Survey on Development Practices and Challenges in Robotic Software Engineering

*Required

Instructions and Disclaimer

Are you an industrial practitioner in robotics? We know that software is becoming increasingly important for the robotics domain. However, researchers have a lack of knowledge on how you develop software for robotics and what challenges you face.

The whole questionnaire takes approximately 15 minutes. It elicits industrial engineering practices and challenges. Thank you for your participation.

Robotic platforms and context

1. **Which types of robots are used in your projects?** *
   Tick all that apply.

   - [ ] Mobile robots (i.e., ground robots with navigation capabilities)
   - [ ] Mobile manipulators (i.e., mobile robots with manipulation capabilities)
   - [ ] Humanoid robots (i.e., a robot with its body shape built to resemble the human body)
   - [ ] Collaborative robots (i.e., robots that are able through some mechanism to collaborate with humans or other robots)
   - [ ] Drones
   - [ ] Underwater robots
   - [ ] Industrial arms
   - [ ] Other: _____

2. **Which is the application field of your projects?** *
   Tick all that apply.

   - [ ] Factory automation
   - [ ] Agriculture
   - [ ] Cleaning
   - [ ] Transportation
   - [ ] Medical
   - [ ] Defense
   - [ ] General research on service robots
   - [ ] Other: _____

3. **Which type of service or product do you provide in your projects?** *
   Tick all that apply.

   - [ ] Drivers of low-level components
   - [ ] Low-level functionalities (e.g., navigation, self-localisation)
   - [ ] Planning and orchestration modules
   - [ ] Complete robotic system (e.g., BOSCH's lawnmower)
   - [ ] Other: _____

Activities and Paradigms

4. **Which activities are performed in your projects?** *
   Mark only one oval per row.

	0 (never)	1 (almost never)	2 (sometimes)	3 (very often)	4 (always)	Don't know
Project management	◯	◯	◯	◯	◯	◯
Requirements engineering	◯	◯	◯	◯	◯	◯
Architectural and detailed design	◯	◯	◯	◯	◯	◯
Implementation (i.e., writing code)	◯	◯	◯	◯	◯	◯
Automatic code generation	◯	◯	◯	◯	◯	◯
Testing and simulation	◯	◯	◯	◯	◯	◯
Real-world experimentation	◯	◯	◯	◯	◯	◯
Software maintenance/evolution	◯	◯	◯	◯	◯	◯
Other (please specify)	◯	◯	◯	◯	◯	◯

5. **If applicable, please specify your answer for "Other":**

6. **Which tools do you use for "Project management" in your projects?**
   For example, Jira, Excel, Trello, Redmine, in-house tool, ...

7. **Which tools do you use for "Requirements engineering" in your projects?**
   For example, Word, Excel, DOORS, Jira, Confluence, in-house tool, ...

8. **Which tools do you use for "Architectural and detailed design" in your projects?**
   For example, PowerPoint, MagicDraw, Rational Rose, Papyrus, OmniGraffle, UML, Papyrus, in-house tool, ...

9. **Which tools do you use for "Implementation" in your projects?**
   For example, Eclipse, IntelliJ, Visual Studio, Sublime, QT-creator, in-house tool, ...

10. **Which tools/languages do you use for "Automatic code generation" in your projects?**
    For example, Xtend, Xpand, Acceleo, Matlab, in-house tool/language, ...

11. **Which tools do you use for "Testing and simulation" in your projects?**
    For example, JUnit, Gazebo, Simbad, LEGO Mindstorms, in-house tool, ...

12. **Which tools do you use for "Real-world experimentation" in your projects?**
    For example, rosbag, roslaunch, multimaster_fkie, in-house tool, ...

13. **Which tools do you use for "Software maintenance/evolution" in your projects?**
    For example, Eclipse, IntelliJ, Visual Studio, Sublime, QT-creator, in-house tool, ...

14. **Which software development paradigms are applied in your projects?** *
    Mark only one oval per row.

	0 (never)	1 (almost never)	2 (sometimes)	3 (very often)	4 (always)	Don't know
Object-oriented programming						
Functional programming						
Component-based software engineering						
Model-based software development						
Software product line engineering						
Other (please specify)						

15. **If applicable, please specify your answer for "Other":**

Development practices

16. **Which of these software engineering processes do you apply in your projects?** *
Mark only one oval per row.

	0 (never)	1 (almost never)	2 (sometimes)	3 (very often)	4 (always)	Don't know
Waterfall						
Hybrid (e.g., V-Model, Spiral)						
Agile (e.g., SCRUM, Extreme Programming)						
Other (please specify below)						

17. **If applicable, please specify your answer for "Other":**

_____

18. **Which of these software languages do you use in your projects?** *
A Domain Specific Language (DSL) is a computer language specialized to a particular application domain.
Mark only one oval per row.

	0 (never)	1 (almost never)	2 (sometimes)	3 (very often)	4 (always)	Don't know
Java						
C						
C++						
Python						
UML						
MATLAB / Simulink						
Self-developed DSLs						
Third-party DSLs						
Other (please specify below)						

19. **If applicable, please specify your answer for "Other":**

_____

20. **Which of these robotic frameworks do you use in your projects?** *
Tick all that apply.

- [ ] ROS
- [ ] ROS 2.0
- [ ] OROCOS
- [ ] SmartSoft
- [ ] Yarp
- [ ] Other: _____

21. **When you use third-party software (e.g., libraries), what are their licensing models?** *
Tick all that apply.

- [ ] Proprietary
- [ ] Open source
- [ ] Don't know
- [ ] Other: _____

22. **Under which license do you release your own software?** *
Tick all that apply.

- [ ] Proprietary
- [ ] Open source
- [ ] Don't know
- [ ] Other: _____

23. **Which software artifacts are reused across projects in your organization?** *
Reuse includes "copy and paste" style reuse and systematic reuse
Mark only one oval per row.

