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Remote Lab

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Report for Project and Seminar Class
Computer Science and Computer Engineering BSc

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Abstract

The design, development, implementation, and finally, the validation of digital systems require, in addition to simulators, the use of hardware to verify their implementations in real devices. In the current teaching paradigm, in which face-to-face time is reduced and remote and autonomous work is increased, it is necessary to create alternatives to the current model. The Remote Lab project aims to provide a virtual lab with access to remote hardware. This lab consists of a web application running on an embedded system. The web application, accessed via a website, aims to provide a dashboard where users can join a laboratory. This is where users can control the remote hardware. A hierarchy system will be implemented to provide different roles, each with their own permissions relative to how users can browse the information provided by the web application.

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Chapter 1

Introduction

1.1 Context and Motivation

In recent years, the need for remote access to laboratory resources has grown significantly, driven by the expansion of online education, research collaboration, and the increasing complexity of experimental setups. Traditional laboratories often require physical presence, which can limit accessibility and flexibility for students, researchers, and professionals. The **Remote Lab** project aims to address these challenges by providing a platform that enables secure, efficient, and user-friendly remote access to laboratory equipment and resources.

1.2 Objectives

The main objectives of the Remote Lab project are:

- To design and implement a scalable platform for remote laboratory access.
- To ensure secure authentication and authorization for different user roles.
- To provide an intuitive user interface for managing and scheduling laboratory sessions.
- To support integration with various types of laboratory hardware.

1.3 Scope

This project focuses on the development of the core platform, including backend services, user management, and basic hardware integration. Advanced features such as real-time data analytics, support for a wide range of laboratory devices, and extensive reporting capabilities are considered out of scope for the current phase.

1.4 Methodology

The project follows a modular and iterative development approach, leveraging modern software engineering practices. The backend is implemented using Kotlin and follows a layered

architecture, while the frontend is developed with Next.js to provide a responsive and accessible user experience.

1.5 Structure of the Document

The remainder of this report is organized as follows:

- **Chapter 2:** Related Work – Overview of existing solutions and technologies.
- **Chapter 3:** System Architecture – Description of the overall system design.
- **Chapter 4:** Implementation – Details of the main components and their interactions.
- **Chapter 5:** Evaluation – Assessment of the system's performance and usability.
- **Chapter 6:** Conclusions and Future Work – Summary of achievements and directions for future development.

Chapter 2

Placement

This chapter is organized into two sections, where we describe related work and some systems similar to the one developed in this project.

2.1 Related Work

In recent years, several initiatives have emerged to provide remote access to laboratory resources, especially in the context of higher education and research. Projects such as MIT's iLab and LabShare have demonstrated the feasibility and benefits of remote laboratories, enabling students and researchers to conduct experiments from anywhere in the world. These platforms typically focus on providing secure access, scheduling, and integration with a variety of laboratory equipment. The literature highlights the importance of usability, scalability, and security in the design of such systems, as well as the challenges associated with real-time interaction and hardware integration.

2.2 Similar Systems

There are several systems that offer functionalities similar to those of the Remote Lab project. For example, the iLab Shared Architecture (ISA) provides a framework for sharing laboratory equipment over the internet, supporting both batch and interactive experiments. LabShare is another notable example, offering a collaborative platform for remote experimentation and resource sharing among institutions. Other systems, such as WebLab-Deusto and VISIR, focus on specific domains like electronics and instrumentation, providing specialized interfaces and tools for remote experimentation. These systems serve as valuable references for the development of the Remote Lab platform, informing decisions related to architecture, user experience, and integration with laboratory hardware.

Chapter 3

Proposed Architecture

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3.1 Nome da secção deste capítulo

Texto da secção. Na figura 4.1 mostra-se o logótipo do ISEL. Em [**?**] encontra várias referências para o assunto. O artigo [**?**] é o mais popular conforme indicação do IEEE. Logo a seguir aparece [**?**]. A identificação das referências deve ser melhorada.

Figure 3.1: Legenda da figura com o logótipo do ISEL.

Continuação do texto depois do parágrafo que refere a figura.

3.2 A segunda secção deste capítulo

Na segunda secção deste capítulo, vamos abordar o enquadramento, o contexto e as funcionalidades.

3.2.1 A primeira sub-secção desta secção

As sub-secções são úteis para mostrar determinados conteúdos de forma organizada. Contudo, o seu uso excessivo também não contribui para a facilidade de leitura do documento.

3.2.2 A segunda sub-secção desta secção

Esta é a segunda sub-secção desta secção, a qual termina aqui.

3.3 Organização do documento

O restante relatório encontra-se organizado da seguinte forma.

Chapter 4

Implemented Infrastructure

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4.1 Nome da secção deste capítulo

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References