Autonomous Rescue Drone

Navigating complex spaces to locate targets in emergency situations using visual-inertial networks

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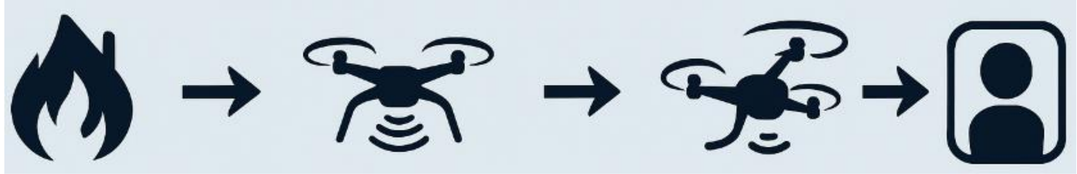
Introduction

The Problem

- Natural disasters, fires, or building collapses leave people trapped.
- Search-and-rescue missions are dangerous and time-sensitive.

The Solution

- An autonomous drone equipped.
- Designed to navigate complex indoor environments without GPS.



Objectives

How do we enable autonomous drones to efficiently locate victims in complex, hazardous environments?

1. **Develop** a drone capable of autonomous navigation in confined indoor environments.
2. **Simulate** real-world disaster recovery scenarios using a maze-like testbed.
3. **Integrate** LIDAR and IMU sensor data to detect obstacles and map surroundings.
4. **Locate** a target or "survivor" placed within the maze using onboard intelligence.
5. **Demonstrate** the feasibility of autonomous aerial search and rescue.

Materials and Methods

Hardware

- Crazyflie Bitcraze 2.1 drone
- Multiranger Deck: LIDAR-based distance sensing
- Flow Deck: for stable indoor flight
- Onboard IMU: for orientation and control
- Camera: for identifying the maze target
- GAP8: ultra-low-power 8+1 core RISC-V processor optimized for CNN inference

Software & Simulation

- Webots used to build and simulate the maze environment
- Implemented custom navigation code in Webots
- Target Classifier

Results

Successful Navigation

- The drone was able to autonomously reach the target at the end of the maze without any collisions.
- Navigation through narrow corridors and tight corners was handled smoothly using data from the LIDAR and IMU sensors.

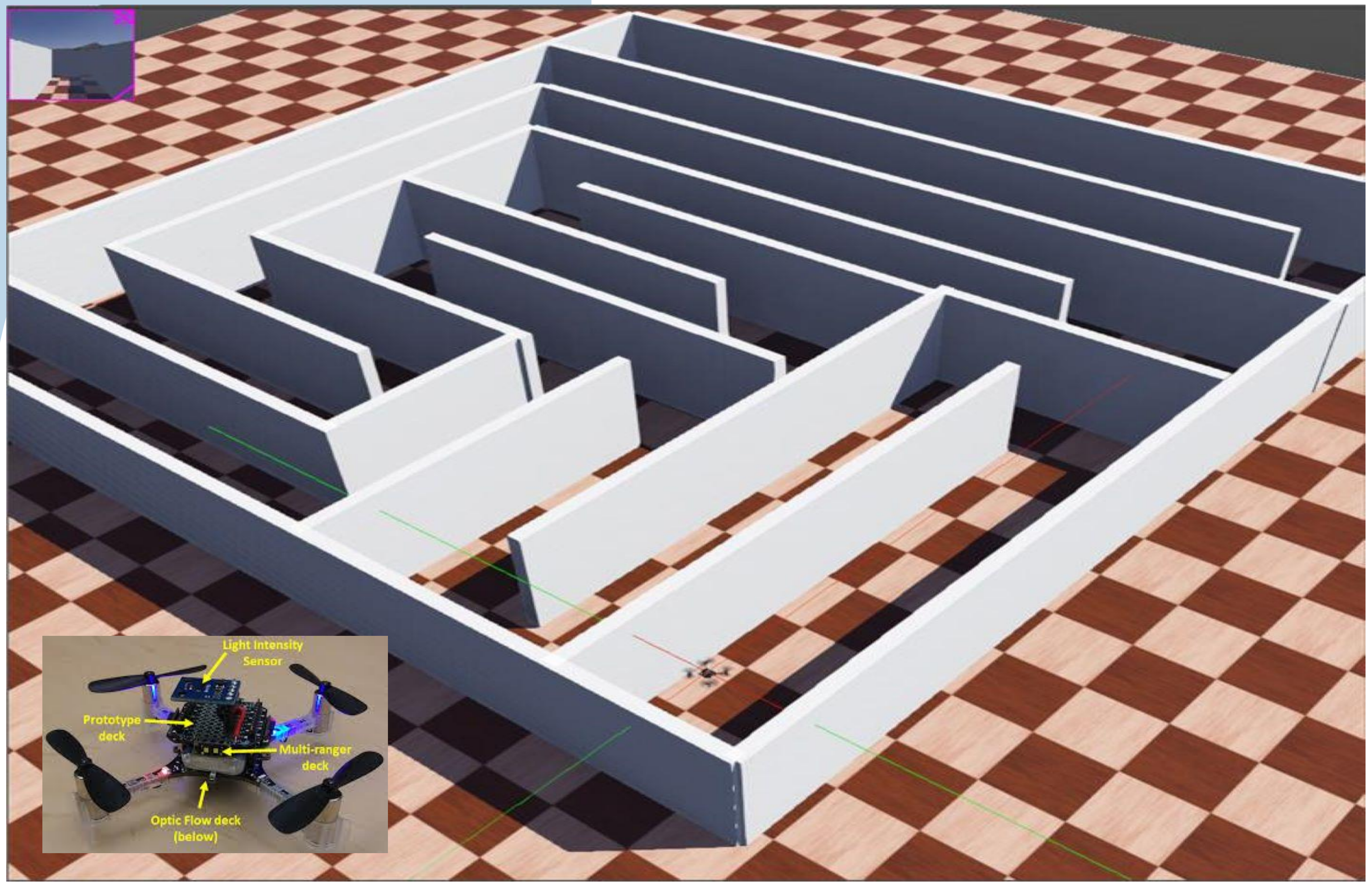
Obstacle Avoidance

- Real-time LIDAR sensing allowed the drone to detect and avoid walls and other obstacles with high accuracy.
- The IMU maintained stable flight and ensured precise maneuvering in confined spaces.

Classifier

- Gathered a dataset of 10k images of a sample target
- Achieved 98.96 % accuracy
- Model size: 3.09 MB
- Model Params: 810K
- Architecture: 3-layer CNN with small Dense

Simulation Maze Navigation via Autonomous Drone



Future Work

From Simulation to Reality

- The next phase involves translating our simulation into a real-world application by constructing a physical maze modeled after the one in Webots.
- We will deploy the Crazyflie drone with the same sensor setup (Multiranger, Flow Deck, IMU, and camera) to test autonomous navigation in real environments.

Visual-Inertial Engine

- Minimizing model power consumption: Testing out different implementations and architectures to ensure low latency
- Collect Data while in flight to obtain visual-inertial data for more robust flight
- Rely solely on a Neural engine

Conclusion

- Simulated successful autonomous drone navigation using LIDAR, IMU, and GAP8.
- Consistently reached maze target without collisions, validating obstacle avoidance and stability.
- Simulation results show strong potential for real-world disaster recovery applications.
- Accurate and compact classifier.