MASTER THESIS

Thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Engineering at the University of Applied Sciences Technikum Wien - Degree Program Mechatronics/Robotics

Virtualisierung eines Echtzeit-Betriebssystems zur Steuerung eines Roboters mit Schwerpunkt auf die Einhaltung der Echtzeit

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Wien, March 26, 2024

Declaration

Wien, March 26, 2024   Signature

Kurzfassung

Erstellung einer Echtzeit-Robotersteuerungsplattform unter Verwendung von Salamander OS, Xenomai, QEMU und PCV-521 in der Yocto-Umgebung. Die Plattform basiert auf Salamander OS und nutzt Xenomai für Echtzeit- Funktionen. Dazu muss im ersten Schritt die Virtualisierungsplattform evaluiert werden. (QEMU, Hyper-V, Virtual Box, etc.) Als weiterer Schritt folgt die Anbindung eines Roboters über eine VARAN-Bus Schnittstelle. Das gesamte System wird in der Yocto-Umgebung erstellt und konfiguriert. Das Hauptziel der Arbeit ist es, herauszufinden, wie die Integration von Echtzeit-Funktionen und effizienten Kommunikationssystemen in eine Robotersteuerungsplattform die Reaktionszeit und Zuverlässigkeit von Roboteranwendungen verbessern kann

Abstract

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

Contents

1 Einleitung

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

$$\bar{x} = \frac{1}{n} \sum_{i=1}^{i=n} x_i = \frac{x_1 + x_2 + \ldots + x_n}{n}$$

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$$\int_0^\infty e^{-\alpha x^2} \mathrm{d}x = \frac{1}{2} \sqrt{\int_{-\infty}^\infty e^{-\alpha x^2} \mathrm{d}x \int_{-\infty}^\infty e^{-\alpha y^2} \mathrm{d}y} = \frac{1}{2} \sqrt{\frac{\pi}{\alpha}}$$

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$$\sum_{k=0}^\infty a_0 q^k = \lim_{n \to \infty} \sum_{k=0}^n a_0 q^k = \lim_{n \to \infty} a_0 \frac{1 - q^{n+1}}{1 - q} = \frac{a_0}{1 - q}$$

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$$x_{1,2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-p \pm \sqrt{p^2 - 4q}}{2}$$

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$$\frac{\partial^2 \Phi}{\partial x^2} + \frac{\partial^2 \Phi}{\partial y^2} + \frac{\partial^2 \Phi}{\partial z^2} = \frac{1}{c^2} \frac{\partial^2 \Phi}{\partial t^2}$$

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1.1 Stand der Technik

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

1.2 Problem- und Aufgabenstellung

In robotics, accurate and timely control is crucial to ensure precise movements and reliable interaction with the environment. However, existing robot control systems often have limitations in terms of real-time capabilities and communication efficiency, which can have a detrimental effect on response time and reliability. The challenge is to develop a powerful real-time robot control platform that overcomes these limitations and improves the performance of robotic applications.

1.3 Zielsetzung

The main objective of this work is to create a real-time robot control platform that integrates Salamander OS, Xenomai, QEMU and PCV-521 in the Yocto environment. By combining these technologies, a platform is to be created that provides real-time functions and efficient communication systems. This integration is expected to lead to a significant improvement in the response time and reliability of robot applications.

2 Methodik

The methodology of this thesis consists of several steps. First, a comprehensive literature review is conducted to understand the current trends and challenges in real-time robot control. Based on the literature study, a suitable virtualisation platform is selected. After the selection of the virtualisation platform, the robot control platform is implemented. This step includes the installation and configuration of Salamander OS, Xenomai, QEMU and PCV-521 in the Yocto environment. Once the platform has been implemented, the robot is connected via a VARAN bus interface. Finally, the platform is evaluated to determine how the integration of real-time functions and efficient communication systems improves the response time and reliability of robot applications.

