AUTONOMOUS BASED VISUAL NAVIGATION ENGINE FOR DRONES

- Author

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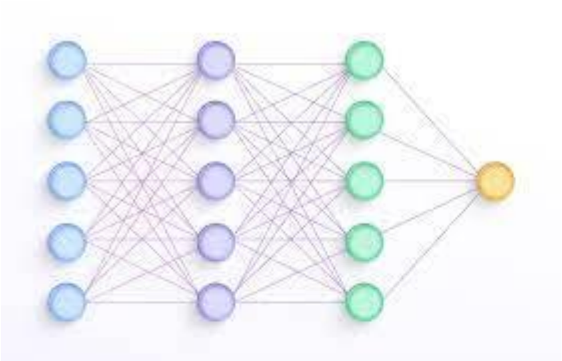
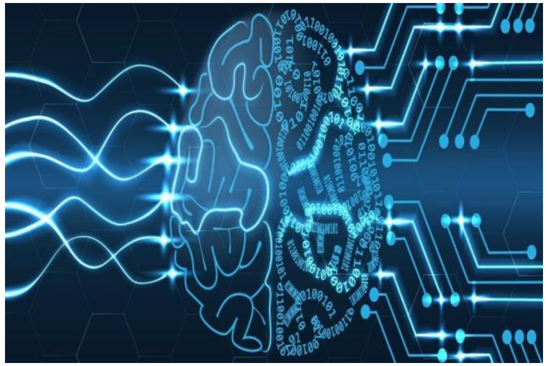
Agenda

Research Motivation

- Drones play a crucial role in our modern world, serving a variety of important functions. With the ability to soar high in the sky, drones provide an invaluable tool for aerial surveillance, offering a unique perspective for monitoring vast areas like forests, farms, and traffic flow.
- Their significance becomes especially pronounced in search and rescue missions, where drones can swiftly navigate challenging terrains or hazardous situations, aiding in locating and assisting individuals in need.

Problem Statement





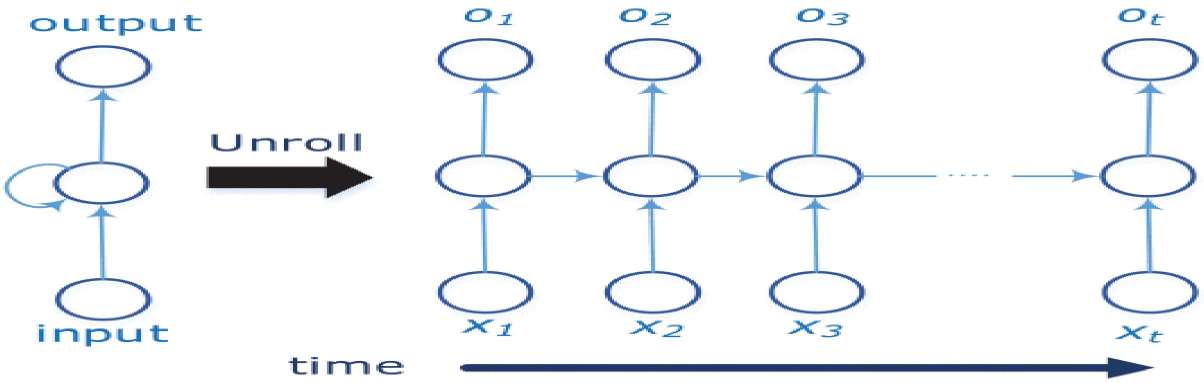
- The central issue addressed in the research paper revolves around improving the battery management and overall performance of drones. Our proposed solution, employing Recurrent Neural Networks (RNN), yielded a notable outcome of 17.5MW, surpassing the results presented in the original paper. T
- he comparative analysis reveals that the paper's use of the CNN method achieved a performance measure of 14.61MW, highlighting the efficacy of our RNN-based approach in achieving superior outcomes in both battery management and overall drone performance.

Background

- The conventional method for nano-drone autonomous navigation necessitates outsourcing computation to a robust remote base station. For instance, Dunkley et al. developed a visual-inertial simultaneous localization and mapping (SLAM) algorithm for a 25 g nano quadrotor. This algorithm stabilized the robot and enabled it to follow a predetermined trajectory, with all computations executed off-board. drawbacks of this approach include issues of latency, restricted communication range, reliability concerns arising from channel noise, and elevated on-board power consumption due to the frequent video streaming.

