MACHINE LEARNING BASED SATELLITE COMPASS

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Thesis/Dissertation submitted in partial fulfillment of the requirements for the degree
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DECLARATION

I declare that this is my own work and this thesis/dissertation does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. I retain the right to use this content in whole or part in future works (such as articles or books).

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Name of Co-supervisor: Commodore (L) Pradeep Gunathilake

Signature of the Co-supervisor:

Name of Supervisor: Dr. Thilini Piyatilake

17/07/2024

Signature of the Supervisor: Date:

DEDICATION

The research thesis is dedicated wholeheartedly to my beloved parents, brother and sister who inspired, motivated and supported me throughout the study.

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Compliments of the thesis is awarded to my beloved family members for their valuable devotion played throughout the research.

ABSTRACT

This thesis documents the development, implementation, and evaluation of an ML-based Satellite Compass System customized for marine navigation. Motivated by the necessity for a low-cost, highly accurate, and reliable navigation sensor unaffected by interferences, the project addresses limitations present in conventional navigation sensors like Magnetic compass sensors and GPS-based satellite compasses. Central to the endeavor is the concept of "heading," representing a ship's direction relative to a reference point, such as magnetic or true north.

Our choice of an ML-based approach stems from its potential to handle the intricate relationships inherent in sensor data more effectively than traditional methods. Throughout the project, we meticulously selected and trained machine learning models, including LSTM, Random Forest, and XGBoost, to predict gyro readings from heading data. The integration of these models facilitated a comprehensive analysis of prediction accuracy, model robustness, and generalizability.

The results of our study underscore the efficacy of the ML-based Satellite Compass System. Through rigorous testing and evaluation, the XGBoost model emerged as the standout performer, demonstrating superior prediction accuracy and robustness compared to alternative models. This achievement represents a significant advancement in marine navigation technology, offering safer, more efficient, and technologically advanced solutions for maritime operations.

Keywords: Satellite Compass System, Marine Navigation, Machine Learning, Heading, XGBoost model

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LIST OF ABBREVIATIONS

Abbreviation	Description
GPS	Global Positioning System
NMEA	National Marine Electronics Association
LSTM	Long Short-Term Memory
MSE	Mean Squared Error
MAE	Mean Absolute Error
RNN	Recurrent Neural Network
GUI	Graphical User Interface
ML	Machine Learning
RS485	Recommended Standard 485
HMI	Human-Machine Interface
PCB	Printed Circuit Board
ARM	Advanced RISC Machine
GLONASS	Global Navigation Satellite System
BeiDou	Chinese Satellite Navigation System
MPU	Microprocessor Unit
MPU	Microcontroller Unit
RMSE	Root Mean Square Error
IMU	Inertial Measurement Unit
UART	Universal Asynchronous Receiver-Transmitter
SHAP	SHapley Additive exPlanations
MLSCS	Machine learning Satellite Compass System

LIST OF APPENDICES