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**CORRECTION OF SHIPS' STEERING ANGLE
FOR SAFE MANEUVERING AGAINST STRONG
WINDS USING MICROCONTROLLER**

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MSc/PG Diploma in Industrial Automation

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Dissertation submitted in partial fulfillment of the requirements for the
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DECLARATION

I declare that this is my own work and this 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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The supervisor should certify the Dissertation with the following declaration.

The above candidate has carried out research for the MSc/PG Diploma in Industrial Automation Dissertation under my supervision. I confirm that the declaration made above by the student is true and correct.

Name of Supervisor: Dr. RM Maheshi Ruwanthika

Signature of the Supervisor:

Date: 13 June 2025

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ABSTRACT

The maritime industry, responsible for approximately 80% of global trade volume, faces significant challenges posed by adverse weather conditions, particularly strong winds. Over-steering in such conditions increases the risk of capsizing, leading to substantial economic and human losses. This research presents the development of a microcontroller-based system designed to adjust ship steering angles in real-time, accounting for wind conditions and enhancing navigational safety. The system integrates various sensors, including wind speed and direction transducers, gyro modules, and GPS receivers, to continuously monitor both environmental conditions and navigational parameters. Data collected from these sensors are processed by a microcontroller, which utilizes a developed mathematical model to assess the impact of wind forces on the ship's motion. Based on this assessment, the model calculates the necessary steering angle adjustments to counteract the effects of wind forces, ensuring stable and safe maneuvering. Key factors considered in the model include wind force, centrifugal force, and heel angle, providing a comprehensive evaluation of ship stability under varying wind conditions. The system is designed to be compatible with existing steering mechanisms, ensuring cost-effectiveness and ease of implementation. Simulations demonstrate the system's ability to predict and correct steering angles accurately, significantly reducing the risk of over-steering and capsizing. Rigorous testing has validated the system's performance, showing substantial improvements in navigational safety under strong wind conditions. The proposed solution offers a robust method for enhancing maritime safety, protecting both crew and cargo.

Keywords: Microcontroller, Maritime, Steering angle, Mathematical models

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LIST OF ABBREVIATIONS

Abbreviation	Description
ADC	Analog-to-Digital Converter
AIS	Automatic Identification Systems
AVR	Advanced Virtual RISC
AVS	angle of vanishing stability
CAN	Controller Area Network
CFD	Computational Fluid Dynamics
CMU	Central Microcontroller Unit
CPU	central processing unit
EEPROM	Electrically Erasable Programmable Read-Only Memory
GPS	Global Positioning System
HMI	Human-Machine Interface
HVAC	heating, ventilation, and air conditioning
LNG	liquefied natural gas
LPG	liquefied petroleum gas
MEMS	Micro-Electro-Mechanical Systems
MWV	Marine Wind Velocity
NMEA	National Marine Electronics Association
ROT	Rate of Turn
SMA	shape memory alloy
SOG	Speed Over Ground
SRAM	Static Random Access Memory
UI	User Interface