Sensor Interfacing with Multicore Aurix TC397 Board

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Abstract. AURIX Board Multicore Application for Effective Temperature and Humidity Sensor Interface.The creation of a multicore application for simultaneous temperature and humidity sensor data processing and acquisition on an AURIX board is presented in this paper. The programme takes advantage of the platform's multicore capabilities to handle data and communicate with sensors efficiently by using distinct cores. Communication and the retrieval of raw data from every sensor are made easier by dedicated drivers. Pre-processing and meaningful unit conversion are applied to acquired data before it is shown in real time over a UART interface. Compared to single-core implementations, this multicore technique clearly increases efficiency and responsiveness, opening the door for future applications integrating a variety of sensor kinds and c apabilities.This paper high- lights the advantages of parallel processing and offers insightful information on multicore programming for sensor interfacing on the AURIX platform

1 Introduction

Microcontrollers are essential to the incorporation of sensors into different embedded systems, enabling control and data collecting in real time. Of them, In this Today, the Aurix Tricore TC397 stands out as a unique option that is praised for its robustness and processing capacity especially designed for industrial and automotive settings. This study adopts a strategic approach to use the TC397's extensible architecture for complete sensor integration, with an emphasis on integrating temperature and humidity sensors with the device. [1]

The TC397 is an example of how temperature and humidity sensors may be integrated into microcontroller systems, which has a wide range of potential applications. By utilising the TC397's flexible range of interfaces, which include GPIO, I2C, and SPI, this project aims to provide smooth channels of communication between the microcontroller and sensors. The ability to precisely retrieve and handle environmental data is made possible by this connection, creating opportunities for advanced techniques that make use of the strong structure of the TC397. These approaches, which are founded on precise sensor data, are meant to support intelligent systems by guiding knowledgeable decision-making and adaptive control techniques.[2]

The integration of state-of-the-art microcontroller systems with sensor technology is the cornerstone of intelligent systems in the field of real-time control applications.This study's investigation of the complexities involved in connecting temperature and humidity sensors to the Aurix Tricore TC397 highlights its dedication to improving sensor integration techniques. The goal is to clear the path for the creation of data-driven control systems that are more accurate, efficient, and adaptable by adding to this growing landscape. These technologies have the ability to completely transform the automotive and industrial sectors and usher in a new era of intelligent and responsive embedded systems. They are enhanced by the combination of TC397's capabilities and precise sensor insights.

Furthermore, a revolutionary impact on the automotive and industrial sectors is predicted by this research. The potential for the upcoming generation of intelligent embedded systems is provided by the integration of accurate sensor insights with the capabilities of TC397. These technologies have the capacity to revolutionise manufacturing processes, push the boundaries of industrial automation, and enhance vehicle performance. Our study will focus on more effective and data-driven control systems in order to contribute to the ongoing paradigm change in embedded system design and pave the way for greater precision, adaptability, and intelligence in the digital era. [3]

2 TriCore™-based AURIX™ microcontroller

AURIXTM microcontrollers based on TriCoreTM technology are shown in Fig. 1. They combine tri-core architecture for high-performance computing with strict functional safety requirements.compliance, a variety of interfaces, and the ability to process data in parallel, all of which guarantee dependable and effective performance in situations where safety is crucial.Infineon Technologies' Aurix TC397 board is a potent microcontroller platform that is well suited for industrial and automotive applications that require high performance, real-time capabilities, and safety features. The AURIX (Automotive Real-Time Integrated NeXt Generation Architecture) TC397 microcontroller, a member of the AURIX family's second generation, is the component that powers this board. Its architecture is based on the TriCore architecture, which combines the TC0, TC1, and TC2 CPU cores into a single chip. Because of its cutting-edge safety and security features, the Aurix TC397 is regarded as appropriate for use in vital

Fig. 1: Aurix TC397 Tricore Board

automobile systems. The board is adaptable for a range of applications because it has a multitude of peripheral interfaces, such as CAN, LIN, SPI, and I2C. The AURIX TC397's real-time capabilities can be used by developers for jobs requiring precise control and monitoring. As of my most recent update in January 2022, the board is still a strong platform for applications requiring high reliability and performance in harsh settings, even though specific features and capabilities may change over time. It is advised to consult the official documentation or get in touch with Infineon directly for the most up-to-date information.

