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MAJOR PROJECT
Medication Reminder Timer

INTRODUCTION

This device is an automatic medicine timer and reminder. It allows for users to create their own weekly medication schedules, which repeats as such. When a reminder is active, the user is alerted with an LED, buzzer, and the OLED reminds them of the medication they need to take. The device also comes equipped with a button, and a potentiometer, allowing users to manually keep track of their medication intake for the day and monitor what they have or have not taken.

CONTEXT:

One of the fifteen *Grand Challenges for Engineering* is the betterment of medicines [2]. One aspect of medicine which is just as important as the medicine itself is medical adherence. The World Health Organization defines medication adherence as, "the degree to which the person's behaviour corresponds with the agreed recommendations from a health care provider," [3]. Medical adherence is a crucial aspect of medical treatment because failing to adhere to medication schedules can lead to poor treatment outcomes, reduced quality of life, increased healthcare costs, and even death [3]. Non-adherence to medication can result from various factors, including forgetfulness, misunderstandings, financials, fear of side effects, and complex medication schedules [5]. Improving medication adherence can be challenging, but it is essential to achieve optimal treatment outcomes and improve patient health.

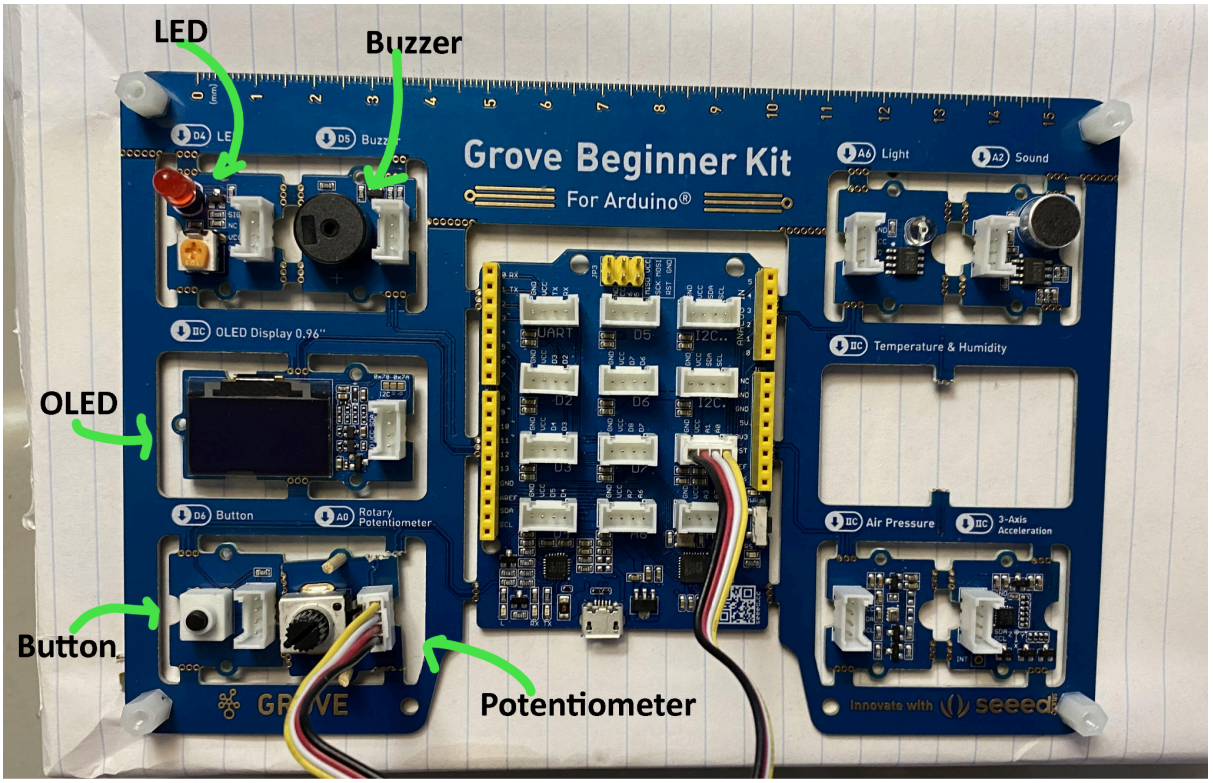
TECHNICAL REQUIREMENTS / SPECIFICATIONS

- Use Java with Firmata4j and Arduino to create a responsive, medication reminder.
- Create a reminder timer for users to take their medication on time. Use the timer tasks, Calendar, and Date libraries to achieve this
