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Application of Drone Technology in Evacuation Guidance and Emergency Support

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Abstract- Currently, drone technology is not widely applied in the emergency sector due to the high cost of implementation, and limited capabilities in terms of first response, where the drone is mainly used to collect data and provide a live feed. Drones are mostly seen as reconnaissance tools, unable to perform any vital "boots on the ground work". However a possible scope for drones in certain evacuation and emergency situations exists, which is explored in this paper. To support and analyze the use of such drones, using a novel prototype drone, combining both a bluetooth module and flight controller in separate systems, was built and deployed for a relatively low cost to demonstrate the applications of the technology in real-world scenarios.

Index Terms- Disaster, Drones, UAV

I. INTRODUCTION

Drones, or Unmanned Aerial Vehicles (UAVs), have stemmed from traditionally military backgrounds, rapidly evolving and being applied in various industries and fields the past 20 years: from Agriculture, Environmental, Health, Photography and Cinema, Mapping, Logistics, Conservation and many more [1]. However, the implementation of Drone technology in a vital field, emergency response, is limited to mapping and searching [2].

Rescue missions using drones have been proven incredibly difficult, oftentimes impossible due to weight limitations, legislation issues to ensure safe and regulated use [3]. Even the more popular reconnaissance drones are accompanied by a high cost, often reaching nearly USD 10,00, not including software and hardware needed to analyze the data collected [4]. However, the merits in using drones for emergencies come in the form of a much faster response time[5] to human response, such as EMS, or accessing locations inaccessible to human services [2]. The lack of success and limited implementation of drones in disaster management is in large part due to the majority of drones trying to imitate human response services, when instead application of drone technology to situations in which a fast response time is elementary, sensory capabilities are unnecessary, and access to human response is limited, may be more fruitful. To explore this idea, a prototype drone was built for these use-case scenarios.

II. DRONE PROTOTYPE

The emergency guidance drone prototype is split into 2 separate systems based on the function played by each particular system. First, there is the actual drone itself, controlled via a transmitter, receiver and flight controller as the main communication pathway. The second system which was to fulfill the 'emergency signaling' purpose of the drone was a separate emergency mechanism built using an Arduino UNO board which received signals through a bluetooth module.

The two systems are then attached together physically on the larger bottom plate of the drone. The novel approach of separating the systems into one controlled by a flight controller and one by a bluetooth module, allowed the cost of the drone to be less and easily replicable.

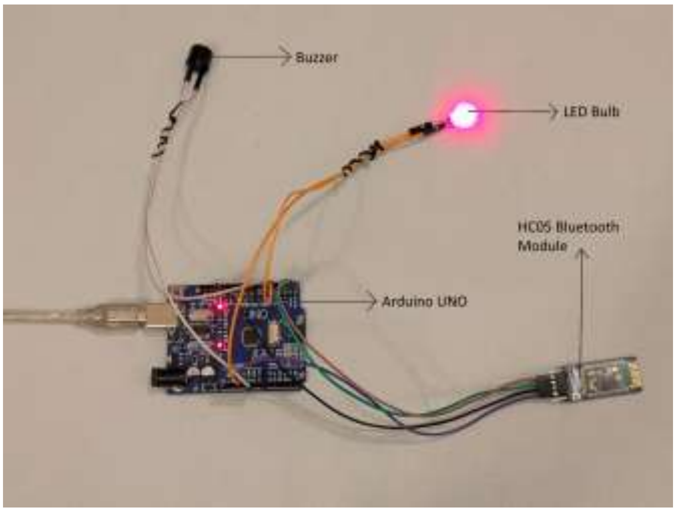

Fig 1: Photo of Arduino System

Fig 1 depicts the emergency signaling system as one component of the 2-part system. Using the Bluetooth module, the buzzer and LED help signal distress/evacuation upon the user's command via a bluetooth message from a phone.

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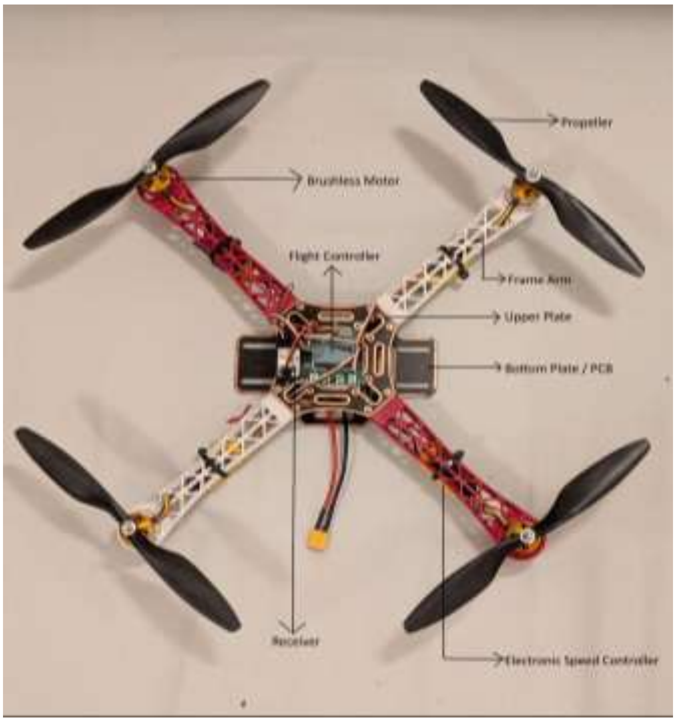