2.1 Features

- TriCore™ Architecture: Integrates three processor cores into a single chip, combining high-performance computing with real-time capabilities, essential for demanding automotive and industrial applications.
- Functional Safety Compliance: Meets stringent automotive safety standards like ISO 26262, ensuring reliability and safety in safety-critical systems.
- Diverse Interfaces and Peripherals: Offers a rich set of interfaces such as GPIO, CAN, SPI, I2C, and Ethernet, along with advanced peripherals, providing versatile connectivity options for various applications.
- Parallel Processing Capability: Employs a multi-core design that enables enhanced parallel processing, optimizing handling of complex tasks in automotive control units, industrial automation, and safety-critical systems.
- Reliability and Deterministic Execution: Provides deterministic execution and reliability crucial for real-time systems, ensuring consistent and predictable performance in critical scenarios.

2.2 Temperature Sensor

- The LM35 is a precision analog temperature sensor.
- It provides an output voltage directly proportional to the Celsius temperature.
- It operates over a temperature range of -55°C to 150°C.
- The sensor is easy to use with a simple interface, as it produces an analog voltage that can be directly measured by a microcontroller or other analog-to-digital converter.

2.3 Humidity Sensor

- The DHT11 is a digital temperature and humidity sensor.
- The sensor has a limited temperature range of 0°C to 50°C and a humidity range of 20 percent to 80 percent.
- DHT11 is a digital sensor that measures both temperature and humidity, providing a digital signal that can be directly read by a microcontroller.
- The DHT11 communicates using a simple one-wire protocol, making it easy to interface with microcontrollers.

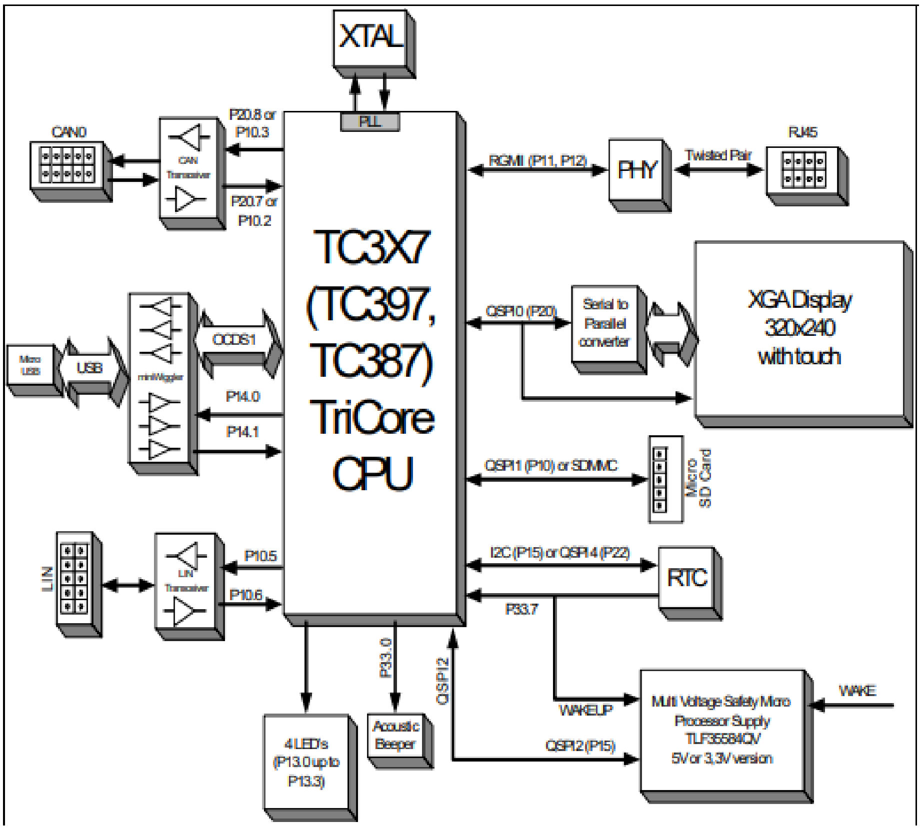

Fig. 2: fig shows Block Diagram of TriCore™-based AURIX™ microcontrolle

3 Methodology

The interfacing of LM35 and DHT11 sensors with the Aurix board is streamlined by connecting their essential pins—VCC (power), GND (ground), and VOUT/DATA (analog or digital output)—to the corresponding pins on the Aurix board. This physical setup establishes the crucial link between the sensors and the processing unit, facilitating the flow of data from the sensors to the Aurix board.[4]

