APPENDIX A: COMPARISON OF EXISTING SURVEY REGARDING ASVS

TABLE A.1: Comparison of existing survey regarding ASVs.

<table>
<thead>
<tr>
<th>Surveys</th>
<th>Publish Year</th>
<th>Focus</th>
<th>P</th>
<th>N</th>
<th>G</th>
<th>C</th>
<th>R</th>
<th>N&amp;C</th>
<th>Co</th>
<th>DL</th>
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<td>Caccia [1]</td>
<td>2006</td>
<td>Recently developed autonomous surface crafts, the research, and legal issues.</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Yan et al. [5]</td>
<td>2010</td>
<td>The applications, developments, and challenges of Navy ASVs.</td>
<td>✓</td>
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<td>✓</td>
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<td>Ashrafzaiion et al. [6]</td>
<td>2010</td>
<td>The development of set-point, trajectory tracking, and path following control algorithms and methodologies for autonomous underactuated marine vehicles.</td>
<td>✓</td>
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<td>✓</td>
<td>✓</td>
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<td>Campbell et al. [8]</td>
<td>2012</td>
<td>The ASVs prototypes, subsystems, and N&amp;C, especially how to comply with COLREGs guidelines.</td>
<td>✓</td>
<td>✓</td>
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<td>Azzari et al. [11]</td>
<td>2015</td>
<td>The review of research work on control system approaches of ASVs, especially the course keeping control.</td>
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<td>Manley</td>
<td>2016</td>
<td>The reviews of sub-component technology and developments for unmanned maritime vehicles system over the past 20 years.</td>
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<td>Liu et al. [13]</td>
<td>2016</td>
<td>A comprehensive survey about the existing ASV prototypes, and N&amp;C methods, along with their applications, methodologies, and challenges.</td>
<td>✓</td>
<td>✓</td>
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<td>Schiaretti et al. [14]</td>
<td>2017</td>
<td>Definition and categorization of autonomy levels for autonomous surface vessels.</td>
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<td>Prasad et al. [16]</td>
<td>2017</td>
<td>A comprehensive overview of various approaches of video processing for object detection and tracking in the maritime environment.</td>
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<td>Liu et al. [17]</td>
<td>2018</td>
<td>Techniques related to the operation of multi-vehicle systems in different environmental domains.</td>
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<td>Cappelle et al. [18]</td>
<td>2018</td>
<td>Technology developments related to autonomous shipping and their technology readiness level.</td>
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<td>✓</td>
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<td>Lee [19]</td>
<td>2018</td>
<td>Wireless communication techniques for ASVs.</td>
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<td>Zerek et al. [20]</td>
<td>2018</td>
<td>The present status of marine robotics and their applications.</td>
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<td>Polvaza et al. [21]</td>
<td>2018</td>
<td>Collision detection and path planning methods for ASVs.</td>
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<td>Moud et al. [22]</td>
<td>2018</td>
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<td>Zolich et al. [23]</td>
<td>2019</td>
<td>Communication and networking technologies that could help the integration of autonomous systems in maritime scenarios.</td>
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<td>✓</td>
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<td>Jorge et al. [26]</td>
<td>2019</td>
<td>Applications and roles of ASVs for Disaster Management.</td>
<td>✓</td>
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<td>✓</td>
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<td>Wang et al. [28]</td>
<td>2019</td>
<td>Development and application related to ASV in China.</td>
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<td>✓</td>
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<td>Thompson et al. [29]</td>
<td>2019</td>
<td>Current advances in automated planning for autonomous marine vehicle fleets.</td>
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<td>Silva et al. [30]</td>
<td>2019</td>
<td>Developments of rigid wing sailboats in terms of hardware and software.</td>
<td>✓</td>
<td>✓</td>
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<td>Wang et al. [31]</td>
<td>2019</td>
<td>Motion control of MASS.</td>
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<td>✓</td>
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<td>Huang et al. [32]</td>
<td>2020</td>
<td>Collision prevention techniques based on motion and conflict detection, and conflict resolution both for manned and unmanned ships.</td>
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<td>✓</td>
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<td>Jing et al. [33]</td>
<td>2020</td>
<td>Path planning and navigation methods for autonomous vessels and sailboats.</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Zhou et al. [34]</td>
<td>2020</td>
<td>The path planning of multi-modality constraint research including Route Planning, Trajectory Planning and Motion Planning.</td>
<td>✓</td>
<td>✓</td>
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<td>Peng et al. [35]</td>
<td>2020</td>
<td>Recent advances and challenges in coordinated control of multiple ASVs.</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Chen et al. [36]</td>
<td>2020</td>
<td>A comprehensive overview on cooperative control methods for waterborne transport.</td>
<td>✓</td>
<td>✓</td>
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<td>Zhang et al. [37]</td>
<td>2021</td>
<td>The major advancements in maritime collision avoidance navigation technologies applied in different scenarios, from transportation to scientific research.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Karimi et al. [38]</td>
<td>2021</td>
<td>Recent developments on guidance and control methods for marine robotic vehicles.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Abrdeo et al. [40]</td>
<td>2021</td>
<td>State-of-the-art in situational awareness for autonomous vessels.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>+</td>
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<tr>
<td>Gu et al. [41]</td>
<td>2022</td>
<td>Overview of recent advances in LOS guidance for path following.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>+</td>
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<tr>
<td>Our Work</td>
<td>2022</td>
<td>A comprehensive survey about application of DL methods on NGC system of ASVs and maritime cooperative operations, as well as their challenges.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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</tr>
</tbody>
</table>

