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Pill Dispenser

Project Report

Second-year Hardware Project
School of ICT

Metropolia University of Applied Sciences

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Contents

1 Introduction

In light of today's hectic lifestyles, people frequently forget to take their medications on time. Moreover, elderly people may face difficulties taking pills independently. Although it might be difficult for many people, medication adherence is an essential part of managing one's health care. Due to the intricacy of contemporary drug regimens and the demands of everyday life, uneven adherence to treatment is common, endangering both patient health and treatment efficacy. Therefore, developing a system or device capable of dispensing medication at preset times becomes imperative.

The primary objective of this project, implemented as a second-year hardware project at Metropolia University of Applied Sciences, is to develop a pill dispenser with eight compartments: one for calibration and seven for storing prescription drugs corresponding to each day of the week. This device operates autonomously and dispenses the content of the compartment by rotating the dispensing wheel at predefined intervals. The piezoelectric sensor plays a crucial role in ensuring the validation of successful pill dispensing, offering a reliable mechanism for confirmation. Simultaneously, the integrated Lorawan facilitates seamless communication of the device's state to the server, enabling real-time monitoring and feedback. Additionally, the EEPROM functions as a dedicated storage space for log messages, providing a systematic record of the device's activities. Together, these components contribute to the overall efficiency and accountability of the pill dispenser system.

This document aims to provide a comprehensive project overview by delving into various key aspects. Chapter 2 explores the theoretical background, methods, and materials employed in the project, followed by a thorough examination of the implementation process in Chapter 3. Finally, Chapter 4 concludes the project's outcomes.

2 Methods and Material

This chapter aims to provide an overview of the components and utilized sensors and introduce the communication method implemented in the pill dispenser project.

2.1 Processing Environment

This subchapter focuses on the processing environment of the embedded device.

2.1.1 Raspberry Pi Pico WH and Raspberry Pi Debug Probe

The Raspberry Pi Pico WH, paired with the Raspberry Pi Debug Probe, forms the core processing unit of the embedded device. Raspberry Pi Pico features an RP2040 microcontroller chip and a dual-core Arm Cortex M0+ processor, as illustrated on the left side of Figure 1. [1] The board supports a wide range of peripherals and also offers a 2.4 GHz wireless LAN connection.

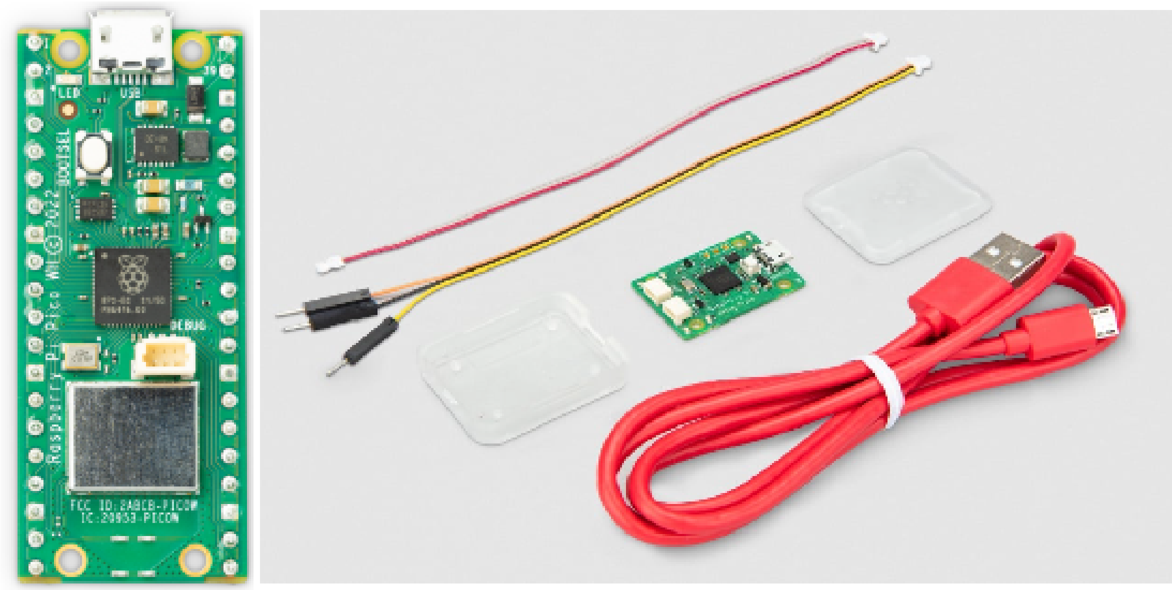

Figure 1: showcases the Raspberry Pi Pico WH on the left and Raspberry Pi Debug Probe on the right. [1][2]