The configuration of Aurix cores orchestrates the process of acquiring data from the connected sensors. Core 0, the designated handler for the LM35 sensor, assumes the responsibility of data acquisition. This involves a sequence of steps: reading the analog-to-digital converter (ADC) value from the LM35 sensor and subsequently converting this raw value into temperature units. This core essentially focuses on translating the electrical signal from the LM35 into a meaningful temperature value.[1]

On the other hand, Core 1 is tasked with managing the data acquisition process for the DHT11 sensor. This involves the implementation of the communication protocol necessary for extracting temperature and humidity values from the DHT11. Core 1 becomes the communication hub, interpreting the digital output from the DHT11 sensor and transforming it into comprehensible data that can be further processed.

The acquired data from both Core 0 and Core 1, representing temperature readings from LM35 and DHT11, is then harmoniously processed. This may involve aggregating, formatting, or performing any necessary calculations on the data to derive meaningful insights. The final step involves displaying the processed data on the terminal, providing a user-friendly interface to access the real-time information collected from the LM35 and DHT11 sensors.

In essence, this systematic approach ensures that each core of the Aurix board is dedicated to a specific sensor, optimizing the processing of data from both LM35 and DHT11. The parallel execution of tasks on separate cores enables efficient multitasking, contributing to the real-time capabilities of the Aurix board. This methodology embraces the strengths of multicore architectures, ensuring a streamlined and concurrent acquisition of data from diverse sensors for enhanced applications in embedded systems.

3.1 Steps for Connecting LM35 and DHT11 Sensors to Aurix Board and Reading Data:

Hardware Connections:

- Connect VCC of LM35 and DHT11 to VCC of Aurix board (usually +5V).

- Connect GND of LM35 and DHT11 to GND of Aurix board.
- Connect VOUT of LM35 to an analog pin of Aurix board(AN18 and AN19 of x103).
- Connect DATA pin of DHT11 to an analog pin of Aurix board.

Aurix Core Configuration:

- Configure core 0 and core 1 of the Aurix board.
- Assign core 0 to handle LM35 data acquisition
- Assign core 1 to handle DHT11 data acquisition.

LM35 Data Acquisition (Core0):

- Initialize the ADC module associated with the analog pin connected to LM35.
- Configure the ADC for single-ended conversion.
- Start a conversion cycle for the LM35 analog pin.
- Read the conversion result from the ADC register.
- Convert the ADC reading to temperature using the LM35 calibration factor (10 mV/°C).

DHT11 Data Acquisition (Core1):

- Initialize the GPIO pins associated with the DATA and pull-up resistor of DHT11.
- Implement the DHT11 communication protocol:
    - Send a start signal to DHT11.
    - Wait for the response signal from DHT11.
    - Receive the 8-bit humidity data.
    - Receive the 8-bit temperature data.
    - Calculate the checksum and verify the received data.
- Extract the temperature and humidity values from the received data.

Data Processing and Display:

- Combine the temperature data from LM35 and DHT11.
- Send the processed data to the terminal for display.

Fig. 3. shows a temperature and humidity sensor connected to an Aurix board. The sensor is powered by the VCC and GND pins, and its data is sent to the Aurix board through the DATA pin. The Aurix board uses its analog-to-digital converter (ADC) to convert the sensor's voltage output to a digital value, which can then be used to calculate the temperature and humidity.[3]

