**Obstacle Detection Sub-System Requirements Specification**

**1. Scope.**

* 1. **Identification.**

*This paragraph shall contain a full identification of the system to which this document applies (for example NS18).*

This document applies to the Obstacle Detection System (OBS), a sub-system of the Autonomous Vehicle System (AVS).

* 1. **Overview.**

*This paragraph shall briefly state the purpose of the system to which this document applies. It shall describe the general nature of the system; summarize the history of development, operation, and maintenance; identify current and planned operating sites; and list other relevant documents.*

The obstacle sensing system shall utilise the HC-SR04 Ultrasonic sensor Arduino module to calculate the distance to any objects within its range. Using the location and Euler angles data from the Location System it shall then calculate the grid reference containing the object, and output this to the navigation system.

* 1. **Document overview.**

*This paragraph shall summarize the purpose and contents of this document.*

This document shall outline the high-level sub-system requirements of the Obstacle Detection System (ODS), which is a sub-system on the Autonomous Vehicle System (AVS).

**2. Referenced documents.**

*This section shall list the number, title, revision, and date of all documents referenced in this specification. Of particular importance is the relationship between the stakeholder’s requirements and the System Requirements Specification.*

**3. Requirements.**

**3.1 Required states and modes.**

Not used.

**3.2 Function and performance requirements.**

**3.2.1 Obstacle Detection Range Requirements.**

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| **Requirement ID:**  *AVS-OD-001* | **Requirement Statement**  The Obstacle Detection System shall correctly detect obstacles inside the grid, at a minimum of 15cm. |
| **Verification Method**  *Method of confirming that the system has met the requirement. Options include demonstration, test, analysis or inspection*  Test | **Verification Description**  The ODS sensors’ range shall be tested on a non-integrated circuit (i.e. breadboard), by aiming them at a cardboard box at different ranges and angles, to confirm they are physically capable of the requirement.  Once integrated onto the AVS the ODS shall be tested while the AVS is both moving and stationery, by placing obstacles in known grid locations and confirming that the ODS outputs the correct grid reference. |
| **Traceability**  *Tracing this requirement back to the source document.* | **Rationale/explanation**  *An explanation or expansion as to why the system needs to do what the requirement says it needs to do. This may be a reminder or a note, or may simply expand on the traceability.*  The given grid space has grid squares with size of 50x50cm hence for the AVS to detect an obstacle in any box directly adjacent, when the AVS is located in the centre of the current box, the lower limit of 15cm allows for sensors to be offset from the centre of the AVS by up to 35cm. |
| **States/Modes applicability:**  Not used | |

**3.2.2 Inputs Conversion To Obstacle Grid Reference Requirements**

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| **Requirement ID:**  *AVS-OD-002* | **Requirement Statement**  The Obstacle Detection System shall convert inputs from the range sensors (distance to detected obstacle) and the Location System (current AVS location and heading) into a grid reference representing the location of an obstacle. |
| **Verification Method**  Test | **Verification Description**  Before full integration the Location System and ODS shall be interfaced in the test grid, with a number of obstacles at different known grid locations. The full system will be emulated by connecting outputting the ODS output grid references to a Serial Monitor, confirming correct locations from each of the sensors in their respective directions. |
| **Traceability**  *Tracing this requirement back to the source document.* | **Rationale/explanation**  Once the ODS has received necessary inputs, this information must be combined in a useful way, i.e. to calculate the location of the detected obstacle. |
| **States/Modes applicability:**  Not used. | |

**3.3 External interface requirements.**

**3.3.1 Interface identification and diagrams.**

*This paragraph shall identify the required external interfaces of the system. The identification of each interface shall include an identifier and shall name the interfacing entities. One or more interface diagrams shall be provided to depict the interfaces.*

**3.3.2 ODS and Location System Interface – Current Location Requirements**

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| **Requirement ID:**  *AVS-OD-002* | **Requirement Statement**  The Obstacle Detection System shall interface with the Location System receiving current location as an input. |
| **Verification Method**  Test | **Verification Description**  Before full system integration, known input shall be fed to the ODS to confirm the ODS receives correct inputs.  Upon full system integration, the same testing will occur to ensure geometry is correct. |
| **Traceability**  *Tracing this requirement back to the source document.* | **Rationale/explanation**  For the ODS to correctly calculate the grid square of the detected obstacle, the AVS location inside the grid reference must be known in order to conduct the geometric calculations. |
| **States/Modes applicability:**  Not used | |

