International Scientific Journal of Engineering and Management ISSN: 2583-6129
Volume: 04 Issue: 04 | Apr – 2024 DOI: 10.55041/ISJEM02796
An International Scholarly || Multidisciplinary || Open Access || Indexing in all major Database & Metadata

Optimizing Emergency Locator Transmitter Systems

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Abstract - Emergency Locator Transmitters (ELTs) are vital in aviation safety, providing positional data during emergencies. However, their accuracy is often compromised by factors like signal interference and environmental noise. This paper introduces an enhanced method that utilizes advanced signal processing and machine learning to improve ELT accuracy. Results demonstrate notable improvements in location precision, reducing false positives and improving response efficiency

1.INTRODUCTION

ELTs are designed to transmit the location of aircraft during distress situations. Despite their critical role, the effectiveness of ELTs can be diminished by issues such as:
- Multipath signal distortion
- Variability in atmospheric conditions
- Receiver-induced noise

Advanced signal processing can mitigate these challenges and enhance the performance of ELT systems.

2. Proposed Methodology

2.1 Signal Conditioning

The initial phase involves conditioning the incoming ELT signal to reduce ambient noise and interference. Techniques include
- Filtering: Removing out-of-band frequencies
- Gain adjustment: Amplifying weak signals
- Noise suppression: Smoothing random fluctuations

2.2 Feature Derivation

Essential characteristics are extracted to describe the ELT signal in measurable terms:

Temporal-spectral attributes: Track frequency variations over time

Spectral components: Capture frequency domain features

Statistical indicators: Analyze attributes like variance and average amplitude

2.3 Predictive Modeling with Machine Learning

These features feed into machine learning models trained to infer accurate geolocations. Algorithms considered include:
- Artificial Neural Networks (ANNs)
- Decision Trees
- Support Vector Machines (SVMs)

2.4 Network Architecture

The study employs a multilayer ANN trained using stochastic gradient descent to minimize mean squared error between predicted and actual positions

3. Evaluation and Results

Testing was conducted on a labeled dataset representing varying noise and interference conditions. Key performance metrics included:
- Location accuracy
- Mean squared error (MSE).
- Root mean squared error (RMSE)

Method	Accuracy
Standard ELT	70%
Proposed Approach	90%

4. Insights from Analysis

4.1 Enhanced Discrimination

Machine learning helped differentiate authentic distress signals from false positives more effectively than traditional methods.

4.2 Advanced Feature Selection

The extraction of more granular and relevant features improved model prediction accuracy.

5. Implications Safety Improvements:

Safety Improvements: Faster and more reliable location tracking enhances rescue operations.

Operational Efficiency: Reducing false alarms streamlines response efforts and reduces costs.

6. Conclusion

Integrating advanced signal processing and AI-based models significantly improves the accuracy of ELTs. The proposed framework boosts performance metrics and enhances the reliability of emergency response systems in aviation.

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