rpi - Raspberry pi.

I. INTRODUCTION

Unmanned vehicles have turned into a boon for humanity in the recent years. The advancement in technology has a huge impact on human lifestyle in many ways and one of the most important ones is the development of disaster robotics or the use of UAVs for safe and convenient disaster management. The main scope for this project is to deploy the unmanned vehicle to areas that can otherwise be inaccessible or risky for humans.

One such issue is the current global pandemic, which is the COVID-19 crisis the world is going through. Doctors and all the medical staff are prone to this virus and have to put their life at risk even for the smallest of tasks like delivering the medicines to the COVID-19 patients or giving them their daily meals. The UAV can be put to efficient use in such a case, as it can provide the medications or food to each patient in the hospital which prevents the medical staff from coming in contact with these patients. Hence, the main purpose of this entire project is to provide mankind with a delivery agent so they can keep themselves safe and perform their daily duties without worrying about the delivery of equipment and resources needed by the patients.

II. OBJECTIVE

The main objective of the project proposed by us is to develop an unmanned autonomous grounded vehicle. Using this vehicle, we hope to improve the disaster management system of our country. This vehicle could be used as a delivery agent which could provide food and medicines from time to time to the numerous quarantine centres, thereby reducing the risk of the doctors getting infected with this contagious disease. Another issue that our vehicle could help to resolve is disaster management. In the case of a natural calamity or an accident, like a plane crash or a building collapsing, several community workers have to risk their lives in order to inspect the damage and to find and rescue the people trapped inside the tower or under debris. This results in the loss of many lives which can be avoided with the help of our vehicle.

This vehicle will be able to transmit all kinds of data that would be required like GPS position with the help of sensors, and it would also provide a live feed to the person in charge with the help of an integrated camera. The vehicle will make use of the concepts of computer vision to capture an image, analyse the conditions using some pre-defined logic and give a relatable output using dedicated hardware.

The detailed goals would be to evaluate the Raspberry-PI module can be programmed using Python programming, to capture images with the help of the integrated camera, to use an image processing technique, and to read and recognize the images. For example, if a person on bed number 24 needs to be given his medications, the vehicle will move around and capture the images of each bed number and will map it to the image that would be pre-fed. If the images match, the medicine or food would be delivered to that patient. If not, the vehicle will keep movinguntil it has found the right bed number. Matching the number on the image with the dataset results in ensuring that the food/medicine has been provided to the respective patient. This system would be convenient to use and would be easily programmable so that it can be used for many other things too. For example, in case of a disaster, it would move around and assess the damage that has been done, thus helping in saving and protecting human lives.

 ISBN: 978-93-5437-776-1

III. PROPOSED DESIGN

The ideal design will comprise of a GPU which would be the brain of the UAV. All Machine Learning and Image processing algorithms will get processed and executed by the GPU. Further, the LiDAR and the IMU would be interfaced with the system. The Lidar will be used for recording the surroundings. Along with the Lidar which will be used for mapping and localization, a stereo camera module will be used recognize the people and objects in the surrounding (patients and medicines). Thus, the program for the autonomous vehicle and its secondary features will be fed to the GPU. The Lidar will be used for obstacle detection and path planning. A Neo-6 M-based GPS module will be interfaced to record precisely where the UAV is. All the data while the UAV is running such as the vehicle speed, obstacle distance, GPS readings, etc will be recorded in an SD card using a microSD card SPI-based Module. GUI using JavaScript framework, Electron.js is used to read data for the Human-Machine co-operation.

The complete simulation of the system is simulated on Gazebo software. The software essentially simulates obstacle detection, perception and path planning of the vehicle in real time using ROS.

The UAV is basically designed to help control the supply and distribution of medications and other essential commodities which fit under the defined payload, during these challenging times. It can also be used during the time of crisis, to scan any affected region for stranded/injured humans. Amidst the pandemic, where minimum human locomotion (especially of the aged) is highly advised and recommended, the main aim is to get them the medical help they need, without them having to step out of their homes. This can be made possible with an unmanned vehicle used as a delivery agent, thereby reducing the risk of not only the people who receive the package but also the people who deliver it, getting infected.

