Resilience in mobile manipulation

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ABSTRACT

Safety and Security in robotics have long been known to go together hand in hand in order to make robots safe around humans. In modern, intelligent robots however, where software is a dominating part, the quality and reliability of software is a key issue.

To gain most from the increased potential of robots, adequate software architectures must be developed to handle their complexity. In this abstract, we sketch our ideas and work towards combining software architectures with robot security to work towards highly capable, secure robots.

KEYWORDS

software, security, mobile manipulation

1 RESILIENT SOFTWARE FOR COMPLEX ROBOTS

Security in robotics has gained some attention in the recent years. It has been shown that the most popular framework, ROS, has severe deficiencies in terms of security [1] resulting in easy-to-hack robots [2]. However, software engineering methods in robotics are still lacking the proper attention. We argue that for safety and security of robots, high-quality software is key. We present our work in software architectures and their security and hint towards later research directions.

1.1 Software architecture for mobile manipulation

In [3], we have shown an architecture for our CHIMERA mobile manipulator. This architecture separates the software into hardware, abstraction and application layers and defines clear interfaces between each. The driver layer can be exchanged to enable the reuse of business software on multiple robot platforms. Further, it defines a dedicated space where system integrators can enhance the core firmware with drivers and additional functions.

1.2 Security architecture for mobile manipulation

The architecture described above needs security measures integrated in order to protect the robot from outside attacks. Obviously, network and operating system security are required measures. However, we are convinced, that a multi-level approach is required, where multiple layers of security are implemented. Our secure architecture is shown in fig 1.

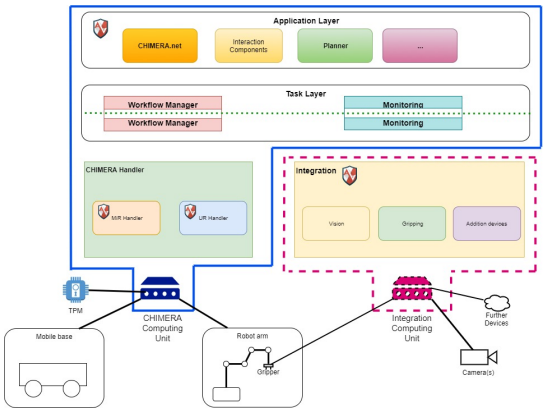

Figure 1: Software architecture for mobile manipulators.

In our approach to securing the software architecture, we heavily rely on isolation. We use two dedicated computing units where each one has different security levels. The CHIMERA computing unit contains the core business software and drivers for mobile base and arm. The Integration computing unit contains code and device drivers developed by system integrators. This separation ensures, that the integrator cannot compromise the security of the core system. In addition, individual layers of the architecture are isolated in separate docker containers with well-defined security boundaries.

2 RESEARCH DIRECTIONS

As part of this ongoing work, we want to establish Software as the third "S" of great robots besides Safety and Security. We see all three topics tightly integrated and required to make future robots productive companions in- and outside of industry. We will work on methods for better robot software that also enables developers to better test their software and easily employ security measures.

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IS2019, October 7–11, 2019, Ljubljana, Slovenia, Europe