- Store user inputted medication based on day of the week entered using ArrayLists
- Allow for the user to see their daily medication for that day, and to manually keep track of them on the OLED display. Use the button and potentiometer to achieve user input.
- When a reminder is not active, there should be a list displaying the users daily medications for the day, allowing the user to manually check or uncheck the boxes next to them, helping them keep track of their intake.
- Create a responsive, user friendly OLED display which is readable, and user input is highlighted (or underlined)
- Remind the user to take their medication by a message on the OLED, as well as providing a visual and audio reminder with the LED and buzzer.
- The user should be able to turn the reminder off (as in, turn off the buzzer and LED with the press of a button)
- The system is event driven, functioning based on reminders and timed tasks, as well as using button event listeners, and classifying potentiometer values as different control inputs

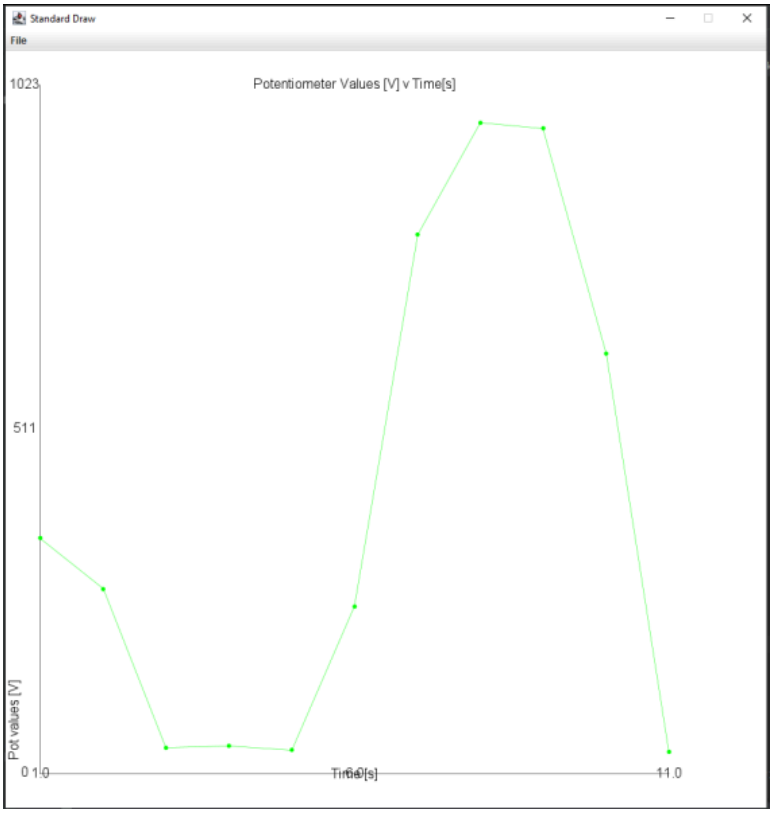
COMPONENTS LIST:

- LED: Turns on when a reminder is active
- Buzzer: Turns on when a reminder is active
- OLED: Displays important information: reminders to take medicine, and a list of daily medication
- Button: Part of user input system

- Potentiometer: Part of user input system (allows user to scroll through different buttons)
- First, the system was created on Java and tested through the console. I then added in the Buzzer and LED, then the OLED. After the buzzer was added, it was important to make sure that it could be stopped, and reminders could be turned off, so I added in the button. Furthermore, when ticking boxes on the list view, I added the potentiometer to allow for more controls (scrolling up, down the list)



