The Sky's Watchmen: Using Drones to Safeguard Forests

Truman Middle School

Team Members: David Chavira and Carlos Cantu

Mentor: Natali Barreto Baca

April 10, 2024

Executive Summary:

Drones have become indispensable tools in forestry, aiding in various tasks such as prescribed fires, wildfire suppression, forest surveys, and damage assessment. They offer valuable insights and data crucial for effective forest management, enhancing decision-making processes for forest managers like Robert Dogden from the Davy Crockett National Forest in Texas.

The integration of drones in forestry has led to significant improvements in decision-making, resource allocation, and environmental conservation. Equipped with advanced cameras and sensors, drones enable accurate forest monitoring, providing essential data on tree species, health, and overall forest conditions.

Advancements in electronic technology, miniaturization, affordability, and sensor efficiency have fueled the widespread adoption of drones in forestry. They supplement traditional data capture methods, offering unique perspectives and additional information for enhanced data quality and collection efficiency.

Drones serve a multitude of purposes in forestry, including stand delineation, forest structure estimation, wildfire detection, ecological mapping, and wildlife monitoring. They provide detailed maps of forested areas, aiding in reforestation efforts, logging operations planning, and wildfire monitoring and research.

We propose an innovative forest fire prevention system using drones, aiming to leverage drone technology for real-time fire detection and mitigation. The project seeks to develop a comprehensive system for early fire detection, rapid response, and data-driven decision-making to minimize the ecological and economic losses associated with wildfires.

The implementation of this forest fire prevention system involves establishing a coordination plan for sharing real-time data with emergency services, conducting community awareness programs, providing emergency response training, implementing secure data storage solutions, integrating weather data, ensuring maintenance and upkeep of drones, collaborating with authorities, and evaluating and continuously improving the system for enhanced effectiveness.

By harnessing the capabilities of drones, we aim to revolutionize forest fire prevention and response, safeguarding our forests, wildlife, and communities. This comprehensive plan integrates cutting-edge technology with strategic collaboration and continuous improvement efforts to mitigate the devastating impacts of wildfires on our natural environment and society.

Introduction

"Drones are our eyes in the sky. We use them to conduct prescribed fires, suppress wildfire, survey forests, assess damages after a storm and generally manage forests," said Robert Dogden, fire management officer on the Davy Crockett National Forest in Texas. "Drones are an important tool when used in the right situations and environments."(1)

The integration of drones in forestry has led to improved decision-making for forest managers, more efficient resource allocation, and reduced environmental impacts. Drones equipped with high-resolution cameras and sensors enable accurate and efficient forest monitoring and inventory. They provide crucial data on tree species, height, and diameter, as well as overall forest health. (2)

Drones are becoming more widely used due to advancement of electronic technology, miniaturization, affordability, efficiency of cameras and sensors, and improved battery power. Drones can serve as a valuable supplement to conventional data capture methods in the forest industry–providing a unique perspective and additional information that can enhance the quality of collected data. In forestry, drones can be used for stand delineation and mapping, harvest planning, forest structure estimation and inventory, carbon inventory, damage assessments, forest disease and pest detection, stand mapping, forest fire detection and post-fire mapping. In addition, drones can also be used for ecological mapping, park management, tourism, topographic modeling, soil erosion mapping, wildlife monitoring, and encroachment/trespass detection. (3)

Drones can be used to create detailed maps of forested areas. These maps can be used for a variety of purposes, such as identifying areas for reforestation or planning logging operations. Using a drone to map a wildfire in the forest can be an efficient and cost-effective way to gather data about the trees and vegetation in a particular area. Drones equipped with cameras and other sensors can collect high-resolution imagery, providing data to create detailed maps of a wildfire. These maps can be used for various purposes, such as monitoring changes in the wildfire or forest over time, identifying areas of deforestation for wildfire or illegal logging, and conducting research on the health and growth of the trees. (4)

Since the 1950s, wildlife ecologists have employed radio telemetry, affixing radio tags to animals and manually tracking their emitted signals. However, this method presented its fair share of challenges. Traversing natural terrains with tracking antennas was labor-intensive, limited the number of animals that could be effectively monitored, and

often distressed the very creatures we aim to protect. In remote and rugged terrains, it even posed risks to field researchers. The good news is that governments and green organizations around the globe are embracing innovative solutions, and at the forefront of this revolution are drones, or Unmanned Aerial Vehicles (UAVs). These aerial marvels, equipped with thermal cameras, offer a safer, cost-effective, and highly efficient alternative. They provide precise data and high-resolution imagery while ensuring minimal disturbance to wildlife.(6)

What Are Wildlife Drones and How Do They Work?