During the developmental phase of the project, the Raspberry Pi Debug Probe, depicted on the right side of Figure 1, plays a pivotal role. This USB device offers solderless, plug-and-play debug functionality through a standard ARM Serial Wire Debug (SWD) interface. [2]

2.1.2 I2C EEPROM

To store the state of the device throughout the boot process and the log messages, the implementation of a non-volatile memory storage is required. For this objective, an electrically erasable programmable read-only memory, the Elecrow's Crowtail - I2C EEPROM, has been selected.

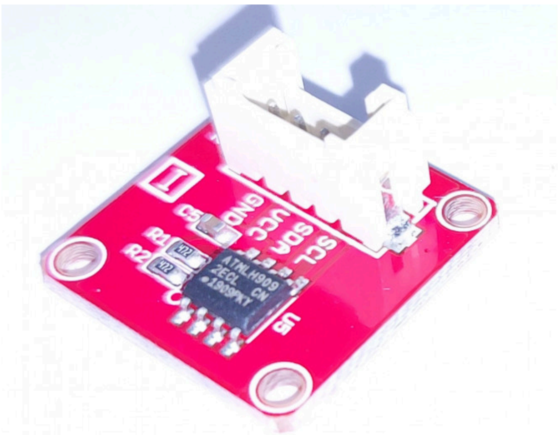

Figure 2: showcases the Crowtail i2c EEPROM, the non-volatile memory of the system. [3]

EEPROM is a modifiable memory, displayed in Figure 2, where bytes or pages can be erased and written to repeatedly by applying electrical voltage. It is widely used to store small amounts of data in electronic devices. The capacity of Crowtail - I2C EEPROM is 256k bits, providing ample storage for the device state. [4]

2.2 LoRaWAN Communication

LoRa, a radio communication technique derived from chirp spread spectrum (CSS) technology, encodes information on radio waves using chirp pulses. The LoRaWAN protocol further defines the communication protocol and system architecture for devices utilizing LoRa technology. [5]

The current state of the dispenser and essential information are transmitted through the LoRaWAN network. To facilitate this communication, the project has adopted the Grove LoRa-E5, showcased in Figure 3. This module establishes a connection to the processing environment through a UART connection.

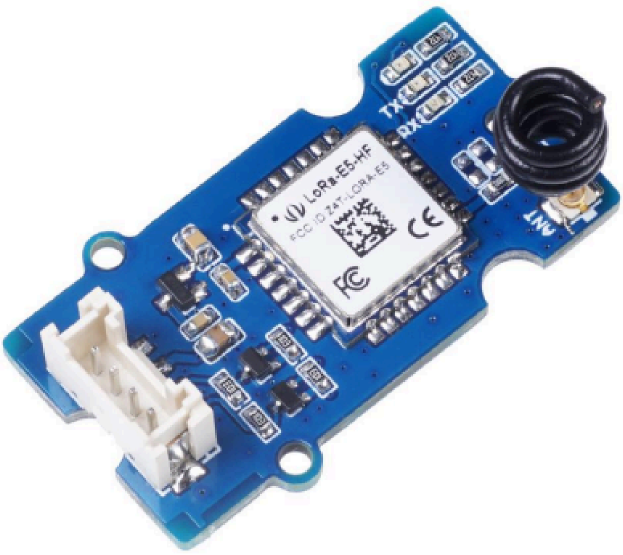

Figure 3: Hardware specifications of the Grove - LoRa-E5, the LoRaWAN communication module for the project. [6]

Designed by Seeed studio, the Grove LoRa-E5 is a wireless radio module that supports both LoRa and LoRaWan protocols. [6] Each communication instance is controlled through AT commands. Once a connection with the server is established, each message is sent individually, with each transmission prompting a 10-second waiting period.