Fig 2: Photo of Drone Prototype

Fig 2 represents the second system in the 2-part system, which is the actual drone and flight mechanism. Here the motion of the drone is commanded by a transmitter, to a receiver, to the flight controller, which controls the ESCs and the brushless motors.

Components Used

- **Flight Controller:** A KK 1.2.5 flight controller was used to control the motion of the drones.
- **Electronic Speed Controller (ESCs):** 4x ESCs were used in the building of the drone to control motor speed via Flight Controller Instruction.
- **Motors:** 4x a2212/13t 1000kV brushless motors were used.
- **Propellers:** 4x 4.7 inch plastic carbon fiber propellers were used for creating thrust in the drone.
- **Frame:** A F450 frame of width 45cm was used with bottom PCB having dimensions 11cm*18cm, and upper plate having dimensions 10.75cm*10.75cm.
- **Battery:** A poly lithium battery of 2200 mAh was used to power the drone.
- **Receiver:** A FSR6B 2.4GHz receiver was used to receive the remote control signals from a FS-CT6B.
- **Transmitter:** A FS-CT6B 2.4Ghz 6 Channel Transmitter was utilized to send signals to the drone to be received via a FSR6B.
- **Arduino UNO:** An Arduino UNO was utilized to control the emergency signaling system physically attached to the drone via bluetooth.
- **Bluetooth Module:** A HC05 bluetooth module was used to collect input from an Android phone and similarly give output through the Arduino system attached to the drone.
- **Emergency Signaling:** A buzzer and LED was used to signify emergencies upon receiving bluetooth signal from HC05 module through the Arduino UNO

III. METHODOLOGY

The principle behind the drone prototype's working is the unique bluetooth module and flight controller 2-pathway signaling which has been implemented in the drone. The emergency signaling system works via a bluetooth message from an android phone, eventually reaching the Arduino UNO, which displays the distress signals.

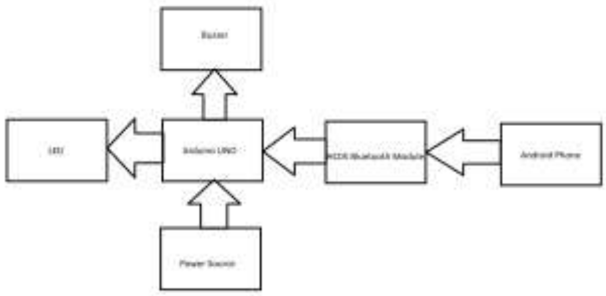

Fig 3: Block Diagram of Arduino UNO Signal Transmission

Fig 3, depicts the signal transmission undergone to eventually display the emergency buzzer/LED signal. At first a text message is sent from an android phone, which is then received by the HC05 module via bluetooth signal. The HC05 then relays the information to the Arduino UNO via USART. Depending on the text message received by the UNO (either '0', '1', '2', or '3'), the Arduino UNO board, connected to a power supply, activates the appropriate serial pin to activate or deactivate the buzzer and/or the led.

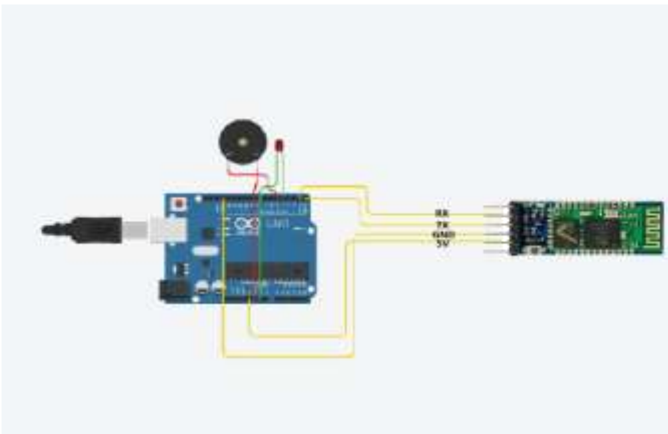

Fig 4: Arduino UNO Connections Diagram.

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As seen in Fig 4, when the relevant text message is received from the android phone, the UNO board activates the emergency signaling. When a text to activate the LED is sent, the 4th serial pin in the Arduino UNO board is activated, lighting up the LED bulb. Similarly, when the text message to activate the buzzer is sent, the 5th serial pin in the board is activated, powering the buzzer.