For this objective to be completed, various components will be used.

Arduino UNO **-** The Arduino Uno is a microcontroller board which is based on the ATmega328. There are 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button

HC SR04 - Ultrasonic ranging module HC - SR04 which gives a 2cm - 400cm non-contact measurement function, the ranging accuracy can reach 3mm.

L298D - It is a low voltage; a high current dual full-bridge driver which is designed in such a way so as to accept standard TTL logic levels and drive inductive loads.

Rpi - The Raspberry Pi 3 (model B), which showcases an HDMI port, audio/video port, Micro USB power input, and two ribbon connectors. Raspberry Pi Foundation is designed to be an easy and accessible platform to promote computer science.

Rpi camera - The Raspberry Pi Camera Module v2 is a high-quality 8-megapixel Sony IMX219 image sensor custom-designed add-on board for the Raspberry Pi, featuring a fixed focus lens.

Ublox NEO 6M - GPS sensors are receivers with antennas that use a satellite-based navigation system with a network of 24 satellites in orbit around the earth. We will be using it to monitor the position of the UAV.

XBee Module - The XBee radios can all be used with the minimum number of connections — power (3.3 V), ground, data in, and data out (UART), with other recommended lines being Reset and Sleep. Additionally, most XBee families have some other flow control, input/output (I/O), analog-to-digital converter (A/D), and indicator lines built-in.

SG90 **-** Servo can rotate approximately 180 degrees (90 in each direction)and works just like the standard kinds but smaller. You can use any servo code, hardware, or library to control these servos.

LiDAR **-** LiDAR, typically used as an acronym for "' light detection and ranging'", is essentially a sonar that uses pulsed laser waves to map the distance to surrounding objects. It is used by many autonomous vehicles to navigate environments in real-time. Its advantages include impressively accurate depth perception, which allows LiDAR to know the distance to an object to within a few centimetres, up to 60 meters away.

IMU **-** The IMU is a key dynamic sensor to steer the vehicle dynamically, maintaining better than 30-cm accuracy for short periods when other sensors go offline. The IMU is also used in algorithms that can cross-compare position/location and then assign a certainty to the overall localization estimate.

