Master Thesis

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1 Abstract

TODO

Contents

2 Introduction

Debugging Rust code on embedded system today is not a very good experience for many reasons. One of the big problems is debugging optimized code is often near impossible. That is because the compilers today are very good at inlining the code and removing unused code. This changes the program so drastically in many cases that when trying to debug the code all the original variable can be optimized out. Thus the user doesn't get any useful information from the debugger about the program which makes is near impossible to debug. One of the big reasons why variable gets optimized out is because unoptimized code always push the value of the variable to memory which then can be read by the debugger at anytime. This is not done for optimized code because speed is prioritized and storing the value of a variable that will not be used on the stack is costly.Thus the time that most variable exist is very short in optimized code which results in that the debugger saying that a variable is optimized out.

2.1 Background

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2.2 Motivation

The main motivation is that optimized *Rust* code can be up to 100 times faster then unoptimised code. That is a very large difference in speed compared to other languages like *C* for example, were the optimized code is about 2-4 times faster then the unoptimized code. Thus for language like *C* it is much more acceptable to not be able to debug optimized code because the different isn't that large compared to *Rust*. But in the case of *Rust* code the different is so large that some programs are to slow to run without optimization. This causes the problem that the code can't be debugged because debuggers don't work well on optimized code and unoptimized code is to slow to run. Because of that there is a need for debuggers that can give enough information to debug optimized *Rust* code. Then there is also the argument that relying only on testing the optimized code instead of going through and checking that is is correct is bad. The reason being that there can be extremely many paths that needs to be tested and it is sometimes not feasible to test all of them. In these cases it is less costly to verify that the code is correct then to test every path.

Another large motivation for this thesis is that the most common way of debugging *Rust* code on embedded systems is complicated for a beginner. One of the reason being that it requires two programs being *openocd* and *gdb*, it also requires configuration files which takes some time to understand and configure. This is not very accessible for people that have no experience with these programs and is unnecessarily complicated. The ideal solution for accessibility would be to have a single program instead of two and that it requires less configuring, thus making it as easy as possible for a new person to debug there code.

Most of the debuggers used for *Rust* code are written in other programming languages and there isn't a lot of debugging tools written in *Rust* yet. Thus one of the motivation for the thesis debugger to be written in *Rust* is to contribute with a example of a debugger written in *Rust* to the *Rust* community. This also relates back to improving debugging for optimized *Rust* code because that is a large and hard problem that requires a lot of work to solve and to maintain the solution. One of the most realistic way that will happen is if the *Rust* community around debugging grows and more people contribute with there solutions and ideas.

Another way this thesis contributes to the *Rust* community is by making a library that simplifies the process of retrieving information form the debug information. This is important because it makes retrieving debug information simpler for new developers to start contributing to the *Rust* debug community. Which will hopefully lead to better debugging for optimized *Rust* code.

2.3 Problem definition

There are two main problem that this thesis tries to tackle to improve the experience of debugging optimized code for embedded systems. The fist problem is about the generation of the debug information, if more debug information can be generated then there is more information the debugger can retrieve an show the user. This is also were the problem starts with debugging optimized code, because debuggers needs the debug information to understand the relation between the source code and the machine code. Thus it is very important that the compiler generates as much debug information as possible, because there is nothing that can be done later to get more information. The first problem then is to look at the different options that can be set in the *llvm* compiler to improve the generations of debug information without impacting the optimisation of the code to much. Speed of the resulting code is still a big priority.

The second problem is looking at the available debug information that the *llvm* compiler generates for optimized code and creating a debugger that utilises that information to the fullest. This problem has two parts to it, the first being retrieving the needed information from the debug information. This will be the hardest part and is the most important for improving the debugging for optimized code. The second part is to display the debug information to the user in a user friendly way.

The goal of solving these to problems is to create a debugger that gives a better debugging experience for optimized rust code on embedded systems then some of the most commonly used debugger, such as *gdb* and *lldb*. And to inspire further development for debugging tools in the rust community.

2.4 Equality and ethics

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2.5 Sustainability

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2.6 Delimitations

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2.7 Thesis structure

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3 Related work

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4 Theory

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5 Implementation

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6 Evaluation

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7 Discussion

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8 Conclusions and future work

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