**3.3.3 ODS and Location System Interface – Current Heading Angle Requirements**

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| **Requirement ID:**  *AVS-OD-003* | **Requirement Statement**  The Obstacle Detection System shall interface with the Location System receiving current heading angle as an input. |
| **Verification Method**  Test | **Verification Description**  Before full system integration, known input shall be fed to the ODS to confirm the ODS receives correct inputs.  Upon full system integration, the same testing will occur to ensure geometry is correct. |
| **Traceability**  *Tracing this requirement back to the source document.* | **Rationale/explanation**  For the ODS to correctly calculate the grid square of the detected obstacle, the AVS location and heading inside the grid reference must be known in order to conduct the geometric calculations. |
| **States/Modes applicability:**  Not used | |

**3.3.4 ODS and Navigation System Interface – Obstacle Location Requirements**

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| **Requirement ID:**  *AVS-OD-005* | **Requirement Statement**  The Obstacle Detection System shall interface with the Navigation System, outputting the correct grid references of all in range obstacles to the Navigation System. |
| **Verification Method**  Test | **Verification Description**  Before full system integration, and after the first stage testing of requirement AVS-ODS-03 is verified, the Location System and ODS shall be interfaced with the Navigation System and placed in the test grid, with obstacles at known locations, confirming that the in range obstacles are added to the Navigation System’s obstacle list. |
| **Traceability**  *Tracing this requirement back to the source document.* | **Rationale/explanation**  Once the ODS has calculated the location of the obstacle, it must output its findings to the navigation system for more informed route planning. |
| **States/Modes applicability:**  Not used. | |

**3.3.x (Project-unique identifier of interface).**

*This paragraph (beginning with 3.3.2) shall identify a system external interface by project-unique identifier, shall briefly identify the interfacing entities, and shall be divided into subparagraphs as needed to state the requirements imposed on the system to achieve the interface. Some example external interfaces are listed below:*

**3.3.x [insert name of system or sub-system] and vehicle chassis**

**3.3.x [insert name of system or sub-system] and DC motor**

**3.3.x [insert name of system or sub-system] and servo motor**

**3.4 Safety requirements.**

Not used.

**3.5 Security requirements.**

Not used.

**3.6 System environment requirements.**

Not used.

**3.7 System quality factors.**

*This paragraph shall specify the requirements, if any, pertaining to system quality factors. Examples include quantitative requirements concerning reliability (the ability to perform with correct, consistent results -- such as mean time between failure for equipment), maintainability (the ability to be easily serviced, repaired, or corrected), availability (the ability to be accessed and operated when needed), flexibility (the ability to be easily adapted to changing requirements), usability (the ability to be easily learned and used), transportability (the ability to be easily transported from one geographic location to another), and manufacturability (ease with which the system can be produced within the constraints of the production capability).*

**3.8 Appearance and surface finishing requirements.**

Not used.

**3.9 Design and construction constraints.**

*This paragraph shall specify the requirements, if any, that constrain the design and construction of the system. This paragraph shall include the physical requirements imposed on the system in the Project Brief. Examples include requirements concerning:*

* 1. *Use of a particular system architecture or requirements on the architecture, such as required use of the Arduino microcontroller.*
  2. *Use of particular design or construction standards; workmanship requirements and production techniques.*
  3. *Physical characteristics of the system (such as weight limits, dimensional limits, colour, protective coatings); interchangeability of parts; ability to be transported from one location to another; ability to be carried or set up by one, or a given number of, persons.*
  4. *Materials that can and cannot be used;*
  5. *Use of nameplates, part marking, serial and lot number marking, and other identifying markings*
  6. *Flexibility and expandability that must be provided to support anticipated areas of growth or changes in technology, threat, or mission*

*Some example constraints are listed below:*

**3.9.1 Arduino microcontroller**

**3.9.2 Battery constraints**

**3.9.3 HC-SR04 Ultra sonic sensors**

**3.10- Personnel-related requirements**.

Not used.

**3.11 Training-related requirements.**

Not used.

**3.12 Support-related requirements.**

Not used.

**3.13 Other requirements.**

Not used.

**6. Notes.**

*This section shall contain any general information that aids in understanding this document (e.g., background information, glossary, rationale). This section shall contain an alphabetical listing of all acronyms, abbreviations, and their meanings as used in this document and a list of any terms and definitions needed to understand this document.*

**A. Appendices.**

*Appendices may be used to provide information published separately for convenience in document maintenance (e.g., charts). As applicable, each appendix shall be referenced in the main body of the document where the data would normally have been provided. Appendices may be bound as separate documents for ease in handling. Appendices shall be lettered alphabetically (A, B, etc.).*