Fig 5: Image of Communication with HC05 via Android Phone.

In Fig 5, we can see the demonstration and working of the Arduino UNO system through the app 'Arduino Bluetooth' available on android phones.

When the phone is connected to the HC05 module via bluetooth, specific text messages as coded into the Arduino UNO board will activate/deactivate certain serial pins. Specifically, the text message '1' from the phone will activate the LED, while '0' deactivates the LED. Similarly, the message '2' from the phone activates the buzzer with '3' deactivating the buzzer. This allows for independent individual control of both the forms of emergency signaling, which means both can be activated together or individually as and when it is necessitated.

Fig 6: Code Excerpt for Arduino UNO System

The code excerpt in Fig 6, shows the program which was 'loaded' onto the Arduino system. Clearly, when the incoming data from the android phone matches one of the conditions, the appropriate serial pin is activated/deactivated, while displaying the necessary serial output for the user. The baud rate for communication is set to 9600, as it is the standard rate to communicate with the HC05 module attached to the Arduino. By sending the necessary text activation, the emergency distress signals can be effectively activated through the Arduino system which has been physically attached to the drone frame.

However, the Arduino system is just 1 part of the combined emergency drone prototype. The other form of signal communication that occurs through the drone is through a transmitter, receiver, and flight controller, to control the motion of the drone itself.

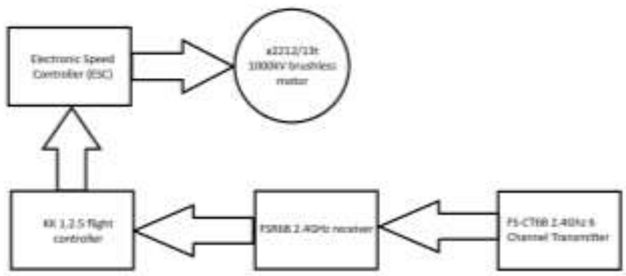

Fig 7: Block Diagram of Drone Signal Transmission Journey

As shown in Fig 7, the drone's motion is connected via a transmitter which the user is manipulating. Any signals from the FS-CT6B remote control transmitter is sent at a 2.4 GHz frequency, to a FSR6B receiver. Upon the FSR6B receiving these signals from the transmitter, it communicates the signal to the KK 1.2.5 flight controller which has been utilized. The flight controller is connected to the electronic speed controllers (ESCs) which have been soldered to the base of the drone's PCB. The signals are then converted to motion when relayed to the motors via the ESC, upon which flight commences due to the thrust provided by the propellers attached to the motors.

Hence the methodology of the drone involves a novel dual signal connection, one via a flight controller, and one via a bluetooth module to effectively combine emergency services into a drone for a cheap cost.

IV. APPLICATIONS

The primary purpose of using the designed drone technology would be when human response is delayed or first response is inaccessible, when first responders are unable to reach the site of emergency.

In such cases, the drone may prove to be an effective solution. It was not designed with the intent of physical or medical assistance to victims, nor was it designed to scope data and analyze emergency situations as most other emergency drones are designed to do.

Instead, the drone prototype and design was built with the purpose of evacuation and emergency guidance at the forefront. As the cost of the drone is low, trading in sensory capabilities for a cheaper build, the drone can easily be deployed in a large quantity for a low cost, making it an effective solution for mass evacuation of people. With its primary advantage and purpose also being a quick response time, the application of the drone would also come useful in situations such as evacuation in wartime crisis, or natural disasters.

As the drone has both visual and auditory signaling, the drone can be used to send instructions and messages, through audio messages or announcements through a speaker, or morse code signal. Additionally, the drone can be used for guidance, such as guiding people to the nearest bunker, instructions on how to proceed in an emergency, ect.

Essentially, the drone would perform the most effectively in guiding people during war-time battlezones, where human intervention may be lethal not fast enough; guidance of a large population during natural disasters, for many of the same reasons; and emergencies in rural areas, where fast response times are necessitated, and human contact may be less.

V. CONCLUSION

In conclusion, the novel approach of combining both a bluetooth module powered Arduino system for emergency signaling, as well as a flight controlled power drone, stripped of most sensory capabilities, leads to a cheap evacuation drone which can most effectively be applied in mass evacuations at a low cost remote guidance and help during crisis such as war battlefields or natural disasters, and assistance to people who are in remote areas, where human first response may be dangerous and/or delayed. The application of this drone would be in a new area not previously explored, in contrast to the traditional application of drones during emergency as a sensory and scoping technology, or a delivery and medical assistance technology. Diametric to these applications, this prototype shows the scope of a cost effective solution to prevent harm through warnings and signals during emergency and remote assistance wherever best applicable through guidance.

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