1. **Introduction**

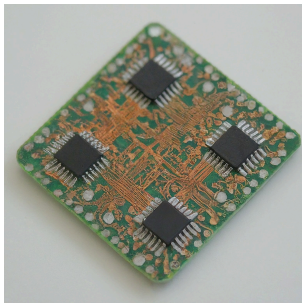
Problem

For college students, industry professionals, and people from all walks of life, alarms or other methods of waking up on time have become essential. Sleep is an essential need that no one wants to give up, yet there are numerous demands in our lives that take us away from the comfort of our beds. To stay on top of their schedules, people resort to various methods of alarms- setting many alarms all two or three minutes apart, downloading an app that forces them to take a picture, or using a smartwatch alarm. However, many times the human body automatically adjusts to the routine of a regular alarm, allowing people to snooze or turn off alarms in their sleep, turn off their phone, or get used to the vibration of a smartwatch alarm.

Solution

To solve this problem and force users to wake up to turn off their alarm, we wish to make an alarm clock with four different challenges using simple sensors (load cell, gyroscope, temperature, pedometer) to complete to turn it off- with the clock randomly picking which challenge needs to be completed every morning. Randomly picking between four different challenges every morning keeps the user on their toes, with minimal effort required from the user to set the alarm by having everything in one succinct device.

Visual Aid (images generated using AI)



Challenge deck connects to alarm

clock to form system

High-level Requirements

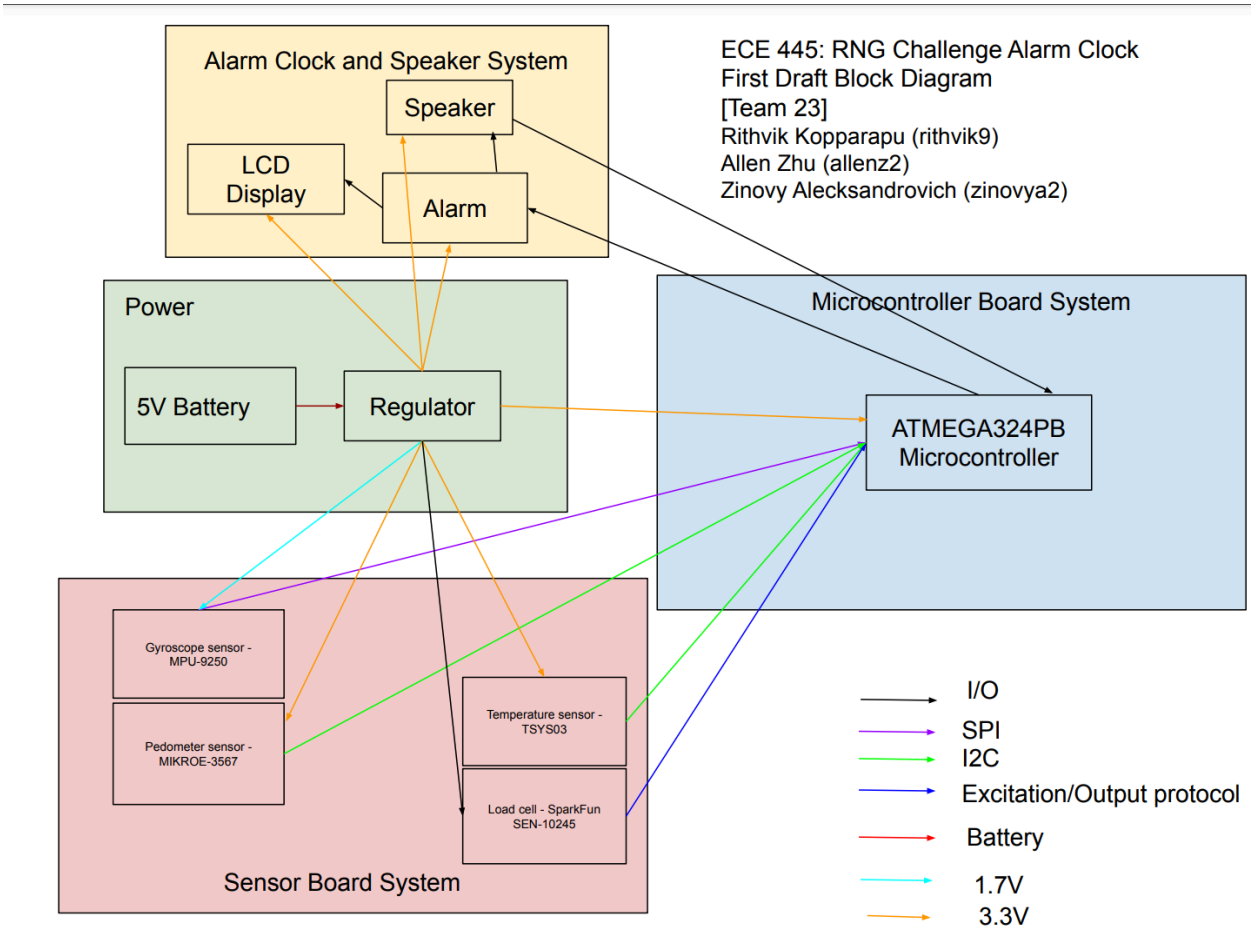
· Challenge subsystem wakes up and decides which challenge to complete within five seconds of the wake-up time, and then stops ringing as soon as challenge is completed or within ten minutes, whichever comes first.