2.3 Dispenser Assembly

This subchapter introduces the aspect of the project with which the user directly interacts. Divided into two parts, the first section delves into the intricacies of the physical pill dispenser, while the second part emphasizes the hardware's sensor components.

2.3.1 Stepper Motor

The base of the pill dispenser comprises two plastic components, crafted with a 3D printer: the base and the wheel, as illustrated in Figure 4. In addition to the plastic compartment, the base houses the stepper motor, as well as the optical and piezoelectric sensors.

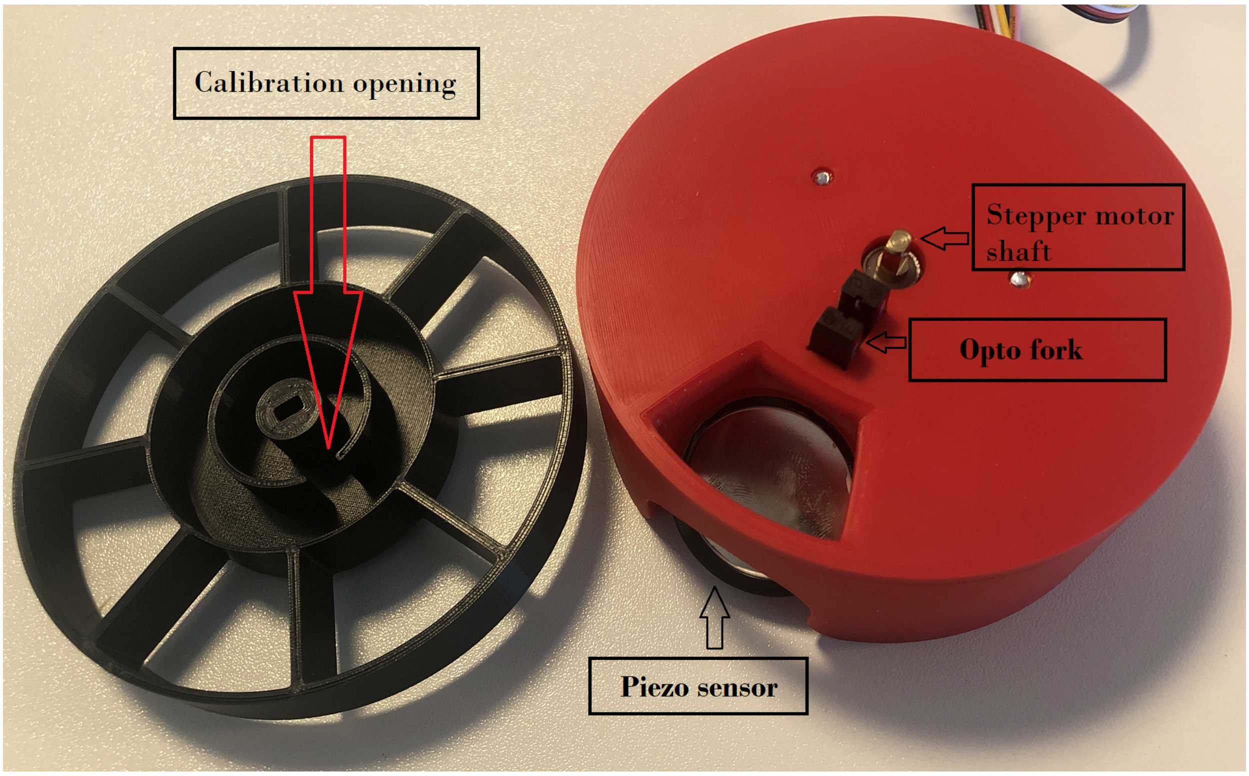

Figure 4: Showcase of pill dispenser: the wheel on the left, base on the right, and the two sensors - piezoelectric and optical.

The plastic part of the base features an opening designed for pill dispensing. At the bottom of this aperture, resides the piezo sensor that detects the descent of the pill(s). The wheel connects to the base through the stepper motor shaft and incorporates a calibration opening that facilitates the functionality of the optical sensor, known as the opto fork. As mentioned in Chapter 1, the wheel is divided into 8 equal compartments: one for calibration and seven for storing drugs corresponding to each day of the week.