Wildlife drones are unmanned aerial vehicles designed to monitor, track, survey, and protect wildlife and their habitats. They come equipped with advanced technology, including cameras, sensors, and even artificial intelligence, to gather crucial data while minimizing human disturbance. These drones are engineered to navigate diverse terrains, from dense forests to open savannas and challenging landscapes. The global market for wildlife drones is experiencing an incredible surge. In 2022 alone, it raked in a whopping $3.70 billion, and the excitement doesn't stop there. Experts are predicting a steady annual growth rate of 4.90% from 2023 to 2026. This soaring demand underscores the pivotal role wildlife drones play in preserving our planet's diverse and endangered species. (6)

Thermal Cameras: Wildlife drones often have advanced thermal cameras. These cameras can detect and capture heat signatures, enabling researchers to identify and track wildlife even in the cover of darkness or dense foliage. Whether it's a hidden animal or an injured one needing help, thermal cameras play a crucial role.
Remote Sensing Technology: Drones are fitted with remote sensing equipment, including GPS and various environmental sensors. These sensors gather critical data on habitat conditions, weather patterns, and other environmental factors, providing insights into the ecosystem's health and the animals' well-being.
Artificial Intelligence and Machine Learning: Many wildlife drones incorporate AI and machine learning algorithms. These cutting-edge technologies enable drones to analyze the data they collect in real-time, assisting in the identification of species, and animal behavior, and even early detection of threats like poachers.(6)
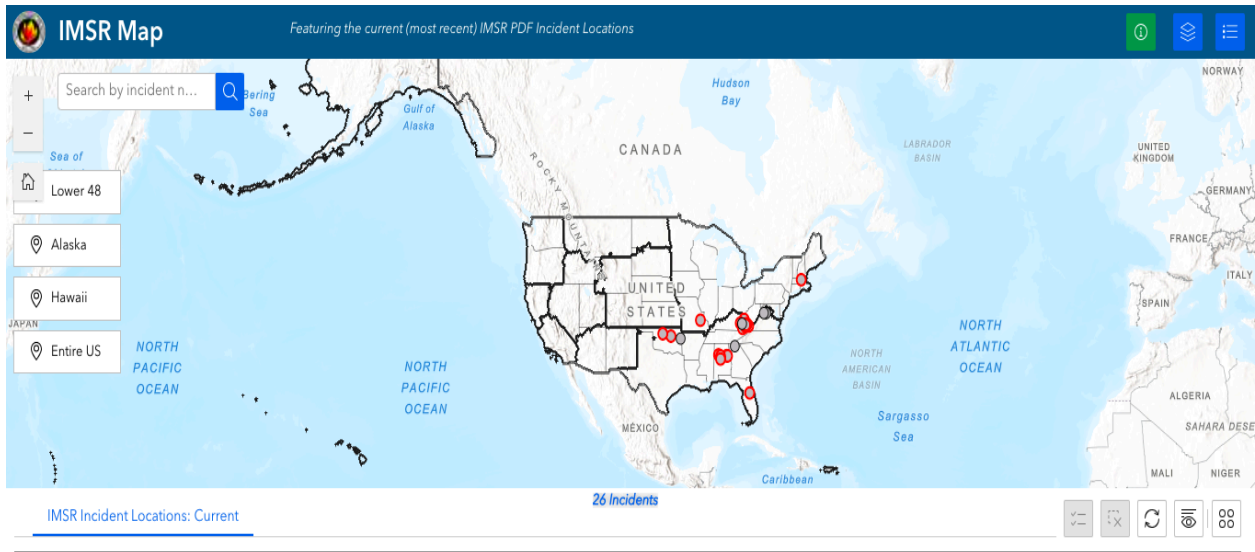
Wildfire Map

Source

IMSR Map

Source IMSR

National Interagency Fire Center
Boise, Idaho

All Social Media | Contact Us

Enter keywords ...

