Software Product Lines for Embedded Systems: Individual Projects/Theses
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Software Product Line Engineering (SPLE) is a paradigm to develop families of related software-intensive systems efficiently. In SPLE, different variants of a software are distinguished in terms of the features they provide.

In our working group, we have developed FeatureIDE, an integrated development environment for software product lines. FeatureIDE integrates several novel implementation techniques that support automated generation of customized variants. In feature-oriented programming (FOP), a software system is decomposed into a set of feature modules that encapsulate the behavior of a feature. A feature module changes the program by introducing or modifying elements. Products can be automatically generated by selecting the desired features and composing the corresponding modules.

The possibility to automatically generate customized variants of a software system is especially promising for embedded systems in which resources are limited and all-in-one solutions do not suffice.

Feature-Oriented Programming with C

So far, FeatureIDE focuses on feature-oriented extensions of object-oriented programming languages such as Java. As a part of ongoing research, we investigate the potential of FOP to the programming language C which plays an especially important role for the development of embedded systems but poses several challenges:

- Variability-Aware C Preprocessor: The C Preprocessor (cpp) is automatically called by the C compiler to transform C programs before they are compiled. It handles the inclusion of header files (#include), expansion of macros (define), and other useful language features. Feature-oriented programming poses some special challenges for the C preprocessor in order to consider the decomposition of the source code into separate feature modules. A concept to handle this challenges must be developed and should be implemented as an extension of FeatureIDE.

- Advanced Refinement Concepts: First experiments with the application of FOP to C indicates that advanced refinement concepts should be investigated. Typically, in FOP the refinement of a program is based on the granularity of complete functions. In this project, novel ideas to improve this refinement concept should be developed, implemented, and evaluated, e.g., by allowing features to refine more specific language elements, e.g., if-then-constructs, structs, switch-case constructs, etc.
Feature-Oriented Development of Robotic Applications

The Robot Operating System (ROS) is widely used as a framework to develop robotic applications. The wide range of applications has lead to the development of more than 1700 different packages that are available for ROS. However, for each application only a small subset of this variety is required, e.g., depending on the used hardware. It becomes increasingly difficult for researchers to maintain an overview of valid configurations for a given robotic device because of many implicit dependencies, e.g., certain sensor devices may require different processing algorithms which must be considered. In an ongoing research project, we investigate the application of Software Product Line Engineering and novel implementation techniques such as feature-oriented programming for the development of robotic applications with ROS.

Key points:

- Learn about two interesting research areas: Software Product Lines & Robotics
- Investigate the challenges of variability in the robotics domain
- Apply Software Product Lines to handle the variability of robotic applications

Please contact us (fabian.benduhn@ovgu.de) to discuss specific tasks for individual research projects, bachelor/master theses, etc. with a focus on one of the topics.