IV. IMPLEMENTATION

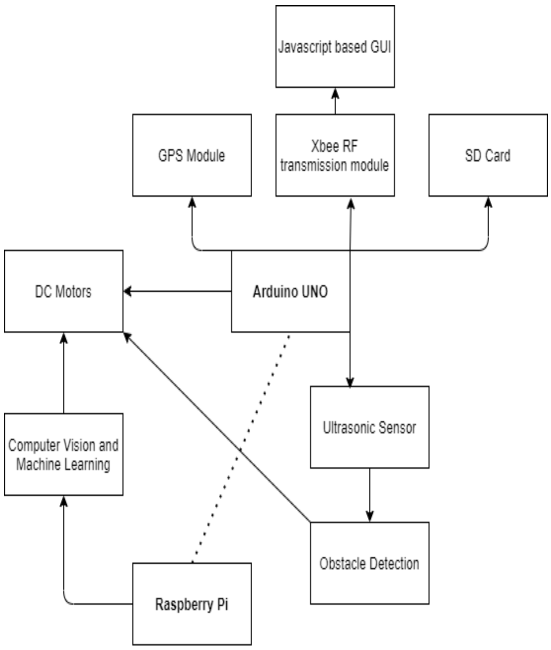


Fig.1 Flowchart of the proposed design

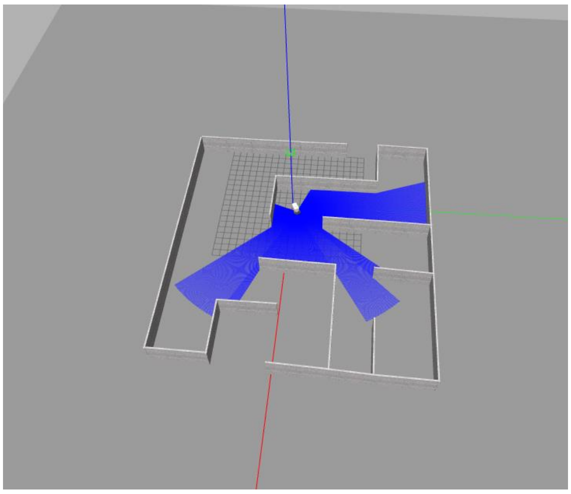
We came up with multiple approaches for the implementation of this project, one hardware and other software. In the software approach we simulated the UAV in gazebo software which is a Linux based simulation software. Robot Operating System (ROS) is a widely accepted meta operating system to develop and control a wide variety of robots. Also, ROS supports Gazebo, a robotic physics-based simulator essential to prototype, debug and develop the control, planning, and AI algorithms. In the simulation, ROS navigation is used to generate the trajectory for the UAV, and it follows a local goal. The trajectory is then tracked using the

ISBN: 978-93-5437-776-1

pure pursuit controller. To map the surrounding, the Hector SLAM package is used. Hector SLAM uses a probabilistic grid-based approach towards mapping the environment.
Packages for various sensors like the IMU and LiDAR were installed. An environment was created in the Gazebo simulator and various obstacles were placed in form of walls to test the path planning and obstacle detection of the UAV.
A GUI was setup which stored and assessed the various sensors.

Fig. 2 Gazebo environment of UAV

Fig. 3 Perception by UAV in Gazebo environment



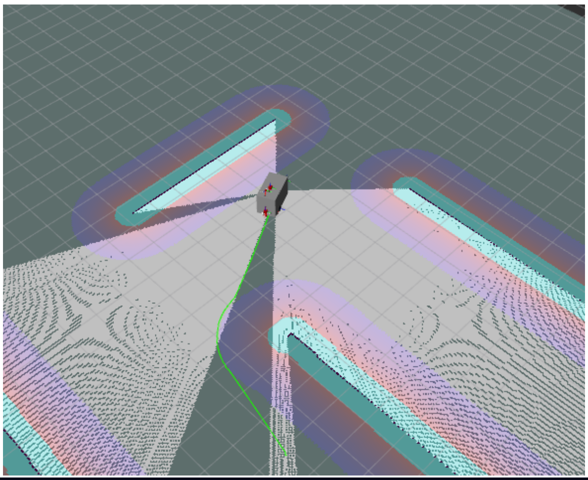


Fig. 4GUI sensor data

For the hardware implementation the main microcontroller used for Machine learning and computer vision is the Raspberry Pi in the UAV. The Rpi cam is interfaced with the microcontroller and is used for computer vision. The python library OpenCV is used for computer vision. Obstacles are detected using computer vision which accordingly varies the motor speed. The secondary microcontroller used is the Arduino UNO, which is interfaced with the GPS module (Adafruit ultimate GPS), Xbee RF Transmission module, Ultrasonic Sensor (HCSR-05), and SD Card. The Ultrasonic Sensor is also used for close-range obstacle detection. The GPS module is used to navigate the UAV to the desired GPS coordinates. The data collected is sent by the RF transmission module to a custom build JavaScript-based GUI. The data is also stored in an SD card.