FIRE INFORMATION   OUR RESOURCES   STANDARDS   PROGRAMS   CAREERS   ABOUT US

NATIONAL WILDLAND FIREFIGHTER DAY   NATIONAL FIRE NEWS   NICC   INTERNATIONAL SUPPORT   FOR MEDIA   FIRE PREVENTION   PIO BULLETIN BOARD   INCIWEB

MAPS   NEWS RELEASES   SITUATION REPORT   STATISTICS

Statistics

Current National Statistics

3 Incidents
Total Number of Large Fires

21 Total
New Large Fires

8,433 Incidents
Year-to-date Wildfires

WILDFIRES

1,144 Acres
Acres Burned on Large Fires

425
Personnel Assigned to Wildfires

1,708,429 Acres
Year-to-date Acres Burned

Last Updated: Friday, April 5, 2024 - 08:35

U.S WILDFIRES
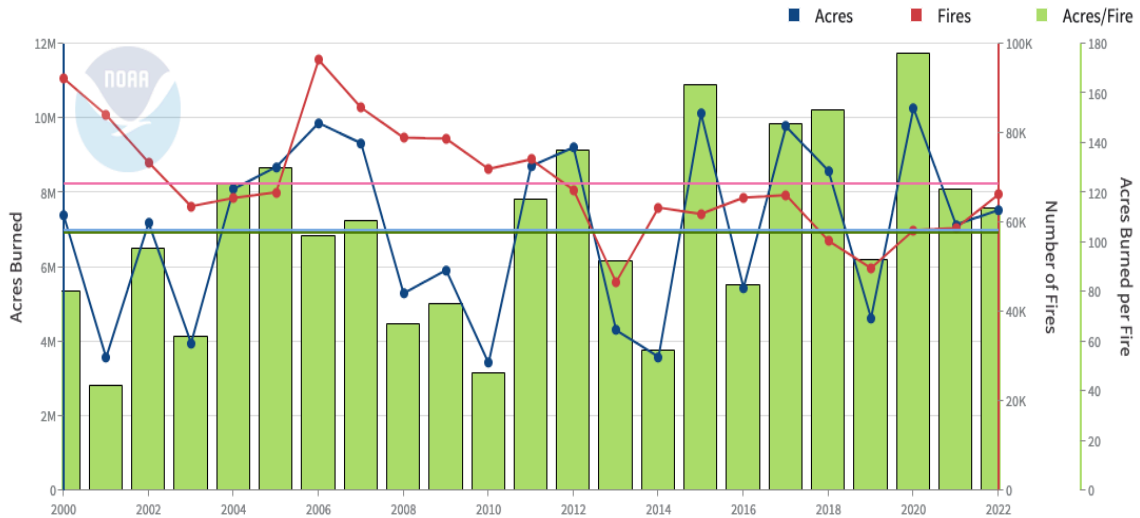
2001-2020 Average: **7,000,513.55** Acres   **68,707.25** Fires   **103.92** Acres/Fire

Source: National Interagency Fire Center (NIFC)

Powered by **ZingChart**

Source National Center for Environmental Information

Year-to-Date Wildfire Statistics

2022	Totals	Rank (out of 23 years)	Record		2001-2020 Average
			Value	Year	
Acres Burned	7,534,403	11th Most	10,274,679	2020	7,000,513.55
		13th Least			
Number of Fires	66,255	12th Most	96,385	2006	68,707.25
		12th Least			
Acres Burned per Fire	113.72	10th Most	176.37	2020	103.92
		14th Least			