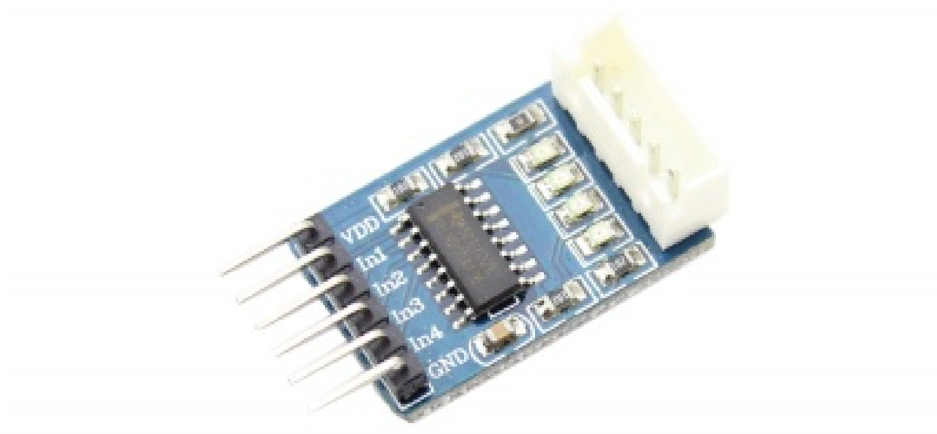

Figure 5: Elecrow's Stepper motor driver. [7]

The project utilizes a 28BYJ-48 stepper motor, characterized as a 5-wire unipolar motor with 4 coils. Controlled through a stepper motor driver, it facilitates the precise rotation of the dispenser wheel, employing a half-stepping mechanism for accuracy. The specific stepper motor driver utilized is Elecrow's ULN2003 Stepper Motor Driver, displayed in Figure 5, connected to the processing environment. This driver utilizes ULN2003A to amplify the signal, ensuring efficient and controlled operation. [7]

2.3.2 Sensors of the System

The system incorporates two sensors: an optical sensor to precisely detect the location of the dispenser wheel and a piezoelectric sensor to verify the dispensing of the pill(s) from the respective compartment. Each is discussed in its subchapter.

2.3.2.1 Optical Sensor

Optical fork sensors, also known as optical sensors, typically consist of a "fork" structure resembling two parallel arms joined together. One arm emits light beams, while the other arm detects whether the beams are interrupted or not. These sensors find applications in various industries for detecting the presence or absence of objects.

In the project, the optical fork sensor with a plastic housing is embedded into the base plastic of the pill dispenser. The programmed functionality, utilizing the opto fork, allows for the detection of the calibration opening on the dispense wheel. This detection facilitates the precise calibration of the wheel by recognizing signals indicating the absence of an interrupting object.

2.3.2.2 Piezoelectric Sensor

A piezoelectric sensor leverages the piezoelectric effect to convert mechanical stimuli, such as changes in pressure, acceleration, temperature, strain, or force, into an electrical charge. [8] This unique property makes piezoelectric sensors versatile instruments capable of capturing and translating various physical phenomena into measurable electrical signals.

In the context of the pill dispenser, the piezoelectric sensor is strategically employed at the bottom of the pill dispensing opening. It detects the impact caused by the falling pill, allowing the system to validate the successful dispensing of medication. This utilization highlights the sensor's crucial role in providing real-time feedback on the dispenser's operational status, ensuring precision and reliability in the medication dispensing process.

