Preface

This special issue of the Indian Journal of Geo Marine Sciences (IJMS) is on the topic of "Underwater Robotics System, Sensors and Instrumentation". In this special issue, there are 19 technical papers divided into three sub-domains, namely, Intelligent Control and Navigation Approaches, Underwater Robotics Platform Design, and Applied Tools. The fusion of these sub-domains is crucial in formulating robust engineering and technology solutions to the robust underwater environment applications. The underwater environment poses complex operational conditions for any underwater robotic platform such as the Autonomous Underwater Vehicle (AUV) and Autonomous Surface Vessel (ASV). To overcome the constraints, special attention is given to various intelligent control approaches available. *Maziyah et. al.* in "*Review of Sliding Mode Control Application in Autonomous Underwater Vehicles*" discussed various sliding mode control approaches for autonomous underwater vehicles. Autonomous underwater vehicles are used under water and operating in the presence of uncertainties (due to hydrodynamics coefficients) and external disturbances (due to water currents, waves, etc.). Sliding mode controller is one of the nonlinear robust controllers which is robust towards uncertainties, parameter variations and external disturbances. Another excellent review on control approaches for robotic platform is by *M. Z. A Rashid et. al.* entitled "*A Comprehensive Review on Controller for Leader-Follower Robotic System*". This paper presents a comprehensive review of the leader-follower robotics system and elaborates on the current trends in the swarm robotic system, leader-follower, and multi-agent system. An example of a control approach applied for an underwater glider is presented in "*Experimental and Simulation Study on Nonlinear Pitch Control of Seagull Underwater Glider*" written by *D. Li et. al* where an adaptive back-stepping control (ABC) method is proposed for the nonlinear pitch control of the underwater glider (UG) gliding in the vertical plane. The linear quadratic regulator (LQR) control and proportional-integral-derivative (PID) control approaches are applied and evaluated with the ABC method to control a glider in saw-tooth motion. Another paper by *Maziyah et. al.* on "*Nonlinear Robust Integral Sliding Super Twisting Sliding Mode Control Application in Autonomous Underwater Glider***"** discussed about the design and simulation of nonlinear robust integral super-twisting sliding mode control for controlling the longitudinal plane of an Autonomous Underwater Glider (AUG). The controller is designed for trajectory tracking problem in existence of external disturbance and parameter variations for pitching angle and net buoyancy of the longitudinal plane of an AUG. The algorithm is designed based on integral sliding mode control and super-twisting sliding mode control. *Jialei et. al.* presented a paper on "*RBF-Based Supervisor Path Following Control for ASV with Time-Varying Ocean Disturbance"* where a robust model-free path following controller an ASV with time-varying ocean disturbance. The findings indicated very promising results. The following paper on *"A Collision Risk Assessment Based Artificial Potential Field Approach for Multi-ships Avoidance"* by *Jian Hong Mei et. al.* presented a fuzzy logic system to assess the collision risk with Distance of Close Point of Approaching (DCPA) and Time of Close Point of Approaching (TCPA). The collision risk is used to modify the Artificial Potential Field for the ASV to avoid multiple ships when they encounter. The simulation results indicate that the proposed method overcomes the problem and successfully avoids the ship collision. For the navigation and path-following aspect, *Zhua Sun et. al*. with the paper entitled "*Surge-Varying LOS Based Path Following of Under-actuated Surface Vehicles*", a novel path-following control (PFC) scheme with accurate guidance and high anti-disturbance ability for Under-actuated Surface Vehicles (USVs) is proposed. The innovative work enables accurate disturbance compensation and guided signal tracking in harsh ocean environment. *Yeong et. al.* proposed an enhanced control-theoretic distributed time synchronization protocol called Time Synchronization using Distributed Observer algorithm with Sliding mode control element (TSDOS) to solve the time synchronization issue in ASV in the paper entitled "*TSDOS - An Enhanced Time Synchronization Protocol in Automated Surface Vehicles".* For the underwater distance measurement application, *Tan C.S et. al.* presented a simple low-cost underwater acoustic distance measurement system based on Fast Fourier Transform (FFT) overlapped in the paper, "*Time of Arrival Estimation using Fast Fourier Transform Overlap for Underwater Distance Measurement***".** For the development of the AUV Platform, a paper entitled "*Design Analysis and Modeling of Autonomous Underwater Vehicle (AUV) using CAD*" by *M.S.M Aras et. al*., the design, analysis and modeling of an AUV module using Computer Aided Design (CAD) simulation software (SolidWork™) is presented. The simulation outcome

