Faculty of Engineering & Technology Electrical & Computer Engineering Department

Interfacing Techniques – ENCS4380

Autonomous Drone with Infrared Camera to Assist First Responders

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The concept

The main concept of this project is to design smart system to help during disasters. This system uses special cameras and computer smarts to guide a flying robot. The robot's job is to quickly and by itself, fly around disaster areas, find people who need help, figure out where they are, and tell rescue teams where to go. We're making sure it can work fast, stay in the air for a good amount of time, and avoid crashing into things. This way, it can search buildings and help save lives efficiently.

How The System Work

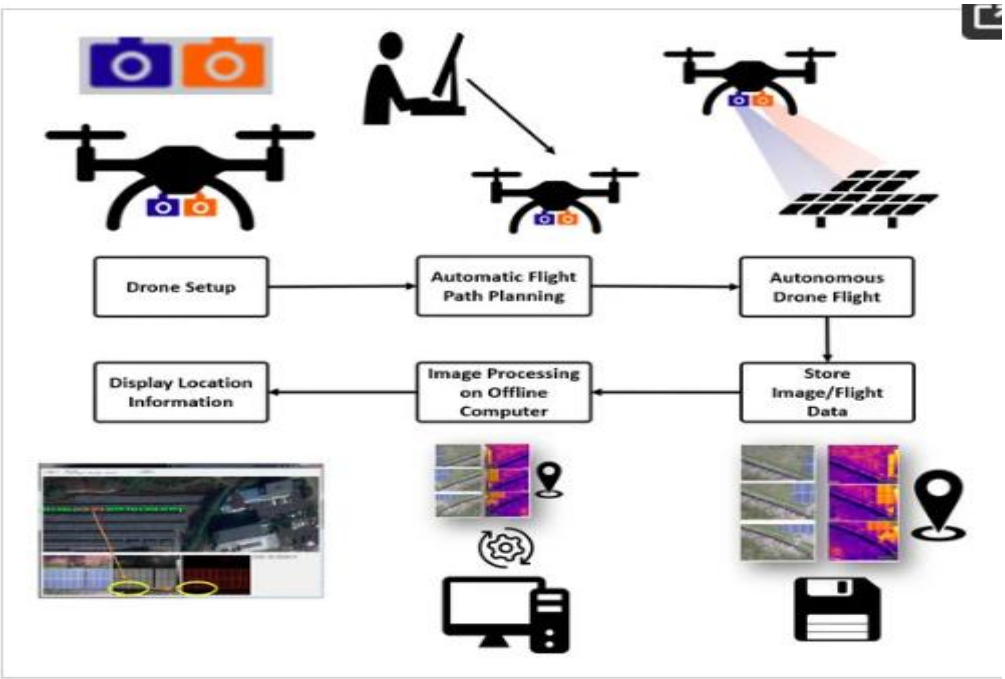

Figure 1: Block diagram of overall system

Sensors

- **Kinect V1**: Can track 3D objects easily up to 6 meters away.
- **Realsense D435**: Has 2 infrared cameras and a Red, Green, Blue, Depth (RGB-D) camera for high precision 3D object detection up to 25 meters away. It is 6 cm wide allowing for easy fit in quadcopter

- **LIDAR**: Beam that can track locations up to 40 meters away in its line of sight.
- **SONAR**: Beam that can track 15 m away but is able to detect transparent objects like glass and acrylic
- **Ultrasonic**: Has a range of up to 3 m and is very inexpensive
- **FLIR Camera**: Able to take depth pictures through smoke without interference and can detect living people through heat signatures
- **PIR Sensor**: Able to detect change in temperature

Microcontrollers

- **Raspberry Pi**: can detect walls and fixed objects
- **Rock64**: able to detect walls and entrances with little latency.
- **Intel Edison**: Able to detect walls and entrances with some lag
- **DJI Naza**: Has integrated gyroscope, accelerometer, and magnetometer, to allow for quadcopter to be stable in the air with micro adjustments to motor speed
- **Pixhawk**: Compact and compatible with sensors used in project by using the General-Purpose Input Output (GPIO)

Actuators

Brushless Motors: These motors are commonly used in quadcopters and can control the rotation of propellers to provide thrust and maneuverability.

Servo Motors: Servo motors can be used for controlling specific functions or mechanisms on the drone, such as tilting the camera or adjusting the angle of sensors.