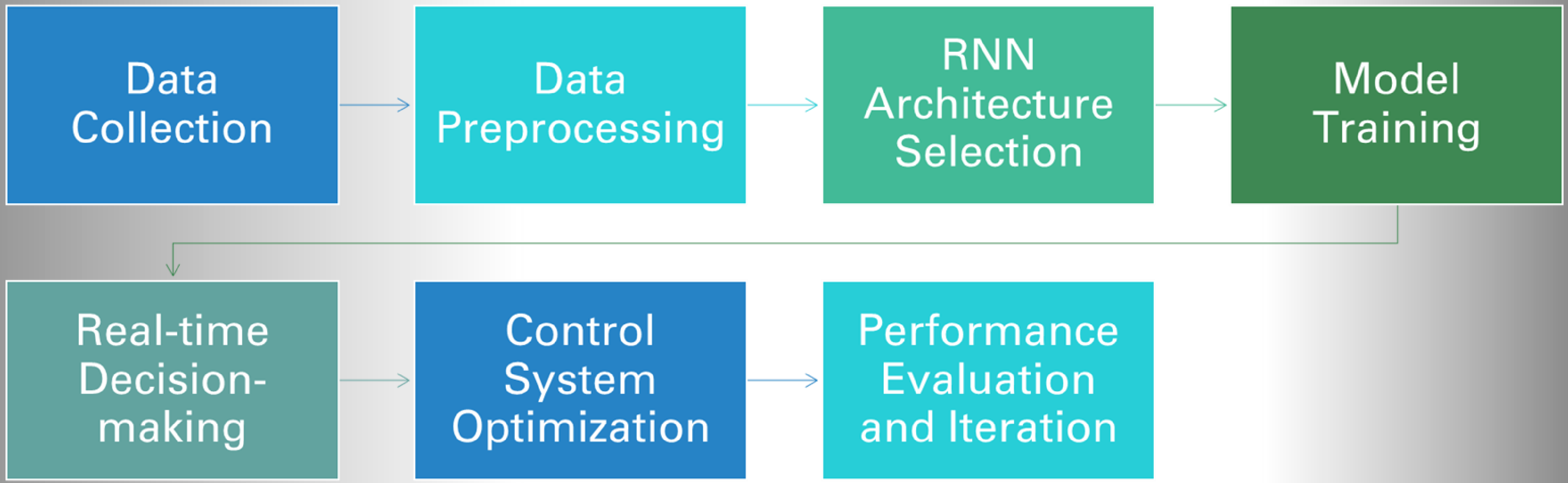
- Researchers have explored lightweight solutions for drone navigation. McGuire et al. developed a 4 g stereo camera and a velocity estimation algorithm for a 40 g flying robot. Although effective for obstacle avoidance at a low speed of 0.3 m/s, it depends on specific flight conditions. Another study introduced an optical-flow-based guidance system for a 46 g nano UAV, using an ego-motion estimation algorithm that runs on the onboard MCU. However, this method is limited to hovering and falls short of the accuracy achieved by more computationally intensive techniques reliant on feature tracking.

Methodology – Enhancing Drone Efficiency using RNN



In tasks requiring analysis of input sequences with dependencies, traditional feed-forward neural networks are insufficient. Recurrent Neural Networks (RNNs) address this by incorporating feedback loops, allowing consideration of both current and past samples. This is crucial for sequential or time-series problems with varying lengths, such as speech recognition or sensor data analysis. BPTT (Backpropagation Through Time) is used to train RNNs, involving unrolling the network over time spans. Examples of RNN applications include detecting drivers' behaviors and estimating household energy consumption.

FLOWCHART



Data Collection
Data Preprocessing
RNN Architecture Selection
Model Training
Real-time Decision-making
Control System Optimization
Performance Evaluation and Iteration

Steps	Description
1. Data Collection	Gathered relevant data that the drones encountered during its operations.
2. Data Preprocessing	Cleaned, preprocessed, and augmented the collected data to make it suitable for training the neural network.
3. RNN Architecture Selection	Chose a suitable neural network architecture that fits the problem at hand.
4. Model Training	Split the preprocessed data into training, validation, and test sets.
5. Real-time Decision Making	The RNN processed this real-time sequential data to predict or classify states of the drone .
8. Control System Optimization	Used RNN predictions and insights to dynamically optimize the drone's control system parameters.
9. Performance Evaluation and Iteration	Continuously evaluated the performance of the RNN model and its impact on drone efficiency.

IEEE INTERNET OF THINGS JOURNAL (VOL: 6, ISSUE: 5, 15 MAY 2019)

Outcomes

- Our study implementing Recurrent Neural Networks (RNN) for battery management in drones achieved a substantial energy efficiency of 17.5MW, surpassing the original paper's Convolutional Neural Network (CNN) results of 14.61MW. This 19.8% improvement highlights the RNN's superiority, promising enhanced drone performance and prolonged flight times due to optimized energy utilization.

References

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