

## Appendix 1 - Thematic Analysis

### EPSRC Robotics Hubs. R&D Themes

| EPSRC Robotics Hubs. R&D Themes                             |
|---|
| <b>FAIR-SPACE Hub</b>                                       |
| #1 Vision & Perception                                      |
| #2 Mobility & Mechanisms                                    |
| #3 AI & Autonomy  |
| #4 Astronaut / Robot Interaction                            |
| #5 System Engineering                                       |
|   |
| <b>ORCA Hub</b>   |
| Intelligent Human-Robot Interaction with Explainable AI     |
| Mapping, Surveying and Inspection                           |
| Planning, Control and Manipulation                          |
| Robot and Asset Self-Certification                          |
|   |
| <b>RAIN Hub</b>   |
| #1, Remote Inspection - Mobility, Inspection and Operations |
| #2, Remote Inspection - Reusability and Robustness          |
| #3, Remote Handling   |

### Horizon 2020 System Abilities

| Horizon 2020 System Abilities |
|-------------------------------|
| Adaptability                  |
| Cognitive Ability             |
| Configurability               |
| Decisional Autonomy           |
| Dependability                 |
| Interaction Ability           |
| Manipulation Ability          |
| Perception Ability            |

## Horizon 2020 Technology Clusters

| Horizon 2020 Technology Clusters |   |
|----------------------------------|---|
| Cognition                        | Natural Interaction, Cognitive Architectures, Action Planning, Knowledge Representation & Reasoning, Learning, Development & Adaptation |
| Human Robot Interaction          | Human Machine Interface, Safety, Human Robot Collaboration  |
| Mechatronics                     | Actuators, Control, Sensors, Communications, Materials, Power Management & Supply, Mechanical Systems                                   |
| Navigation                       | Motion Planning, Mapping, Localisation  |
| Perception                       | Interpretation, Sensing   |
| Systems Development              | Systems Engineering, System Design, System Integration, System Architecture, Modelling & Knowledge Eng, Systems of Systems              |

## DOE Robotic Application Areas (Needs)

| DOE Robotics Application Areas (Needs)                                   |
|--|
| Nondestructive Assay (NDA) of Process Equipment and Piping               |
| Remote Structural Evaluation   |
| Site Modeling, Work Planning, and Training • Hazardous Material Handling |
| Fluid and Liquid Waste Processing and Removal                            |
| Process Equipment Removal  |
| Visual Inspection and Inventory Operations                               |
| Hazardous, Reactive and Explosive Gas Monitoring and Removal             |
| Access and Assessment of Confined, Physically Challenging Spaces         |
| Mapping and Assessment of Underwater Radiation Environments              |
| Material Handling and Manipulation in Glove Boxes and Hot Cells          |
| Remote Remediation of Contaminated, Physically Challenging Spaces        |
| Emergency Response   |
| Worker Enhancement and Injury Reduction                                  |
| Waste Material and Landfill Operations                                   |
| Soil Characterization and Handling                                       |
| Remote Equipment Maintenance and Repair                                  |

## DOE Robotic Technologies

| <b>DOE Robotic Technologies</b> |
|---------------------------------|
| Manipulator                     |
| Computer Vision                 |
| Robotic Hand                    |
| Mobility                        |
| Machine Learning                |
| ROS                             |
| Telepresence                    |
| Teleoperative Control           |
| Autonomous Control              |
| Modeling                        |
| Rotorcraft                      |
| Localization                    |
| Robot Teams                     |
| Wearable                        |

## DOE D&D Tasks

| <b>DOE D&amp;D Tasks</b> |
|--------------------------|
| Inspection               |
| Mapping                  |
| Swabbing                 |
| Manipulation             |
| Human Training           |
| Robot Training           |
| Radiation Detection      |
| Pipe Inspection          |
| Rubble Inspection        |
| Opening Enclosures       |
| Cleaning                 |

## DOD Robotic Themes

| DOD Robotic Themes          |  |
|-----------------------------|--|
| Interoperability            | Common/Open Architectures, Modularity and Parts Interchangeability, Compliance/Test, Evaluation, Verification and Validation, Data Strategies, Data Rights |
| Autonomy                    | Artificial Intelligence and Machine Learning, Increased Efficiency and Effectiveness, Trust, Weaponization   |
| Secure Network              | Cyber Operations, Information Assurance, Electromagnetic Spectrum and Electronic Warfare   |
| Human-Machine Collaboration | Human-Machine Interfaces, Human-Machine Teaming  |

## National Science Foundation (NSF) Robotics

| National Science Foundation (NSF) Robotics                 |
|--|
| Mechanisms and actuators                                   |
| Mobility and manipulation                                  |
| Perception   |
| Formal methods (particularly with respect to robot safety) |
| Learning and adaptation                                    |
| Control and planning                                       |
| Human robot interaction                                    |
| Multi-agent Robotics                                       |

## Innovate UK Robotics and Automated Systems

| Innovate UK Robotics & Automated Systems (RAS) Processes | Innovate UK Robotics & Automated Systems (RAS) Technologies |
|--|---|
| Manipulation & Processing                                | Cross Cutting Technology                                    |
| Data Gathering Monitoring                                | Cognitive Technologies                                      |
| Sorting & Storage  | Mechatronics  |

|                |                     |
|----------------|---------------------|
| Transportation | Systems Engineering |
|----------------|---------------------|

## Rolls Royce

| Rolls Royce       |
|-------------------|
| Inspection        |
| Material Removal  |
| Material Addition |
| Remote Operation  |
| Automation        |

## NASA

| NASA TX04 Robotics Taxonomy     |
|---------------------------------|
| Sensing & Perception            |
| Mobility                        |
| Manipulation                    |
| Human-Robot Interaction         |
| Autonomous Rendezvous & Docking |
| Robotics Integration            |