- Evaluation der Virtualisierungsplattform: Ich werde verschiedene Virtualisierungsplattformen wie QEMU, Hyper-V, Virtual Box usw. evaluieren. Dies ist ein wichtiger Schritt, um die beste Plattform für meine Anforderungen zu finden.

- Erstellung und Konfiguration des Systems in der Yocto-Umgebung: Ich werde das Yocto-Framework verwenden, um mein Embedded Linux System zu erstellen und zu konfigurieren. Yocto bietet viele Tools und Funktionen, die mir bei der Erstellung und Konfiguration meines Systems helfen können.

- Verbesserung der Reaktionszeit und Zuverlässigkeit von Roboteranwendungen: Mein Hauptziel ist es, herauszufinden, wie die Integration von Echtzeitfunktionen und effizienten Kommunikationssystemen die Reaktionszeit und Zuverlässigkeit von Roboteranwendungen verbessern kann. Ich strebe an, die Leistung und Zuverlässigkeit meiner Roboteranwendungen zu verbessern, indem ich ihre Fähigkeit verbessere, in Echtzeit auf Ereignisse zu reagieren.

- Anbindung eines Roboters über eine VARAN-Bus Schnittstelle: Ich plane, einen Roboter in mein System zu integrieren. Ich werde eine VARAN-Bus Schnittstelle verwenden, um eine schnelle und zuverlässige Kommunikation zwischen dem Roboter und dem Steuerungssystem zu gewährleisten.

Querverweise werden in LaTeX automatisch erzeugt und verwaltet, damit sie leicht aktualisiert werden können. Hier wird zum Beispiel auf Abbildung **??** verwiesen.

Figure 1: Beispiel für die Beschriftung eines Buchrückens.

Und hier ist ein Verweis auf Tabelle **??**. Das gezeigte Tabellenformat ist nur ein Beispiel. Tabellen können individuell gestaltet werden.

Hier wird auf die Formel **??** verwiesen.

Figure 2: 2. Beispiel für die Beschriftung eines Buchrückens.

Table 1: Semesterplan der Lehrveranstaltung „Angewandte Mathematik".

Datum	Thema	Raum
20.08.2008	Graphentheorie	HS 3.13
01.10.2008	Biomathematik	HS 1.05

Table 2: 2. Semesterplan der Lehrveranstaltung „Angewandte Mathematik".

Datum	Thema	Raum
20.08.2008	Graphentheorie	HS 3.13
01.10.2008	Biomathematik	HS 1.05

$$x = -\frac{p}{2} \pm \sqrt{\frac{p^2}{4} - q} \tag{1}$$

$$x = -\frac{p}{2} \pm \sqrt{\frac{p^2}{4} - q} \tag{2}$$

```cpp
#include <iostream>

void SayHello(void)
{
    // Kommentar
    cout << "Hello_World!" << endl;
}

int main(int argc, char **argv)
{
    SayHello();
    return 0;
}
```

Code 1: 1. Beispiel

Literaturverweise sollten automatisch verwaltet werden, vor allem, wenn es viele Quellenverweise gibt. Beispiele sind [**Ko05a**], [**Ko05b**], [**MiGo05**], [**TeGo14**], [**HuHa07**], [**HuZi10**], [**ZiKu07**], [**He07**], [**SIE11**], [**SIE14**], [**ISO98**], [**ATM11**], [**Hu11**], [**Po10**]. Das verwendete Zitierformat (bzw. das Format des Literaturverzeichnisses) ist entspechend der Vorgaben der Studiengänge zu wählen. Es wird dringend empfohlen, BibTeX zu verwenden (wie in diesem Beispiel).

3 Hauptteil

4 Resultate

5 Diskussion

6 Zusammenfassung und Ausblick

List of Figures

List of Tables

List of Code

List of Abbreviations

ABC Alphabet

WWW world wide web

ROFL Rolling on floor laughing

A Anhang A

B Anhang B