Electronic Speed Controllers (ESCs): ESCs are used to control the speed of brushless motors and can help in precise movement and stabilization of the drone.

Algorithm where Intelligence is utilized

- **Initialization**: Start the system and sensors.
- **Environment Mapping**: Create a digital map using AI and sensor data.
- **Autonomous Navigation**: Enable the drone to navigate autonomously while avoiding obstacles.
- **Survivor Detection**: Use AI to detect survivors based on heat signatures and movements.
- **Localization and Mapping**: Pinpoint survivor locations and update the map.
- **Communication**: Establish communication with first responders.
- **Optimized Scanning**: Plan efficient scanning routes and prioritize survivor areas.
- **Continuous Monitoring**: Monitor system and battery status.
- **Emergency Notifications**: Send real-time survivor location updates to first responders.
- **Emergency Response**: Aid first responders in planning and executing rescue operations.
- **Mission Completion**: Conclude the mission safely.
- **Data Analysis**: Analyze data for system improvement.

Layout and Assembly

Figure 2: Autonomous Quadcopter Drone

Figure 3: System Development

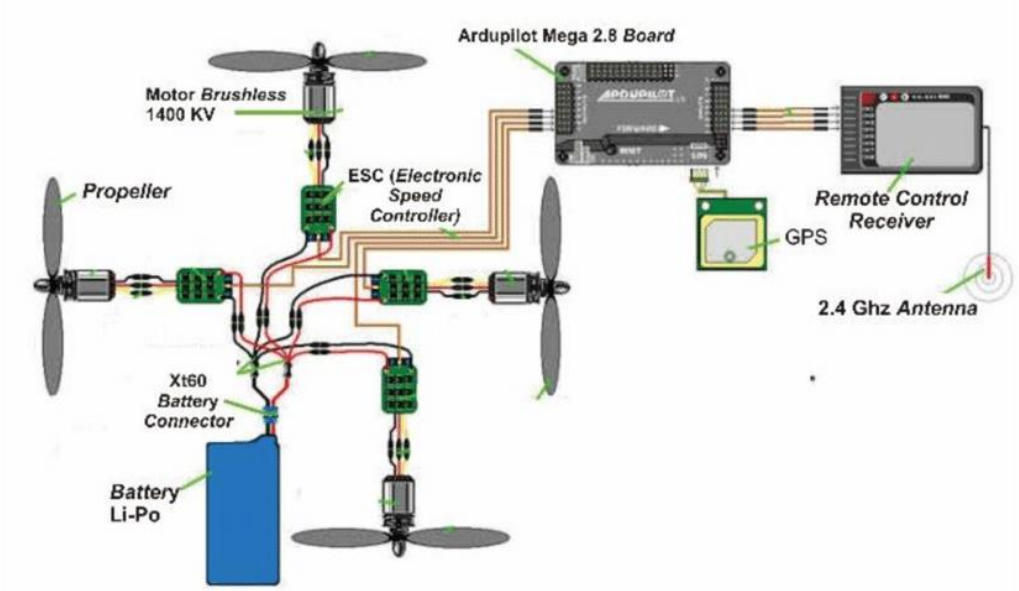

Figure 4: Circuit of Quadcopter Components

System Evaluation

Accuracy: The system was assessed for its ability to accurately detect survivors, obstacles, and temperature variations. The evaluation considered how well the system distinguished between humans and non-living objects.

Response Time: Response time was a critical parameter assessed during the evaluation. The system's capability to detect and respond to emergencies rapidly was closely examined, as quick responses are essential in disaster scenarios.

Reliability: The system's reliability under various environmental conditions and real-world disaster scenarios was evaluated. This included assessing its performance in different types of buildings, lighting conditions, and obstacle-laden environments.

Range: The system's detection range was assessed, specifically its ability to identify hallways and entrances from a minimum distance of 5 meters. The evaluation considered the ideal minimum range of 0.25 meters for close-range object detection.

Duration of Operation: The system's operational duration was tested to determine its ability to last for at least 10 minutes, taking into account the number of rooms it needed to scan during this time.

Speed: Scanning speed was assessed to ensure the system could efficiently scan entire buildings in less than 10 minutes. Quick scanning capabilities are crucial for expediting the rescue process.

References

[1] https://www.instructables.com/Autonomous-Drone-With-Infrared-Camera-to-Assist-Fi/. Accessed on 7-10-2023 at 11:50 AM.