Build a Cloud-based Temperature Monitoring system IOT using Spartan3an Starter Kit

A Project Work Synopsis

Submitted in the partial fulfilment for the award of the degree of

BACHELOR OF ENGINEERING

IN

COMPUTER SCIENCE WITH SPECIALIZATION IN

DevOps

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January, 2024

Abstract

Keywords: IOT Based, Temperature Monitoring System, FPGA

This research paper presents a temperature monitoring system that utilizes the Internet of Things (IoT) technology and the Spartan3an Starter Kit. The system's purpose is to provide real-time temperature data, which allows for efficient and remote monitoring of various applications. The project aims to develop a flexible and scalable solution to meet remote temperature monitoring needs. The system could significantly impact the development of sustainable technologies in areas such as India, where demand for cleaner energy sources is high. This abstract introduces the project, its methodologies, and its potential impact on different applications. The proposed research aims to develop an Internet of Things (IoT) based temperature monitoring system using the Spartan3an FPGA Starter Kit. This system will enable real-time temperature tracking and data uploading to the cloud. By utilizing Wi-Fi connectivity and cloud servers, we can achieve efficient and remote monitoring of temperature-sensitive environments.

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1. INTRODUCTION

The emergence of Internet of Things (IoT) technologies has brought about a significant transformation across various sectors, facilitating effortless connectivity and data exchange between physical devices and the virtual world. One of the most notable advancements has been the integration of IoT with Field Programmable Gate Arrays (FPGAs), which has opened up a whole new realm of possibilities for developing adaptive and highly efficient embedded systems. In this paper, we introduce a pioneering approach to creating a Cloud-based temperature monitoring system using the Spartan3AN FPGA starter kit.

Traditionally, temperature monitoring in different settings, ranging from industrial installations to food processing plants and medical facilities, has relied on standalone sensors with limited connectivity. However, by harnessing the power of FPGA technology alongside IoT principles, this system provides a scalable and versatile solution. By integrating sensors, analog-to-digital conversion, and wireless communication modules, we can acquire, process, and transmit real-time temperature data to the cloud for centralized monitoring and analysis.

1.1 Problem Definition:

- **Comparison of Proposed Technologies:**
    - Evaluate the effectiveness and efficiency of Spartan3AN FPGA platform vs. traditional ARM processors in IoT-based temperature monitoring systems.
    - Investigate the advantages and limitations of FPGA-based implementations in terms of scalability, compatibility, and performance.
- **Integration of Cloud Services:**
    - Explore integration of cloud services (e.g., AWS IoT, Azure IoT) for data storage, processing, and visualization.
    - Assess the feasibility and reliability of cloud-based solutions for real-time temperature monitoring and data analytics.
- **Security and Privacy Considerations:**
    - Address security concerns related to data transmission over the internet and storage in cloud environments.
- **Comparison with Previous Research:**
    - Review existing literature on cloud-based IoT temperature monitoring systems to identify gaps and opportunities for improvement.
    - Highlight advancements in hardware and software technologies for similar applications and compare their performance with the proposed solution.[2]

1.2 Problem Overview

Developing a cloud-based temperature monitoring system utilizing the Spartan3AN Starter Kit for IoT involves evaluating the efficacy and efficiency of FPGA (Field-Programmable Gate Array) platforms versus traditional ARM processors. This entails investigating FPGA-based implementation advantages like scalability and performance, juxtaposed with limitations in compatibility. Additionally, integrating cloud services such as AWS IoT or Azure IoT for storage, processing, and visualization necessitates assessing feasibility and reliability for real-time monitoring and analytics. Security considerations encompass encryption, authentication, and access control to ensure data confidentiality and integrity during transmission and storage. This study also reviews existing literature to identify gaps and opportunities, comparing advancements in hardware and software technologies for similar applications.[3][4][5]

1.3 Hardware Specification

The Spartan3AN FPGA starter kit features a 2-channel ADC onboard, with one channel connected to an LM35 temperature sensor. By utilizing VHDL code, this kit is capable of converting analogue signals to digital and reading the LM35 output as digital data. Additionally, a 2*16 LCD is included to conveniently present the hardware information.