· The active set of challenge sensors, the pedometer and gyroscope sensors, function as expected by tracking the correct data and registering completion of challenges.

· The passive set of challenge sensors, the temperature and force sensors, function as expected by tracking the correct data and registering completion of challenges.

2. Design

Block Diagram



Subsystem Overview

- Subsystem 1 - Alarm clock and speaker

The first part of our solution is the physical alarm clock that we will be modifying to add to our challenges. We wish to use a simple AA-powered alarm clock with a clear LCD display for the user to be able to easily program times in and use power efficiently. To inform the user what challenge is to be completed that morning, pressing the clock's snooze button will play an instruction on a separate speaker that we will add (i.e., "SHAKE CLOCK FOR ONE MINUTE").

- Subsystem 2 - Challenge Deck with sensors

The second part of our solution is our challenge deck with the associated sensors:

Gyroscope sensor - MPU-9250 with built in gyroscope and accelerometer sensors. The challenge we want to incorporate here is to shake the clock for one minute, and we will use the data from the sensor to verify the shaking of the clock.

Temperature sensor - TSYS03 temperature sensor. The challenge we want to incorporate here is to get up and put the clock in the fridge for two minutes while waiting there for the alarm to turn off. We will check to see if the clock holds a temperature below 40 degrees Fahrenheit (avg fridge temp is 37 degrees) for at least one minute, to consider the time it takes for the clock to cool.

Pedometer sensor - MIKROE-3567 pedometer sensor. The challenge we want to incorporate here is to get up and take 250 steps with the alarm clock.

Load cell - SparkFun SEN-10245 load cell. The challenge we want to incorporate here is to apply an even and constant force for three minutes, to make it inconvenient enough time to be unable to do it in your sleep.

- Subsystem 3 - Linkage to alarm clock

To link all the sensors, we will be using an ATMEGA324PB microcontroller. To make the alarm clock stop ringing when the challenge is completed, we will generate the signal that is usually generated by the "stop alarm" button to the alarm. Once the challenge is completed, we will also use the previously mentioned speaker to give the user simple audio feedback that they've completed the challenge, with a "ding" sound.

- Subsystem 4 - Power supply and management

To power our alarm clock, we will be using a standard pair of AA batteries. This power supply and then the subsequent power regulator, the [], will be used to successfully power the display and alarm as well as the challenge deck with the appropriate step down voltage.

Subsystem Requirements

- Subsystem 1 - Alarm Clock and Speaker System

The alarm clock must keep accurate time and the speaker must provide an indicator of what challenge to complete when prompted.

- Subsystem 2 - Challenge Deck with sensors

The gyroscope sensor accurately registers shaking and is able to interface with the microcontroller to communicate the completion of the 1 minute challenge requirement.

The temperature sensor accurately registers cooling of the clock at the accurate average fridge temperature and is able to interface with the microcontroller to communicate the completion of the 2 minute challenge requirement.

The pedometer sensor accurately registers steps and is able to interface with the microcontroller to communicate the completion of the 250 step requirement.

The load cell sensor accurately registers the force applied and is able to interface with the microcontroller to communicate the completion of the 3 minute challenge requirement.

- Subsystem 3 - Linkage to alarm clock

The microcontroller is successfully able to read data from all sensors in order to register completion of the appropriate challenge.

The microcontroller is successfully able to send a signal to the alarm clock that the challenge is completed in order to turn off the alarm.

- Subsystem 4 - Power supply and management

The regulator is successfully able to step the voltage down from 5V to 3.3V to interface with the challenge deck while also powering the clock.

Tolerance Analysis

ATMEGA324PB : .25mA

TSYS03 : 400uA

SEN-10245 : 1.5mA

MIKROE-3567 : 60uA

MPU-9250 : 0.2mA

Typical Digital Alarm : 260mA

Iout = 262.41mA

Tj(MAX) = 150°C

Vin = 5V

Vout = 3.3V

(Θjc+Θca) = 100 C/W

Ta = 38°C

Regulator: AZ1117CD-33TRG1

$Tj = iout(vin - vout)(\Theta jc + \Theta ca) + Ta$

Tj ≈ 82.61°C < Tj(MAX)

3. Ethics and Safety

The main ethical and safety concerns that arise from this project are in the form of disruption of the natural environment for unintended persons, such as companions or roommates of the user. In addition to this, another issue we potentially identified is the possibility of the challenges being excessively strenuous to our users. The IEEE code of ethics states that engineers should not injure others in any way, whether that be mental or physical. For the case of disrupting anyone else, we prioritized having our challenges be as minimal time as possible in order to

wake the user up but not be exceedingly long. In addition to this, we focused on making our challenges as easily accessible as possible, not involving any form of running or jumping to prevent excessive physical strain on the user.