Source National Center for Environmental Information

WildFire Simulation NETLOGO
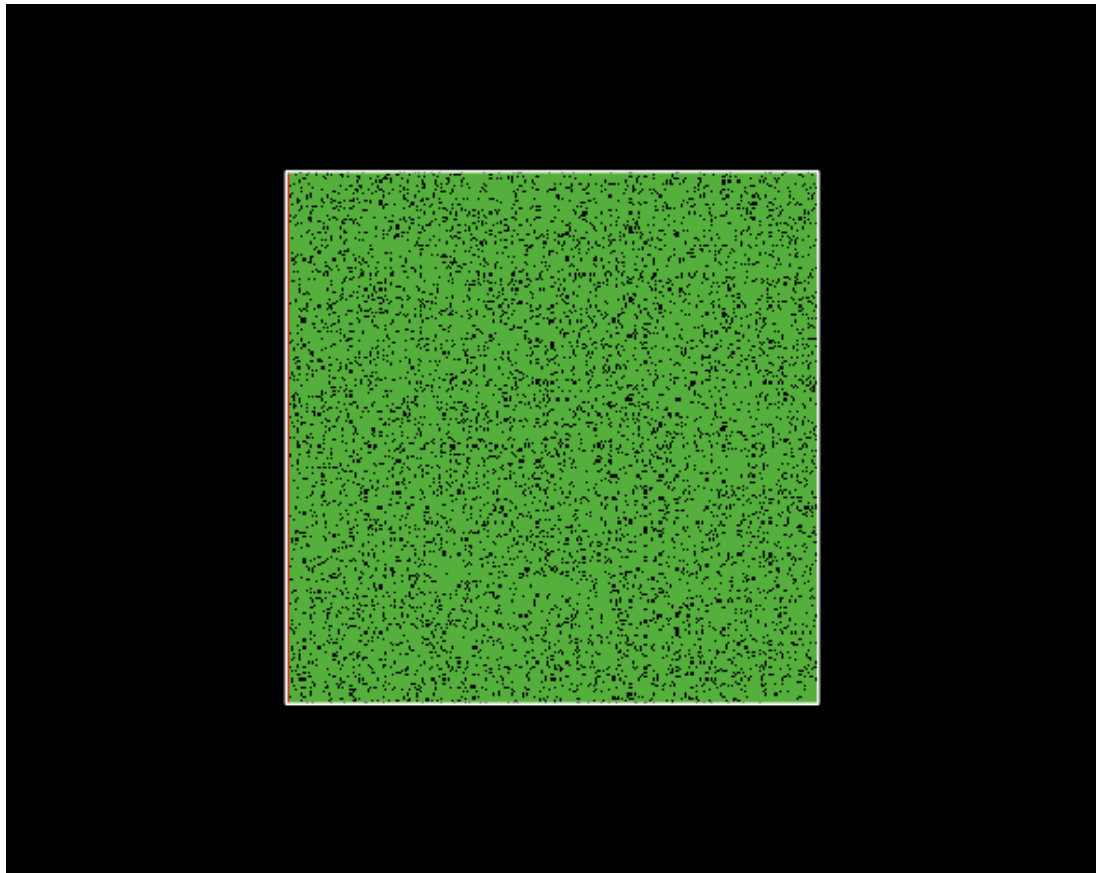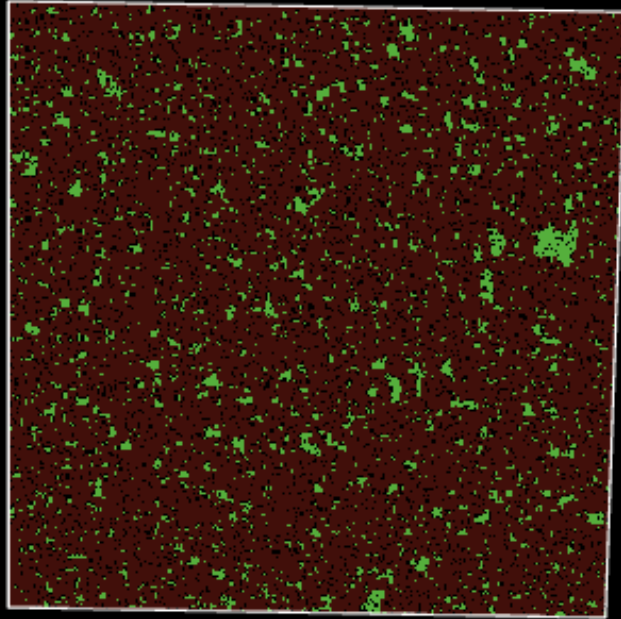
DENSITY 89%
PERCENT BURNED 91.3%
PROBABILITY OF SPREAD 57%
SOUTH WIND SPREED 25%
Source Netlogo

PLAN

We propose the implementation of an innovative forest fire prevention system using drones. The objective of this project is to leverage drone technology to detect and mitigate forest fires in real-time, significantly reducing the risk of extensive damage to our forests and the associated ecological and economic losses.

