**Domain:** Design Fault Modes and Effects Analysis (DFMEA) and issue reporting in the context of robotics

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**Purpose:** Ontology to bridge DFMEA and issue reporting to reduce the effort necessary for transferring knowledge from issue reports to DFMEA worksheets. The ontology will serve as a framework in which both DFMEA and issue report information can be codified. This enables such information to be transferred between the two document types. Special attention is given to robotics, including terminology and concepts unique to the field, to improve the usability of the ontology in this domain.

**End users:** Robot developers, knowledge engineers, safety engineers

**Level of formality:** Semi-informal. “Expressed in a restricted and structured form of natural language, greatly increasing clarity by reducing ambiguity” – Uschold and Grüniger (1996). Reference the Enterprise Ontology by Uschold et. al. (1998) as an example.

**Scope:**

All terminology found in DFMEA worksheets and issue reports is included.

DFMEA terms: *DFMEA, DFMEA worksheet, to examine, to have, to depend on, failure, failure cause, failure mode, to cause, to lead to, failure effect, component, function, system, severity, occurrence, preventative/mitigation action, detection action, detection, risk priority number, counter measure, deadline, accountability, design, state, identification number, starting date, ending date, latest revision date, use measures, design measures, preventative maintenance, hazard, internal, external, software failure, hardware failure, failure location, recommended action, action taken, to be part of, component type, component name, failure history, usage*

Issue report terms: *title, identification number, date of occurrence, to relate to, reporter of issue, software version, hardware configuration, classification of issue, severity, occurrence, detection, person(s) in charge, description, procedure for reproduction, fault analysis, affected software, affected hardware, procedure for fixing issue, procedure for validating fix, software/hardware release, to involve, temporary solution, permanent solution*

Only robotics terms relating to the design and structure of the robot are used. As the DFMEA primarily targets robot design, specifically hardware, terms relating to robot operation, knowledge representation, software, and control are omitted.

Robotics terms: *robot group, robot, artificial system, robotic system, robotic environment, robot sensing part, robot actuating part, robot communicating part, robot processing part, collective robotic system, single robotic system, robot architecture document, robot structure, robot behavior, robot architecture, element of robot architecture, layer of robot architecture, module of robot architecture, robot motion, structural robot part, autonomy, fully autonomous, semi-autonomous, teleoperated, remote controlled, automated, member*

Miscellaneous terms are those used to define the terms in the above domains, but that are too general to be included in any of the above domains.

Miscellaneous terms:  *entity, physical, object, process, collection, agent, group, artifact, device, abstract, quantity, attribute, set/class, relation, proposition, design, design object, physical environment, blueprint, content bearing object, interaction, idealization, region*

**Sources of Knowledge:**

Existing research: See State of the Art and Methodology sections of the project report.

Proprietary KELO documents: FMEA KELO Drive 2020-11-19, KELO LC 200 FMEA, FMEA KELO UV-C Person Detection System 2022-06-09, KELO 500 Risk analysis 2022-02-17, ROPOD Risk analysis 2020-04-03, Safe navigation and obstacle avoidance 2021-02-11, KELO LC 200 overview, KELO LC 200 Sensor configuration.

KELO issue report GitLab: industrialization-issue-reports 1-47, dbot-issue-reports 1-11, kelo-uvc-issue-reports 1-16.

**Knowledge acquisition process:**

1. Define domains for which terms must be gathered.
   1. Refer to purpose of the ontology.
2. Discover knowledge sources for each domain.
   1. For DFMEA, consult existing DFMEA documents and standards.
   2. For issue reports, refer to the existing KELO issue report repository.
   3. For robotics, refer to existing IEEE standards and robotics ontologies.
   4. For miscellaneous terms, gather terms that are required for the other domains but are too general to be included in them.
3. Collect terms from each knowledge source.
   1. Use the middle-out approach.
      1. Gather a set of terms that is applicable to the ontology domain(s), regardless of whether their exact meaning is known.
      2. Remove terms that are synonyms or that are no longer relevant to the ontology as development progresses.
      3. Specialize or generalize the remaining terms as necessary.
4. Add terms to their respective domains, discarding those that are already included directly or through synonyms.
   1. Define which terms count as synonyms by comparing the definitions for terms between knowledge sources in a domain.