3 Implementation

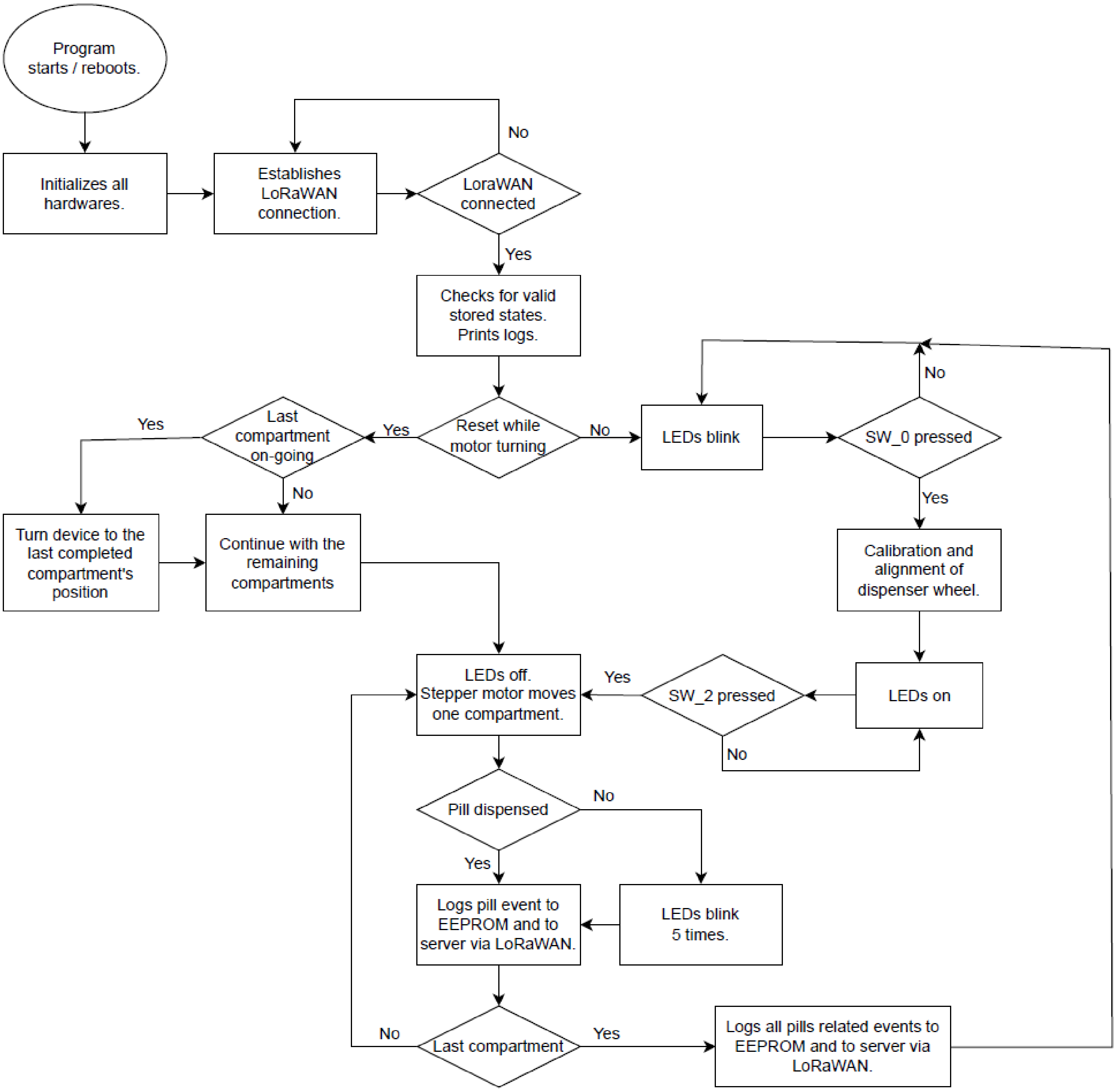

Figure 6: Flow chart of the program

4 Conclusions

In conclusion, the project has made significant strides in meeting its objectives, completing the development of the pill dispenser, and achieving the primary goal of dispensing medication at the prescribed time. While these accomplishments mark a substantial achievement, some areas require further refinement and expansion. Continued improvements are crucial to maximize the utility of the dispenser in aiding patients with their medication adherence, ensuring both robustness and accuracy in the dispensing process.

Several challenges arose during the project, primarily related to technical intricacies and unforeseen obstacles. Early in the development phase, the team encountered issues with the dispenser's mechanism, leading to delays. Effective communication and a collaborative problem-solving approach were employed to identify and address these challenges. Regular team meetings and brainstorming sessions played a crucial role in devising innovative solutions and keeping the project on track.

To enhance the project's impact and utility, future work should focus on refining the dispenser's design and functionality. Additionally, the system may benefit from enhanced connectivity features, such as integration with mobile applications, to provide users with real-time medication reminders and monitoring.

In conclusion, the project has laid a solid foundation, but there is ample room for growth and refinement. By addressing the identified limitations and pursuing ongoing improvements, the medicine dispenser can evolve into a more versatile and indispensable tool for promoting medication adherence and improving overall user-friendliness.

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