showed reliable maximum thruster velocity and acceptable acceleration for the AUV. Another work on "*Experimental Study on Hydrodynamic Characteristics of a Newly Developed Underwater Glider"* by *Javaid M.Y. et. al.* presented the hydrodynamic performance of a newly developed AUG in a horizontal plane towed tank environment. Both experimental and simulation results showed potential development of AUGs and their control surfaces. Two papers by *Xianbo et. al.* entitled "*Underwater Dual Manipulators — Part I: Hydrodynamics Analysis and Computation*" and "*Underwater Dual Manipulators — Part II: Kinematics Analysis and Numerical Simulation*" discussed the design and analysis of two 4-DOF underwater manipulators mounted on autonomous underwater vehicle with grasping claws, such that the AUV can accomplish the underwater task by using the dual manipulators. An integrated result of computed torques by combining the theoretical calculation and simulation results are presented. *M. Rezal and D. Ishak* discussed about the "*Performance Enhancement of Underwater Propulsion Motor Using Differential Evolution Optimization*". For this purpose, a three-phase, 6-slot/4-pole permanent magnet synchronous motor (PMSM) intended for the underwater propulsion system is firstly designed by using ASM and then later optimized by differential evolution algorithm. The results showed an improved performance of the proposed PMSM. Another interesting paper is by *M.S.M. Aras et. al.* entitled "*Monitored and Controlled Underwater Scissor Arm Manipulator using Pixy Camera*" where the manipulator is used in an object recovery task. An acrylic scissor arm which is electro-mechanically driven will be used as manipulator in this research. Permanent magnets are used as its end effector. A *Pixy CMUcam5* vision sensor was paired with the manipulator to control the AUV and manipulator. For the robotic module gait movement design, a paper entitled "*Reconfigurable Multi-Legs Robot for Pipe Inspection: Design and Gait Movement"* by *M.Z.A Rashid et. al.* studied the reconfigurable multi-legs robotic system. The aim was to identify and acquire the optimum mechanism for multi-legs robot motion for a pipe system. This multi-legs robot has more movement gaits compared to wheeled robot, but in terms of speed, wheeled robot is better. Therefore, the proposed design has both wheel and multiple legs to make system stable and with better maneuverability. The following paper talks about the sloshing problem which is a phenomenon where a partially filled tank is exerted into various environmental sea conditions, such as wave and wind. Sloshing in a tank of liquefied natural gas (LNG) carrier can lead to structural damage of tank structures and motion instability of the carrier. Thus, sloshing analysis needs to be conducted beforehand to minimize the risk of damages. The paper entitled "*Sloshing In a Closed Domain under Unidirectional Excitation*" by *U.G.M. Arif et. al*. discussed the issue in more detail. Another interesting paper is on "*MPI Application of 3D Hydroelasticity on a Barge Deployed above the Uneven Seabed*" by *Y. Lu et. al.* presents the hydro-elastic analysis method with variable water depths to calculate the sea-keeping of the floating structures, considering the uneven seabed as the boundary condition. The final paper in this special issue is on "*The Characteristics of the Butt Welding Imperfections Joint Using Co-Occurrence Matrix*" by *H.N.M. Shah et. al.* which presents the characteristics of the butt joint imperfections with different types of joint shapes: Curve, straight and tooth saw work-piece according to their class categories, namely, good welds, excess welds, insufficient welds, and no welds. The results showed that no welds class categories exhibit higher homogeneity compared to the other class categories. In summary, the special issue has covered topics on control and navigation, underwater robotics module design and analysis and additional tools which can be utilized for ocean-related applications. There is tremendous potential for ocean exploration and exploitation and with the advance tools, the mission can be made to be constructive and sustainable.

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