Background:

Forest fires pose a severe threat to our natural environment, wildlife, and communities. Traditional methods of fire prevention and monitoring have limitations, especially in remote or inaccessible forested areas. Drones equipped with advanced sensors and technology offer a promising solution to enhance early detection and response.

Project Goals:

Develop a drone-based forest fire prevention system.
Implement real-time fire detection using thermal and visual sensors.
Enhance data collection capabilities for fire risk assessment.
Facilitate rapid response and fire suppression through drone deployment.
Collaborate with relevant authorities and organizations for effective implementation.

Drone Technology:

Integrate real-time data transmission capabilities for immediate analysis.
Develop a user-friendly drone control.

Fire Detection Algorithms:

Implement advanced algorithms for real-time fire detection using thermal imaging and visual data.
Establish a robust data analysis pipeline for early warning alerts.

Data Analysis and Reporting:

Develop a dashboard for visualizing data, fire alerts, and historical trends.
Establish communication protocols for alerting relevant authorities.

Project Benefits:

Improved forest fire prevention and early detection.
Reduced ecological and economic losses caused by wildfires.
Enhanced safety for wildlife and local communities.
Data-driven decision-making for fire risk assessment and mitigation.
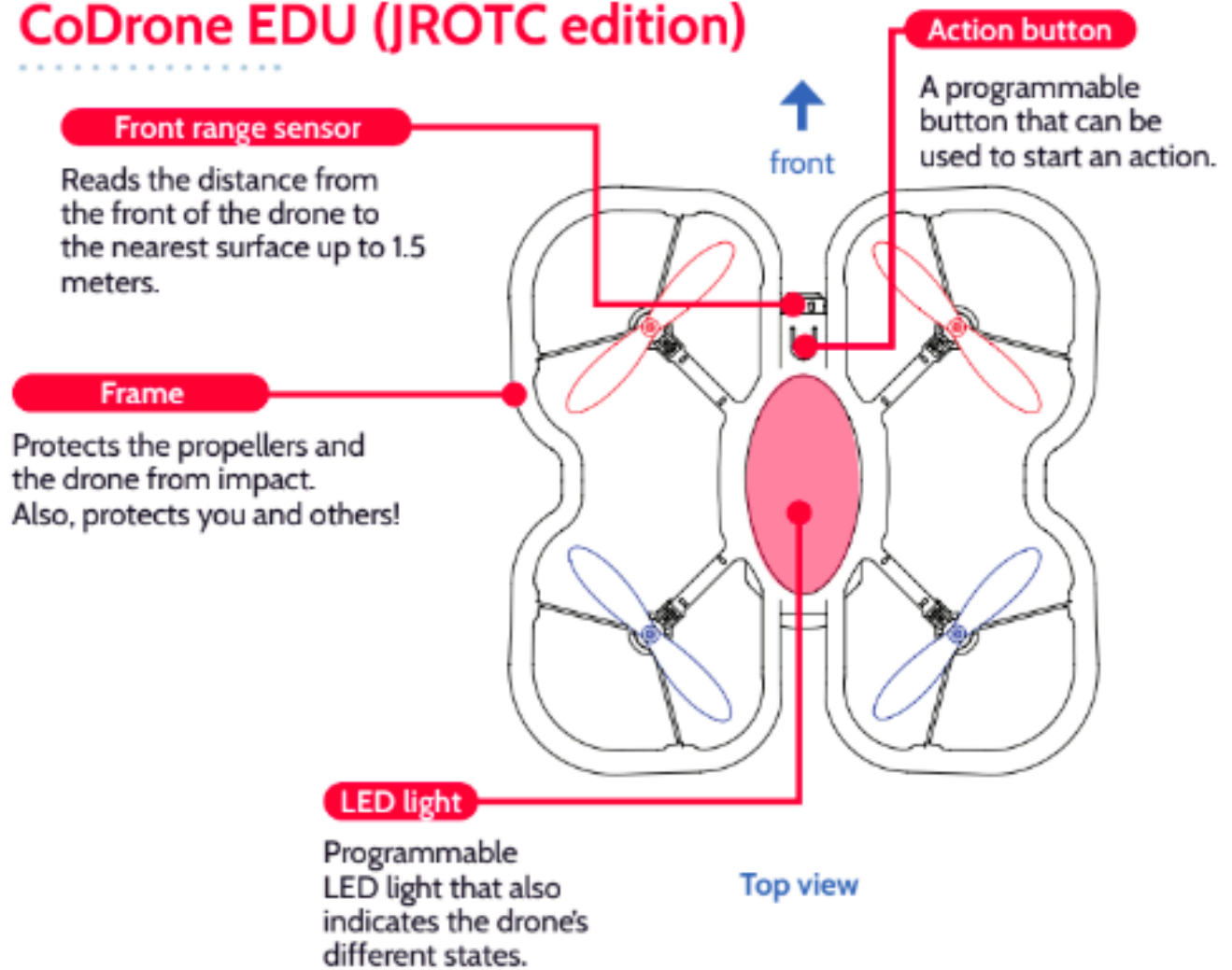Technological innovation and expertise development.