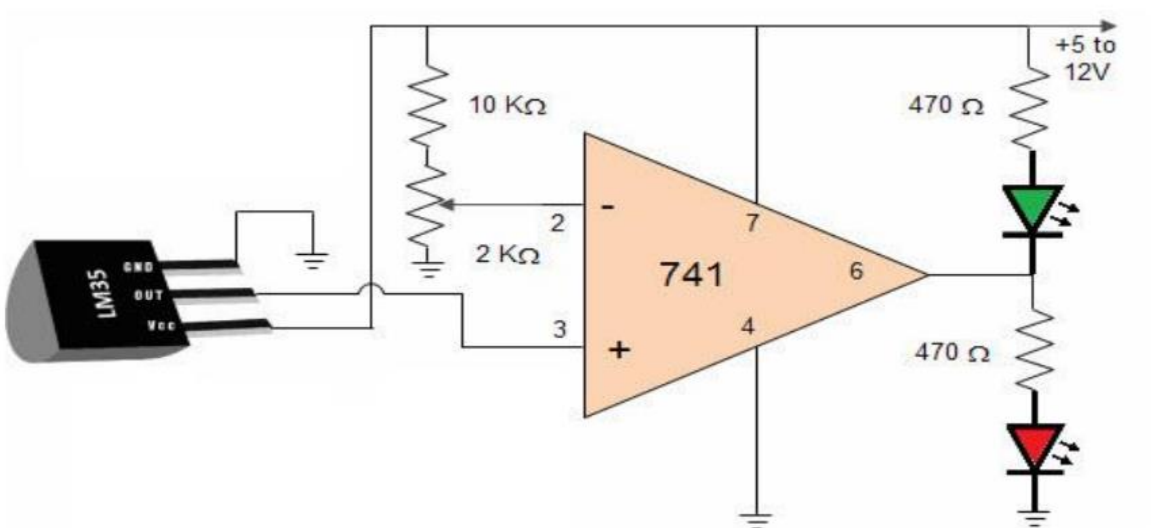

Figure 1: Circuit Diagram[1]

This circuit consists of-

- LM35 temperature sensor transmitter and receiver pair
- Resistors ranging in kilo-ohms
- Supply voltage.

2. LITERATURE SURVEY

Ajay Rupani, in her review article titled "A Review of FPGA Implementation of Internet of Things," discusses the growth of IoT [1]. With the advent of embedded and sensing technology, the internet has enabled an unprecedented growth of information sharing. As a result, the number of smart devices, including sensors, mobile phones, RFIDs, and smart grids, has rapidly increased in recent years. In her review article titled "A Review of FPGA Implementation of Internet of Things," Ajay Rupani discusses IoT's growth. IoT is a global dynamic network infrastructure that integrates into the information network and allows services to interact with "smart things/objects."

Andrea Caputo's review article titled "The Internet of Things in Manufacturing Innovation Processes" discusses IoT services. It can be defined as a future internet component that links and modifies the state of smart devices while considering security and privacy concerns.

2.1 Existing System

Figure 2: Cloud-based temperature monitoring output image[2]

The existing system for building a cloud-based temperature monitoring system using Spartan3an Starter Kit involves integrating IoT sensors with the FPGA board to capture temperature data. This data is then processed and transmitted to the cloud via Wi-Fi or Ethernet connection, where it can be accessed and analyzed remotely. Utilizing the FPGA's processing power ensures real-time data processing and efficient communication with the cloud. Additionally, cloud platforms such as AWS or Azure provide the infrastructure for storing and managing the collected data securely.