V. SOCIAL IMPACT

UAVs are one of the most anticipated technologies which open various doors of development with a wide range of social applications. Our goal with this project was mainly eliminating human labour during a time of crisis and to provide assistance for the ones in need. UAVs can reach out at the required locations and provide the necessary medical assistance or food-related aidwhich can result in minimizing the risk involved not only for the people at the delivering end by at the receiving end as well.
UAV is equipped with some advanced technologies including GPS, R pi camera which is of immense help during natural calamities, an accident report containing the cause of an accident, people injured can be generated using the same.
Unmanned vehicles have become a blessing for humans in these years. Technology advancement has had a huge impact on human life in numerous ways and one of the most important ones is the development of disaster robotics or the use of UAVs for safe and convenient disaster management.
Every disaster puts forth a different issue, but the experience of using UAVs for the COVID-19 pandemic gives an opportunity to finally learn important and much awaited lessons documented over the past 20 years. One of them is that during a disaster UAVs do not replace people. They either perform tasks that a person could not do or do safely or take on tasks that free up responders to handle the increased workload.
Most UAVs which are used in hospitals treating COVID-19 patients have not replaced health care professionals. These robots are operated by professionals, making it possible for the health care workers to apply their expertise and compassion to sick and isolated patients solely. The UAVs will greatly help the existing hospital staff cope with the rise in infectious patients. The carts would reduce the amount of time and personal protective equipment nurses and aides must spend on ancillary tasks. Specially equipped UAVs can disinfect rooms and deliver meals or prescriptions, and can handle the hidden extra work associated with a surge in patients. Delivery vehicles can transport infectious samples to laboratories for testing.
UAVs outfitted with sensors would allow doctors and nurses to take temperatures, measure respiration, and even monitor blood oxygen levels without being in the same room as a patient.
Everyone is not entirelyconvinced that a new robot era is dawning. People point out that "autonomous" vehicles will often need a human supervisor to jump in when the machine is faced by the obstacles of navigating streets, hospitals, warehouses, or homes. For now, most of the work COVID-19 created—inpatient care, delivery, enforcement, and other areas—is still performed by people. A different concern is that bots may proveto be too good at what they do—that they will permit massive surveillance and privacy violation, or that they'll make it too easy to do harm to the environment in the name of pandemic response.
Then, as always with robots, there are fears for people's jobs. In the spring, as the pandemic was ramping up, employers

 ISBN: 978-93-5437-776-1

adopting robots were focused on protecting their employees, not replacing them. That may be changing soon though. Still, people around the world appear more willing than ever to let UAVs do work once done by humans. The COVID-19 pandemic has launched a global experiment in how, where, and why to insert UAVs into daily life.

VI. RESULT

Applications of UAVs in the field of medicine & beyond are broad and we have just begun to explore their immense potential. The above-shown simulations prove that the various systems installed on the UAV will work together to provide the desired output. We have employed various components & sensors efficiently keeping in mind the minimum needs we want the module to fulfill UAV and budget constraints. As with any emerging technology and due to the highly regulated healthcare environment, the safety and effectiveness of this technology need to be thoroughly discussed. Despite the many questions that need to be answered, the application of drones in medicine appears to be promising and can both increase the quality and accessibility of healthcare.

REFERENCES

[1] Targeted Applications of Unmanned Aerial Vehicles in telemedicine.- Kunj Bhatt, Ali Pourmand, and Neal Sikka.

[2] Huang, Hui-Min (September 2004). Autonomy Levels for Unmanned Systems (ALFUS) Framework. Volume I: Terminology. National Institute of Standards and Technology.

[3] Unmanned Autonomous Vehicles-John W. Lane ; Johannes B. Stoll

[4] Koenig, Nathan, and Andrew Howard. "Design and use paradigms for gazebo, an open-source multi-robot simulator." *2004 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) (IEEE Cat. No. 04CH37566)*. Vol. 3. IEEE, 2004.

[5] Kohlbrecher, Stefan, et al. "Hector open source modules for autonomous mapping and navigation with rescue robots." Robot Soccer World Cup. Springer, Berlin, Heidelberg, 2013.

[6] An Embedded Real-Time Pedestrian Detection System Using an Infrared Camera Robert Walczyk* Alistair Armitage** T. David Binnie***

[7] Detection and Tracking in Thermal Infrared Imagery Amanda Berg

 ISBN: 978-93-5437-776-1