By harnessing drone technology, we aim to revolutionize forest fire prevention and response. This project has the potential to safeguard our forests, wildlife, and communities while providing valuable data for informed decision-making. We seek your support and partnership to make this project a reality and protect our natural heritage.

CoDrone Edu Drone Fire Prevention and Monitoring Plan

Objective:
To leverage Code drones equipped with capabilities for early detection and monitoring to prevent and manage wildfires effectively using sensors.
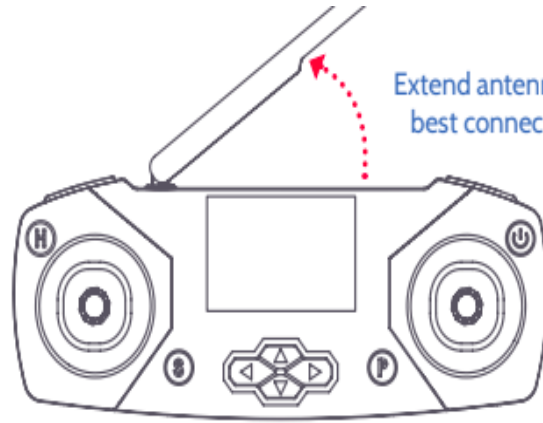
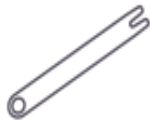## Getting to Know Your CoDrone EDU (JROTC edition)

Front range sensor
Reads the distance from the front of the drone to the nearest surface up to 1.5 meters.

Frame
Protects the propellers and the drone from impact. Also, protects you and others!

Action button
A programmable button that can be used to start an action.

front

LED light
Programmable LED light that also indicates the drone's different states.

Top view

Source (5) Codrones edu
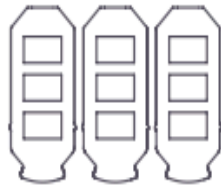
Extend antenna for best connection

front
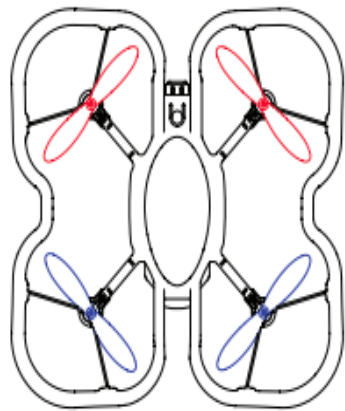
CoDrone EDU (JROTC edition)

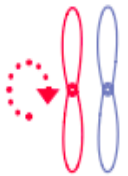Smart Controller (JROTC edition)

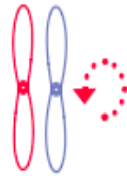Propeller removal tool

Battery x 3

Multi-charger

USB-C cable

clockwise (F)

counter-clockwise (R)