	0 (never)	1 (almost never)	2 (sometimes)	3 (very often)	4 (always)	Don't know
Source code	◯	◯	◯	◯	◯	◯
Configuration files	◯	◯	◯	◯	◯	◯
Software models	◯	◯	◯	◯	◯	◯
Libraries (source or binaries)	◯	◯	◯	◯	◯	◯
Software components	◯	◯	◯	◯	◯	◯
Documentation	◯	◯	◯	◯	◯	◯
Test cases	◯	◯	◯	◯	◯	◯
Other (please specify below)	◯	◯	◯	◯	◯	◯

24. **If applicable, please specify your answer for "Other":**

_____

25. **Have you ever developed a software component from scratch rather than reusing an existing (either self-developed or third-party) one? If yes, why?**
Reuse includes both "copy and paste" style reuse and systematic reuse (e.g., creating shared libraries or a platform)
Tick all that apply.

- [ ] Lack of documentation
- [ ] Lack of trust
- [ ] Licensing issues
- [ ] Internal policies
- [ ] Technical problems (e.g., component's granularity didn't fit, missing functionality, incompatible interfaces)
- [ ] Favouring self-developed solutions
- [ ] Other: _____

26. **Which reuse style is the most commonly used in your projects?** *
Tick all that apply.

- [ ] Copy-paste-modify
- [ ] Systematic reuse (e.g., frameworks, components, libraries, ...)
- [ ] Both equally

27. **Which mechanisms to facilitate interoperability among components are applied in your projects? Leave empty if none.**
Tick all that apply.

- [ ] We rely on the experience and skills of our team
- [ ] We follow a precise architecture of the system
- [ ] We have a clear definition of interfaces of each component
- [ ] We follow a standard (please specify below)
- [ ] Other (please specify below)

28. **If applicable, please specify your answer for "We follow a standard " / "Other":**

_____

Quality Assurance

29. **Which kind of quality assurance techniques do you perform in your projects?** *
Mark only one oval per row.

	0 (never)	1 (almost never)	2 (sometimes)	3 (very often)	4 (always)	Don't know
Unit testing	◯	◯	◯	◯	◯	◯
Integration testing	◯	◯	◯	◯	◯	◯
Performance testing	◯	◯	◯	◯	◯	◯
Code reviews	◯	◯	◯	◯	◯	◯
Formal methods (please specify below)	◯	◯	◯	◯	◯	◯
Other (please specify below)	◯	◯	◯	◯	◯	◯

30. **If applicable, please specify your answer for "Formal methods" / "Other":**

_____

31. **From where do you get test data in your projects?** *
Tick all that apply.

- [ ] Manual specification based on experience
- [ ] Simulation
- [ ] Runtime monitoring
- [ ] Don't know
- [ ] Other: _____

32. **How do you find the root causes of failures in your projects?** *

Mission Specification

A mission is a kind of functional requirement that describes the set of tasks a robot should do. For example: "A robot must go the kitchen, grab a cup of coffee and go back to the office".

33. **Who specifies missions for robots in your projects?** *

Tick all that apply.

- [ ] Developer
- [ ] Non-technical end-user
- [ ] Technically skilled end-user
- [ ] Integrator
- [ ] Don't know
- [ ] Other:

34. **Which mission specification method do you use in your projects?** *

A Domain Specific Language (DSL) is a computer language specialized to a particular application domain. In this case, mission specification.

Mark only one oval per row.

	0 (never)	1 (almost never)	2 (sometimes)	3 (very often)	4 (always)	Don't know
Hard-coded (in the used programming language, XML file, etc)						
Use of logical language (e.g., LTL, CTL)						
Use of a third-party DSL						
Use of an own DSL						
Other (please specify)						

35. **If applicable, please specify your answer for "Other":**

Challenges and solutions

36. **For the following items, to which extent do you agree that they describe a challenge in your projects? A challenge is a task that makes the development difficult.** *

Mark only one oval per row.

	0 (strongly disagree)	1 (disagree)	2 (neutral)	3 (agree)	4 (strongly agree)	Don't know
Specifying missions for robots						
Software reuse						
Lack of documentation						
Lack of standards						
Interoperability among heterogeneous components						
Validating the robotic system						
Safety certification						
Robustness						
Dynamic adaptation of robotic behavior						
Transition from simulation to real world applications						
Applying artificial intelligence techniques						
Other (please specify below)						

37. **If applicable, please specify your answer for "Other":**

38. **For the encountered challenges, which solutions do you apply to address them? Please, specify solutions together with the challenges they address.** *

39. **Is there something you would like to add regarding the biggest challenges in robotics software engineering?**

General perception

40. **How do you think robotics software engineering differs from software engineering in other domains?** *

41. **Do you think the practices applied in robotics software engineering should change? If yes, in what way?**

Survey part: Participant background

To put your responses into context, we would appreciate if you could provide us with a bit of your background.

Demographics

42. **What is your occupation?**
Mark only one oval.

- ◯ Industrial practitioner: Programmer
- ◯ Industrial practitioner: Leading Technical Role
- ◯ Academic/Scientist
- ◯ Other: _____

43. **For how long have you been working in robotics? Please specify the time in years.**

44. **To which gender identity do you most identify?**
Mark only one oval.

- ◯ Female
- ◯ Male
- ◯ Diverse
- ◯ Prefer not to say
- ◯ Other: _____

45. **What is the size of your company?**
Mark only one oval.

- 1-10
- 11-30
- 31-50
- +50

46. **Contact information**
To receive the study results, please enter your email address

47. **Can we contact you via this email address for clarifications and follow-up questions?**
Mark only one oval.

- Yes
- No