2.2 Literature Review Summary

Year and Citation	Article /Author	Tools /Software	Technique	Source	Evaluation Parameter
2018 [7]	**"Cloud-Based IoT Solutions for Monitoring Temperature and Humidity"**	**FPGA (Spartan3an Starter Kit), Cloud Platforms (AWS, Azure)**	**IoT Sensor Integration, Data Processing, Cloud Communication**	**IEEE Xplore**	**Real-time Data Processing, Efficiency, Cloud Connectivity**
2020 [8]	**"Design of Cloud-Based Temperature Monitoring System for Agricultural Greenhouse Environment"**	**Spartan3 an Starter Kit, Cloud Platforms**	**IoT Sensors, Cloud Integration**	**IEEE Xplore**	**Agricultural Applications, Remote Monitoring, Data Analysis**
2021 [9]	**"Cloud-Based IoT Temperature and Humidity Monitoring System"**	**Spartan3an Starter Kit, Cloud Platforms**	**IoT Sensor Integration, Cloud Communication**	**International Journal of Engineering and Advanced Technology**	**Scalability, Security, Remote Access**
2022 [10]	**"Implementation of IoT-based Temperature Monitoring System Using Spartan3an Starter Kit"**	**Spartan3an Starter Kit, Cloud Platforms**	**FPGA Programming, Cloud Integration**	**IEEE Conference**	**Accuracy, Power Consumption, Cost-effectiveness**

3. Project formulation:

Developing a cloud-based temperature monitoring system using the Spartan3AN Starter Kit for IoT applications requires addressing several key challenges. These challenges include optimizing the FPGA-based implementation for efficient sensor data processing, ensuring seamless integration with cloud services for data storage and analysis, and addressing security concerns related to data transmission and storage. The main objective of this study is to devise an effective solution that maintains a balance between performance, scalability, and security to enable real-time temperature monitoring in various IoT environments.

4. Objectives:

- Develop a robust cloud-based temperature monitoring system leveraging the capabilities of the Spartan3AN Starter Kit for IoT applications.
- Integrate FPGA-based temperature sensors and communication interfaces for efficient data acquisition and transmission.
- Explore the integration of cloud services such as AWS IoT or Azure IoT for data storage, processing, and visualization.
- Implement security mechanisms to ensure data confidentiality and integrity during transmission and storage.
- Evaluate system scalability, compatibility, and performance to optimize real-time monitoring and analytics capabilities.

5. METHODOLOGY

The methodology for developing a cloud-based temperature monitoring system using the Spartan3AN Starter Kit for IoT applications involves several key steps:

1. **System Architecture Design**:
    - Define the overall architecture of the temperature monitoring system, including the roles of the Spartan3AN FPGA, sensors, communication modules, and cloud services.
    - Determine the data flow between different components of the system, from sensor data acquisition to cloud storage and visualization.
2. **FPGA Implementation**:
    - Develop VHDL code to interface with the LM35 temperature sensor and ADC onboard the Spartan3AN FPGA starter kit.

- Implement logic for analog-to-digital conversion and processing of temperature data within the FPGA.
- Ensure compatibility and efficiency of the FPGA-based solution for real-time temperature monitoring.

3. **Integration with Cloud Services**:
   - Explore and select appropriate cloud platforms such as AWS IoT or Azure IoT for data storage, processing, and visualization.
   - Develop communication protocols to securely transmit temperature data from the FPGA to the cloud.
   - Implement cloud-side functionalities for receiving, storing, and analyzing temperature data in real time.
4. **Security Measures**:
   - Address security concerns related to data transmission over the internet and storage in cloud environments.
   - Implement encryption, authentication, and access control mechanisms to ensure data confidentiality and integrity.
5. **Evaluation and Testing**:
   - Evaluate the efficacy and efficiency of the developed system in terms of real-time temperature monitoring, scalability, compatibility, and performance.
   - Conduct rigorous testing to validate the reliability and accuracy of temperature measurements under various environmental conditions.
   - Fine-tune system parameters and functionalities based on testing results and feedback.