Spare propellers x 4

PB 1.45.0mm / D=2.5   2x

PWB 1.4 * 4 * 4.5mm   2x

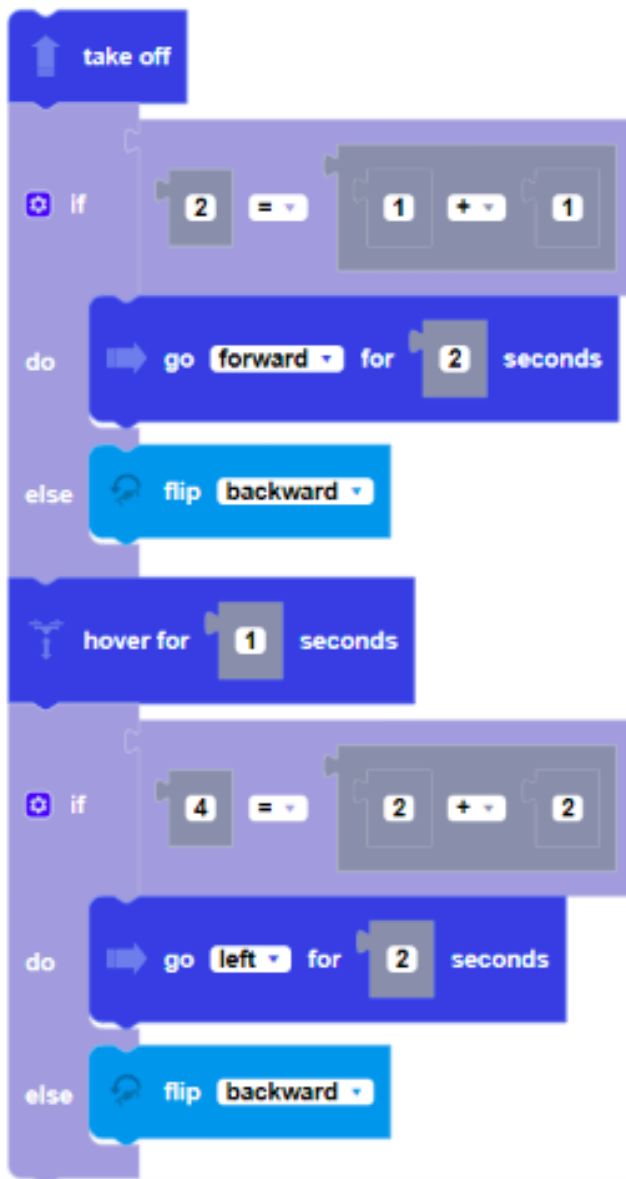Screw driver, spare screws and bolts

Color landing pads x 8

Labels

Source (5) Codrones edu

Using Block to drive the Drone

Example

take off

if 2 = ▾ 1 + ▾ 1

do go forward ▾ for 2 seconds

else flip backward ▾

hover for 1 seconds

if 4 = ▾ 2 + ▾ 2

do go left ▾ for 2 seconds

else flip backward ▾

CoDrone EDU Library Reference

take off

land

emergency stop

hover for [seconds] seconds

hover for 1 second(s)

go [direction] for [seconds] seconds at [power] % power

go forward for 1 second(s) at 50 % power

turn [direction] [degrees] degrees

turn left 90 degrees

turn [direction] for [seconds] seconds at [power]% power

turn left for 1 second(s) at 50 % power

Flight Sequences

flip [direction]

flip back

code is running

code is running

Lights

set drone LED color to [color], with brightness of [brightness]

set drone LED color to [ ] , with a brightness of 255

turn drone LED off

turn drone LED off

set controller LED color to [color], with brightness of [brightness]

set controller LED color to [ ] , with a brightness of 255

turn controller LED off

turn controller LED off

Sound

play this note [note] for [duration] seconds on drone

play this note C3 for 1 second(s) on drone

play this note [note] for [duration] seconds on controller

play this note C3 for 1 second(s) on controller

Source (5) Codrones edu

Components of the Plan:

Drone Deployment:
Strategically position CoDrone drones in high-risk areas prone to wildfires.
Ensure drones are equipped with high-resolution sensors

Surveillance and Monitoring:
Implement regular drone surveillance schedules to monitor designated areas.
Set predefined flight paths to cover a comprehensive range of terrain.
Utilize the CoDrones' sensors capabilities to identify potential fire hazards, such as dry vegetation, smoke, or unusual heat patterns. (5)

RESULTS

- Establish a coordination plan for sharing real-time data with emergency services, enabling a swift and targeted response to potential wildfire threats.
- Conduct community awareness programs to inform residents about the use of Drones for wildfire prevention.
- Provide information on the early warning system and the importance of swift response to alerts.
- Train local emergency responders on the use of drone data for assessing wildfire situations.
- Conduct joint drills to enhance coordination between drone operators and response teams.
- Implement secure data storage solutions for captured imagery and analysis results.
- Periodically analyze historical data to identify trends and further improve wildfire prevention strategies.
- Integrate weather data into the drone system to enhance the accuracy of risk assessments.
- Factor in wind speed, humidity, and other meteorological variables to predict the potential spread of wildfires.
- Establish a routine maintenance schedule for drones to ensure optimal performance.
- Regularly update software and firmware to incorporate the latest advancements in imaging technology and analytics.
- Collaborate with local, state, and federal authorities to align the Tello drone program with existing wildfire prevention and response initiatives.