Notes: The symbol ✓ marks publications that discuss the topic in detail; + indicates corresponding scope is briefly mentioned instead of careful investigation. "P" is for prototypes or projects: including the physical ASV prototypes and their hardware, software and applications, or the projects that develop these prototypes; "G" is for Guidance; "N" is for Navigation; "C" is for Control; "R" is for rules or regulations, e.g., the effect to comply with COLREGs guidelines; "N&C" is for Networking and Communications; "Co" refers to cooperation between multi-vehicles; "DL" is for deep learning.
### APPENDIX B: OVERVIEW OF COMMERCIAL AND RESEARCH ASV PROJECTS

#### TABLE B.1: Overview of Commercial and Research ASV projects I

<table>
<thead>
<tr>
<th>Prototype</th>
<th>Name</th>
<th>Sensors</th>
<th>Navigation</th>
<th>Guidance</th>
<th>Control</th>
<th>COMM.</th>
<th>Purpose</th>
<th>REF.</th>
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<td>rudder</td>
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<td>PID</td>
<td>rudder</td>
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<td>rudder</td>
<td>radio</td>
<td>fish tracking</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>NOMOTO</td>
<td>rudder</td>
<td>UHF</td>
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<td>✓</td>
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<td>✓</td>
<td>EKF</td>
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**Notes:**
1. Cooperation with AUV
2. Cooperation with UAV

**Navigation:**

**Control:**
- HA: Hybrid Automation, NMPC: Nonlinear Model Predictive Control, DT: Differential Thrust

**Algorithm:**
- DR: Dead-Recteckoning, Kalman Filter, EKF: Extended Kalman Filter, UKF: Unscented Kalman Filter, RA: Radial Analysis

**Approach:**
- OKID: Observer/Kalman System Identification, EBD: Edge and Blob Detection, FSM: Finite State Machines, CC: Colorimetric Criteria

**Based Algorithm:**

**SODMN:** Self Organization Direction Mapping Network, VGA: Visibility Graph Algorithm, GA: Genetic Algorithm, NMHE: Nonlinear Moving Horizon Estimation
### TABLE B.2: Overview of Commercial and Research ASV projects II

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<tr>
<th>Prototype</th>
<th>Name</th>
<th>Institution</th>
<th>Year</th>
<th>Country</th>
<th>Year</th>
<th>Type</th>
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Note: 1. Because all the prototypes have power supplied by batteries, “batteries” here denotes batteries are the only power.

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<td>W(m)</td>
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**Dimension**: L: Length, W: Width, Type: M: Monohull, C: Catamaran, Parameter: Sp: Speed, Wt: Weight, En: Endurance
REFERENCES