TEST:



- I was able to reuse some of the graphing code from my minor project to test the potentiometer. I verified that the values crawled to 1023 when turning it one direction, and to 0 when turning the other way.
- Another thing I did to test my system, is by modifying the date and time settings on my computer, I was able to cycle through day switches (11:59 pm - 12:00 am), and different times, to test that my reminder system fully refreshed the medicines for each day

LEARNING OUTCOMES:

- [CLO 1] I was able to test that my system was fully functional and would carry out its purpose of reminding the user to take their medicine, and display a list of their medication for the day. I tested the potentiometer values with a graph, and carried out trials of my system as it should be used.
- [CLO 2] I used Firmata4J to connect my computer to the Arduino, I used ArrayList to store medicine data for each day of the week, I also used the Timers, Date, and Calendar libraries to create and set reminders based on real time.
- [CLO 3] I used ArrayList to store medicine objects, and sorted them by days of the week in order to create a repeating schedule.
- [CLO 4] My system is fundamentally an event driven application. For instance, when a reminder goes off, the state of the button changes to allow the user to stop the reminder. After stopping, it switches back to user control state. The program runs on reminders which are timed tasks, and the potentiometers values are converted into button states (up, down, select)
- [CLO 5] Originally, my system was a very simple almost 'alarm clock' but I was able to add several features such as the user control over ticking medicine boxes, a responsive OLED display, and storage for user inputted medications.

CONTINGENCY

- One idea I wanted to implement was a user interface to add medications. As of right now, the prototype allows users to add medications directly through the source code (which isn't very user friendly!). If I had more time, I would've been interested in implementing a Java Swing type of form to allow for this functionality. This experience has taught me that I need to plan for these sorts of things in advance, and have a better understanding of what I want my finished product to look like before starting it.
- Further, I had a few issues with my OLED display being slow or buggy, which is not great considering this product was made to be used by real people. I figure that there must've been something wrong with the amount of information I was attempting to display, or I was refreshing the screen too much. This is something I would've wanted to take a further look into. This ties into having a better understanding of what I want a finished product to look like before starting it.

ADDITIONAL MATERIAL

- The degree to which patients follow their prescribed medication schedules can have a greater, more direct influence on their outcomes than the medication itself. Estimates show that only around 50% of patients adhere to their medication schedules, while 80% is needed for optimal results [4]. In fact, medical non adherence is responsible for up to 50% of treatment failures in patients [4], and an estimated 125,000 deaths annually in the United States [1]. Beyond health reasons, estimates show that non adherence is responsible for between $100 and $300 billion in annual medical costs in the United States.
- There are many factors which can affect medical adherence, such as stigma, lack of understanding, fear of side effects, and more [5]. This device focuses on alleviating complex medical schedules and forgetfulness in hopes of increasing medical adherence. By increasing

medical adherence, the effectiveness of medication will undoubtedly be enhanced, working towards the grand challenge of engineering better, more effective medicine.

CONCLUSION

- While genetic advancements are continuing to grow and medicines are becoming increasingly more personalised and effective, medical non-adherence remains a major issue in the medical field. The problem of non-adherence is not limited to a particular population or disease. It affects patients of all ages, backgrounds, and medical conditions, and can lead to significant health consequences. By prioritising the development of devices like this one, we can improve medication adherence rates and ensure that patients receive the full benefits of their prescribed medications, ultimately leading to better health outcomes, and better medicines.

While genetic advancements are continuing to grow and medicines are becoming increasingly more personalised and effective, medical non-adherence remains a major issue in the medical field. Non-adherence is a problem which affects everyone regardless of age, background and medical conditions. By working on tools and products like this one, we can hope to increase medical adherences to make sure that patients receive the full benefits of their prescribed medications, ultimately leading to better health outcomes, and better medicines.

REFERENCES

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