- Seek input from forestry and environmental agencies to refine the drone deployment strategy based on ecological considerations.
- Regularly assess the effectiveness of the drone fire prevention system through post-implementation evaluations, stakeholder feedback, and performance metrics. Use findings to make necessary adjustments, enhance protocols, and ensure the ongoing improvement of the wildfire prevention plan.

Conclusions and Discussions

The implementation of the forest fire prevention system using drones represents a significant step forward in enhancing wildfire management strategies and mitigating the associated risks. By leveraging drone technology for real-time fire detection and mitigation, we aim to address the pressing challenges posed by wildfires to our forests, wildlife, and communities.

The coordination plan established for sharing real-time data with emergency services ensures a swift and targeted response to potential wildfire threats, enabling effective firefighting efforts and minimizing damage. Community awareness programs play a crucial role in informing residents about the use of drones for wildfire prevention and the importance of prompt response to alerts, fostering a sense of collective responsibility in wildfire management.

Emergency response training for local responders equips them with the necessary skills to utilize drone data for assessing wildfire situations accurately and coordinating response efforts efficiently. Joint drills conducted between drone operators and response teams enhance coordination and preparedness, ensuring a cohesive and effective response to wildfire incidents.

The implementation of secure data storage solutions and periodic analysis of historical data enables us to harness the full potential of drone-collected imagery and analysis results for informed decision-making and continuous improvement of wildfire prevention strategies. Integrating weather data into the drone system enhances the accuracy of risk assessments, allowing us to factor in meteorological variables and predict the potential spread of wildfires more accurately.

Establishing a routine maintenance schedule for drones and collaborating with authorities at local, state, and federal levels ensures the seamless integration of

the drone program with existing wildfire prevention and response initiatives. Seeking input from forestry and environmental agencies facilitates the refinement of drone deployment strategies based on ecological considerations, ensuring minimal impact on natural habitats.

Regular evaluation of the effectiveness of the drone fire prevention system through post-implementation evaluations, stakeholder feedback, and performance metrics allows us to identify areas for improvement, refine protocols, and ensure the ongoing enhancement of wildfire prevention plans. By continuously striving to optimize our wildfire prevention efforts, we can better protect our forests, wildlife, and communities from the devastating impacts of wildfires.

REFERENCE

1. **USDA Drones change the way forest fires are managed** **https://www.fs.usda.gov/inside-fs/delivering-mission/sustain/drones-change-way-forest-fires-are-managed#:~:text=%E2%80%9CDrones%20are%20our%20eyes%20in,Crockett%20National%20Forest%20in%20Texas**.

2. **Drones in Forestry: Revolutionizing Forest Management** **https://dronenodes.com/drone-for-forestry/#:~:text=real%2Dtime%20data.-,Drones%20can%20be%20equipped%20with%20a%20range%20of%20sensors%20to,and%20effectiveness%20of%20these%20operations**.

3. **Alabama A&M University and Auburn UniversityDrones in Forest Management** **https://www.aces.edu/blog/topics/forest-resiliency/drones-in-forest-management/#:~:text=Large%20drones%20are%20designed%20to,impacted%20by%20a%20forest%20pest**.

4. **Drones ebook** **https://www.droneflyers.com/free-dji-phantom-3-4-ebook/**.

5. **The CoDrone EDU is a programmable drone** **CoDrone.edu**

6. **Wildlife Drones | How to Use Drones for Wildlife Conservation?**
   https://www.jouav.com/blog/wildlife-drone.html

7. **National Interagency Fire Center**
   https://www.nifc.gov/fire-information/maps
8. **IMSR Map**
   https://experience.arcgis.com/experience/92dfba48047d484b8868b35d0f708532/page/Page/

9. **Annual   2022   Wildfires   Report**
   https://www.ncei.noaa.gov/access/monitoring/monthly-report/fire/202213#:~:text=According%20to%20the%20National%20Interagency,wildfire%20statistics%20visit%20U.S.%20Wildfires.