**High Level Project Summary -**

Wildfires pose a significant and growing threat to communities and ecosystems worldwide. Traditional fire management strategies have often relied on centralized approaches, but a paradigm shift towards community-based fire management is gaining momentum. This abstract explores the concept of community-based fire management and its potential to enhance wildfire resilience. It highlights the importance of empowering local communities to take an active role in mitigating wildfire risks, emphasizing the benefits of localized knowledge, cultural practices, and collaborative efforts. The abstract also discusses the challenges and opportunities associated with implementing community-based fire management, including the need for policy support, capacity building, and inclusive decision-making processes.

We Developed user-friendly mobile applications that enable local communities to report fires or suspicious smoke in their vicinity. These apps can incorporate geolocation services to pinpoint the fire's location accurately. Users can take photos and provide additional context, which can be automatically uploaded to a centralized database for analysis.

**Detailed Project Description -**

While NASA collects and disseminates valuable data about active fires using satellite technology. These data are a critical resource for monitoring and managing wildfires, as they offer insights into the location, size, and intensity of fires in near real-time. The challenge is to create innovative ways to collect data from the drones.

Wildfires are becoming more frequent, numerous, and larger in scale due to a combination of factors, including climate change, land management practices, and population growth in fire-prone areas. This trend poses a growing threat to communities and ecosystems. To address this challenge, innovative technology solutions are needed. These solutions should be user-friendly, accessible, and capable of harnessing publicly available data to enhance fire monitoring, reporting, and response.

The problem statement highlights the urgency of addressing the increasing wildfire threat by democratizing access to and utilization of NASA's satellite-derived fire data. This involves developing innovative technological solutions and improving data distribution methods to engage a more diverse range of stakeholders, especially local communities, in the effort to monitor, report, and respond to wildfires effectively.

* Solution

We plan to solve the problem statement by implementing and applying various concepts into a single App-based interface. The App will be a result of application of concepts like Tensor RT, NumPy, PID Controller and CNN Model, open CV. The front-end incorporates various tools like HTML, CSS and Figma. The Hardware used is Jetson nano 4G.

* Process: -

The control system takes the sensor data from the sensors described above and will process these into positional movement commands that the quad copter can perform. In the Take-Off state the quad copter will perform flight checks. After this the quad copter will arm its motors and takeoff. The state is excited when the quad copter reaches it target altitude. In the Search state the quad copter will attempt to find a fire to track. First the quad copter hovers for 10 seconds in the same location while running an AI based object detection model to find a fire detection in the thermal camera view. If after 10 seconds no valid detection’s are found, then the quad copter will perform a slow rotation in the yaw axis to find a detection. If after 80% battery drained , then the quad copter will go to the Land state . If a valid detection is found then the quad copter will go into the Track state. In the Track state the quad copter will run the main vision(OpenCV) and control algorithms described in section Vision And Control. The quad copter will use the sensor data from the lidar and thermal camera to keep the fire the center of the quad copter. If the fire is lost during tracking, then the quad copter will return to the Search state. In the Land state the quad copter will perform a landing in the power station using frequency modulation. After landing its start charging itself.

The Vision and Control system is responsible for processing the sensor data and converting this data into usable movement commands for the quad copter’s flight computer (jetson nan0 4g). The system proposed in this document is explained below. First the raw camera feed is read using a CSIZ interface (camera serial interface) and down scaled to 300 \* 300 pixels. After this a TensorRT optimized CNN model from Google called Mobile-net is used to find objects in the camera feed. the detection’s are filtered to only include humans. From the list with detection’s the first detection is used. From this detection the 4 corner coordinates of the surrounding bounding box are used to calculate the center point of the detection. A second static point that represents the center of the camera feed has been created at the startup of the system. This static point represents the quad copters heading since the camera is mounted in line with the front of the quad copter. The distance between the two center points in the X axis is calculated. This distance becomes larger when the detection is further away from the center of the drone and becomes closer when the detection is closer to the center of the drone. This makes the value suitable for the yaw control. To enable control in 3 dimensions, depth vision is needed. This is achieved using the solid state Lidar mounted in the same direction as the thermal camera. This Lidar is positioned and calibrated such that the center point of the thermal camera feed overlaps the 2.5cm\*2.5cm IR square of the Lidar at a distance of 2.5 meter. This makes that the object where the center of the thermal camera feed is pointed has the distance given by the Lidar at that moment. To make sure the Lidar only gives valid depth information when the lidar is pointed the fire, the Lidar distance will only be used when the center of the thermal camera is within the bounding box of the detection being tracked. Since the lidar distance represents the distance between the quad copter and the fire being tracked, it can be used for controlling the pitch axis.

The center point distance and the Lidar distance are both filtered using two separate moving average filters of 5 steps. This removes spikes in the raw data because of for example faulty model detection’s or faulty Lidar data such that they don’t disturb the control of the quad copter. The distances for yaw and pitch are then fed into their respective separate PID controller. Both PID controllers where manually tuned by visual observation and by recording the yaw and pitch responses to later plot these for finer adjustment. The results from the PID controllers are the speed in m/s for the pitch axis and the difference in heading between the current heading and desired heading in degree. These values are both send to the quad copter to finalize the control loop. Because of optimizations in the entire loop, the system is capable of running at an average of 24hz. The altitude is kept static using a PID controller located in the flight computer. The main control loop described above is separate from the control loop for altitude control.

* Future Scope
* We are going to increase the response time of the Drone
* Give the access for the local users
* Improve the response of Drone
* Carrying sodium Azide and sodium bicarbonate to use it as an alternate source for controlling forest fire.

**Hackathon Journey -**

The overall experience of the space apps challenge has been a constant learning process. We registered under the Bengaluru local event and the atmosphere provided to us at Jain(deemed-to-be-university) was very enthusiastic and motivating which made us go a step beyond what we thought we could do.

We chose this challenge because we already have worked on this autonomous charging drones and the deep learning model which was trained to analyse the thermal image with each degree variations. We would like to thank our local lead Mr Sundar M.N for continuous guidance and support throughout the hackathon. we would also like to thanks all the other mentors from various other fields for giving us their valuable feedback

**Space Agency Data -**

We used some data from NASA for inspiration and guidelines -

We used [**Deep Space Habitability Design Guidelines Based on the NASA NextSTEP Phase 2 Ground Test Program**](https://ntrs.nasa.gov/api/citations/20200001427/downloads/20200001427.pdf) for **guidelines on outfitting a space habitat**.

We also used [**Project Olympus: Off-World Additive Construction for Lunar Surface Infrastructure**](https://ttu-ir.tdl.org/handle/2346/87095) for **inspiration regarding dust barriers and habitat protection.**

**References –**

Problem statement: <https://www.spaceappschallenge.org/2023/challenges/managing-fire-increasing-community-based-fire-management-opportunities/>

Picture citation[: https://www.paperdesk.in/robot-drones-help-detect-and-prevent-ever-increasing-forest-fires/](:%20https:/www.paperdesk.in/robot-drones-help-detect-and-prevent-ever-increasing-forest-fires/%20)

Picture: Using figma our team created an app

Ideate[: https://spectrum.ieee.org/drones-sensors-wildfire-detection](:%20%20https:/spectrum.ieee.org/drones-sensors-wildfire-detection)

logos: Respective companie’s logos

**Tags -**

#mars #space #space-colonization #mars-colonization #space-journey #design #3D-printing #habitat-outfitting