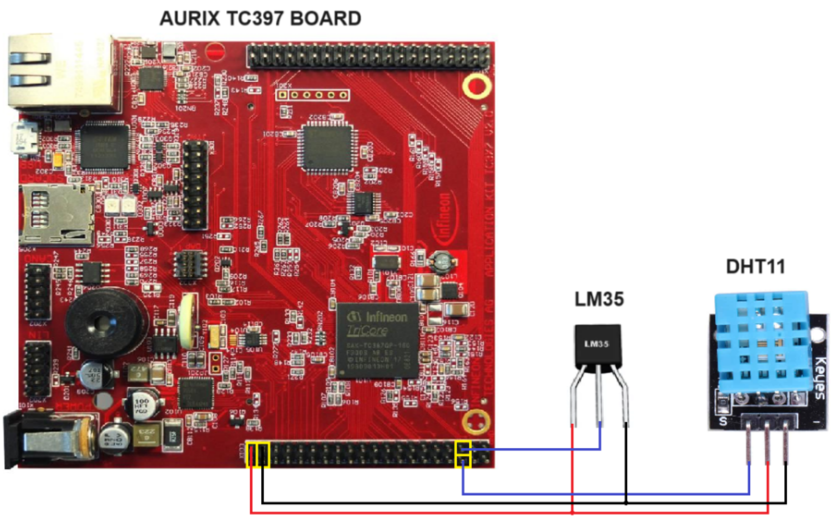

Fig. 3: Circuit Connections

4 Results and Discussion

- The methodology outlines a systematic process for interfacing LM35 and DHT11 sensors with an Aurix board, emphasizing hardware connections, core configuration, and data acquisition.
- Connections involve linking VCC and GND of both sensors to the Aurix board and connecting LM35's analog output to an analog pin, with DHT11's data pin to another analog pin.
- The approach assigns core 0 for LM35 and core 1 for DHT11, allowing for parallel processing. However, specific core settings are not detailed.
- Steps include initializing the ADC module, configuring it for single-ended conversion, and scaling results using the LM35 calibration factor (10 mV/°C).
- Involves initializing GPIO pins, implementing the DHT11 communication protocol, and emphasizing error checking for checksum verification.
- The methodology suggests combining and displaying temperature data from both sensors on the terminal for user monitoring.
- Important considerations include robust error handling, precise sensor calibration, real-time monitoring, and comprehensive documentation for future troubleshooting. Continuous testing and iteration are essential for system refinement.
- Here is the link for video https://drive.google.com/file/d/1YeUm011ns6M3etoEqe1C17zwZBcYrMdY/view?usp=sharing

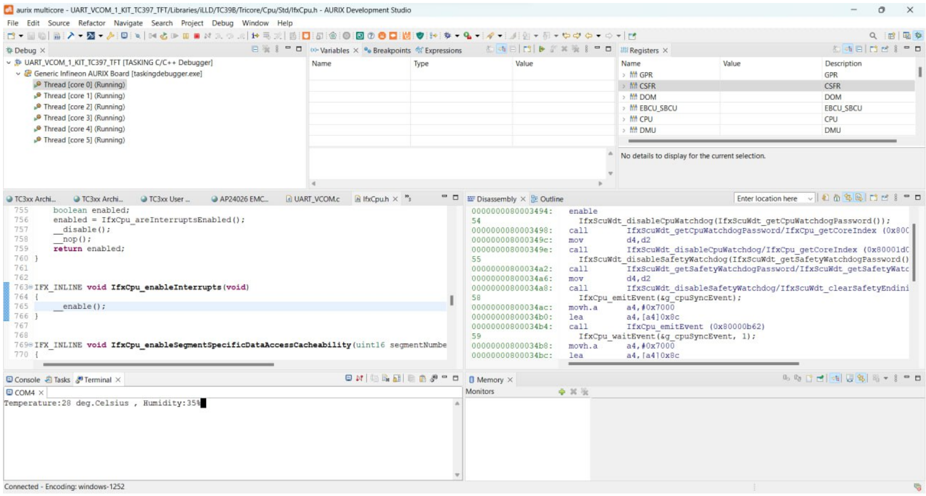

Fig. 4: Results

5 Conclusion

An important advancement in embedded systems designed for automotive and industrial applications is the integration of temperature and humidity sensors with the Aurix Tricore TC397 microcontroller. This study emphasises the tactical application of TC397's flexible design (Fig. 4). solutions that easily allow for the integration of sensors, making precise data processing and retrieval possible. The efficiency of this convergence is increased by utilising the microcontroller's flexible interfaces and advanced control techniques, demonstrating the possibility for revolutionary breakthroughs. This integration has the potential to completely transform a number of industries, especially those related to vehicle performance and industrial automation. As a result, a new era of extremely responsive embedded systems has emerged, promising to improve operational accuracy and efficiency in a variety of application domains, representing a notable advancement in the realm of embedded technology.

6 Future Scope

The future holds immense promise for advancements in sensor integration with microcontrollers like the Aurix Tricore TC397. Further exploration could focus on refining interface protocols and optimizing sensor data processing algorithms to enhance efficiency and accuracy. Additionally, leveraging machine learning and AI algorithms in conjunction with the TC397's robust framework could lead to predictive and adaptive control systems, paving the way for intelligent embedded solutions that dynamically respond to diverse environmental inputs.

This evolution holds the potential to revolutionize not just automotive and industrial sectors, but also diverse fields where precise, real-time data processing is essential.

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