6. EXPERIMENTAL SETUP

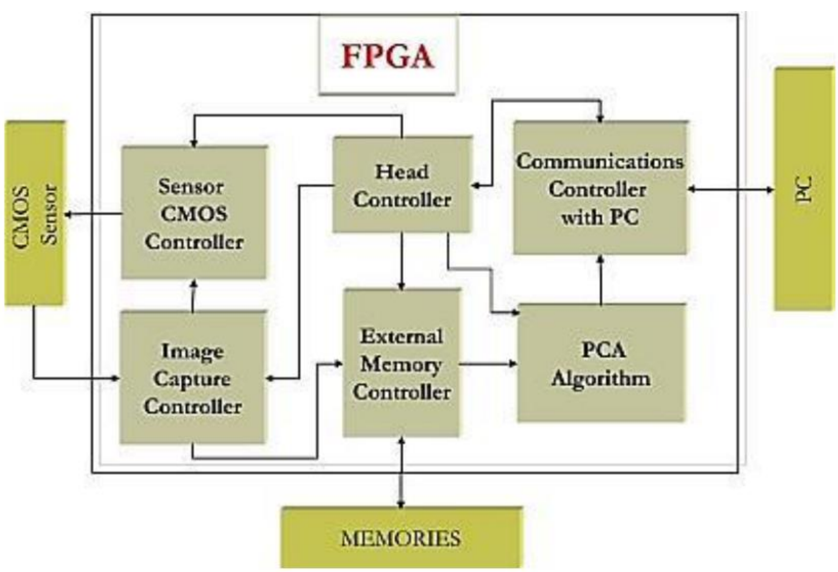

Figure 3:Block diagram of FPGA[1]

The general FPGA architecture shown in Fig. 1 consists of three types of modules. They are I/O blocks, Configurable logic blocks (CLB) and Switch Matrix/Interconnection Wires. The FPGA has two-dimensional arrays of logic blocks which are used to arrange the interconnection between the logic blocks. FPGAs have gained rapid growth over the past decade because they are useful for a wide range of applications. Some of the applications are cryptography, filtering communication encoding and many more.

LM35 Temperature Sensor-

Temperature sensors are devices that measure temperature. They can be a thermocouple or a resistance temperature detector (RTD). These sensors collect temperature data from a specific source and convert it into a form that can be easily understood by machines or people. Temperature sensors are used in a wide range of applications, including high voltage (HV) systems, alternating current (AC) systems, medical devices, food processing units, chemical handling, controlling systems, and automotive under-the-hood monitoring[6].

7. CONCLUSION

The IOT-based embedded system has faced many challenges in difficult IOT applications. The Field Programmable Gate array structure is the alternate arrangement to overcome the problem that is faced in ARM processors. In this paper, we have introduced the study of the technology paradigm for IOTs on the FPGA Platform. The IOT-based FPGA includes communication protocols, Data Acquisition and controlling systems. The temperature has been monitored with the combination of IOT and FPGA architecture and for every second period the temperature has been updated in the particular IP address. Various business spaces need you to observe the temperature and update the status to the cloud. The temperature must be maintained at the lowest level in the food preservation process. IOT-based temperature monitoring systems help us monitor the food preservation system temperature and update the data to the cloud at regular intervals.

8. TENTATIVE CHAPTER PLAN FOR THE PROPOSED WORK

CHAPTER 1: INTRODUCTION

- Introduce the concept of cloud-based temperature monitoring systems utilizing FPGA technology and IoT principles.
- Discuss the significance and relevance of the proposed work in the context of IoT applications.
- Outline the objectives and structure of the paper.

CHAPTER 2: LITERATURE REVIEW

- Review existing literature on FPGA implementation in IoT, cloud-based temperature monitoring systems, and related technologies.
- Summarize key findings from relevant studies and identify gaps in the current research.

CHAPTER 3: OBJECTIVE

- Define the specific objectives of the proposed work, including the evaluation of FPGA-based temperature monitoring systems, integration with cloud services, and addressing security concerns.

CHAPTER 4: METHODOLOGIES

- Describe the methodologies employed in developing the cloud-based temperature monitoring system using the Spartan3AN Starter Kit.
- Detail the steps involved in integrating FPGA-based temperature sensors, communication interfaces, and cloud services.
- Discuss the implementation of security mechanisms for ensuring data confidentiality and integrity.

CHAPTER 5: EXPERIMENTAL SETUP

- Present the experimental setup used for testing and validating the proposed system.
- Provide details on the hardware components, including the Spartan3AN FPGA starter kit, temperature sensors, and communication modules.
- Explain the configuration of the FPGA and the setup for data acquisition and transmission.

CHAPTER 6: CONCLUSION AND FUTURE SCOPE

- Summarize the findings and outcomes of the study.
- Discuss the implications of the research and its contribution to the field of IoT and embedded systems.
- Outline potential areas for future research and development in cloud-based temperature monitoring systems using FPGA technology.

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