# Early Bird Alarm Clock

***Project Proposal***


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# Introduction

**Problem:**

As college students and as individuals soon entering the workforce, it is critical that we are able to wake up and be on time for lectures or meetings. To be on time, we tend to usually set alarms on our phones or on stationary alarm clocks. However, once it's time to wake up, our body defaults to hitting the snooze button for a few more minutes of rest which causes us to run late. While some may believe that oversleeping is not a major issue, two-thirds [of polled respondents] say snoozing their alarm at least once is part of their morning routine and that 72% snooze between one to four separate times on any given morning (Melore).

**Solution:**

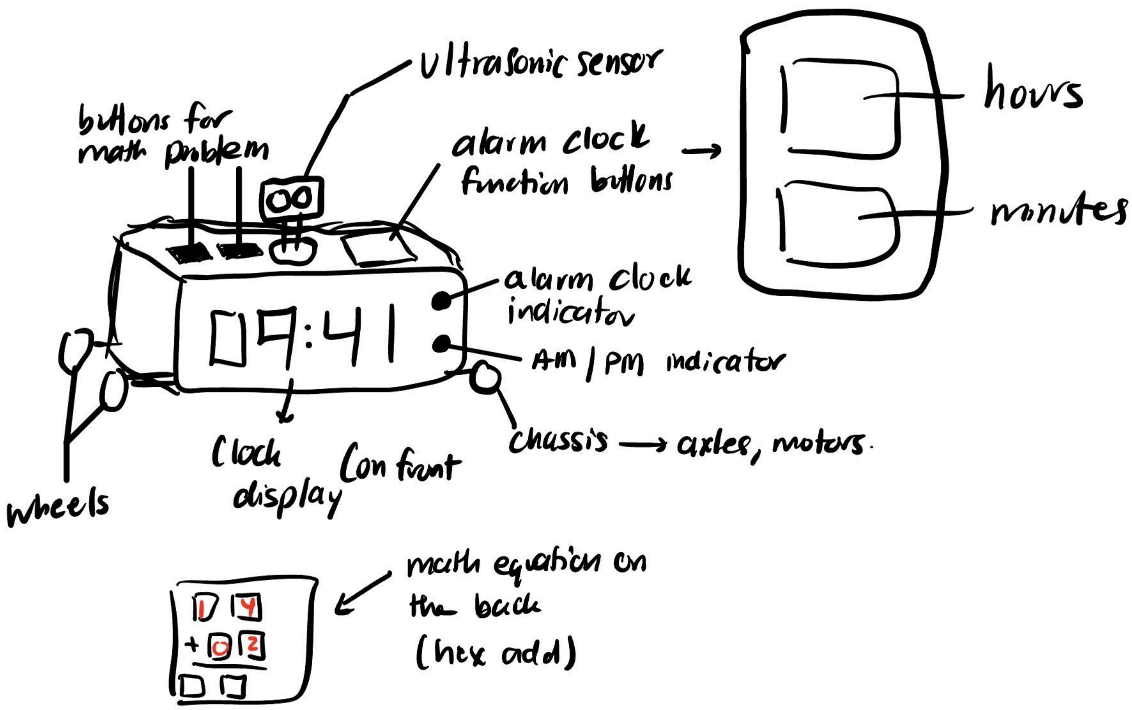
Our group's project offers a potential solution to the problem of oversleeping by creating an "interactive" alarm clock which forces an individual to wake up and begin their day. At a high level overview, our mobile EarlyBird alarm clock will sound an alarm and will begin "running around" autonomously while also navigating around any objects which may lie in its random path. Upon the alarm being switched off, the user will be required to type in an answer to a hexadecimal addition problem displayed on the alarm clock. If a correct answer is inputted, the verification is complete and the alarm is turned off. If an incorrect answer is inputted, then a different problem will be shown on the alarm clock and the user will need to re-enter a valid answer to shut the alarm off.

Our EarlyBird alarm clock will contain the following three components: alarm clock, driving system - motors + ultrasonic sensors, and a programmable hexadecimal addition problem needed to switch the alarm off for good. The alarm clock will show the time using and will also include function buttons which allow the user to set the correct time in hours and minutes. The alarm clock component will also include an AM/PM indicator as well as an alarm indicator. The driving system component consists of four motors which will be attached to four wheels respectively and servo motors to which the ultrasonic sensors will be attached. The driving system will also include autonomous obstacle detection and avoidance which is a key component as part of the alarm clock "running away". To give our clock a complete picture of its surroundings during autonomous control, we plan to use multiple ultrasonic sensors which will be attached to the front of the alarm clock and will constantly perform scans to give the clock a more accurate mapping of its surroundings. The final component is the hexadecimal addition problem which ensures that the alarm remains off if a correct answer is provided. The hex-add display will be on the opposite side of the time display and features an addition between two-bit hex values. If the answer inputted matches the correct answer, then the alarm clock will stay turned off. Otherwise, it will continue to ring as an invalid answer has been given.

**High Level Requirements:**

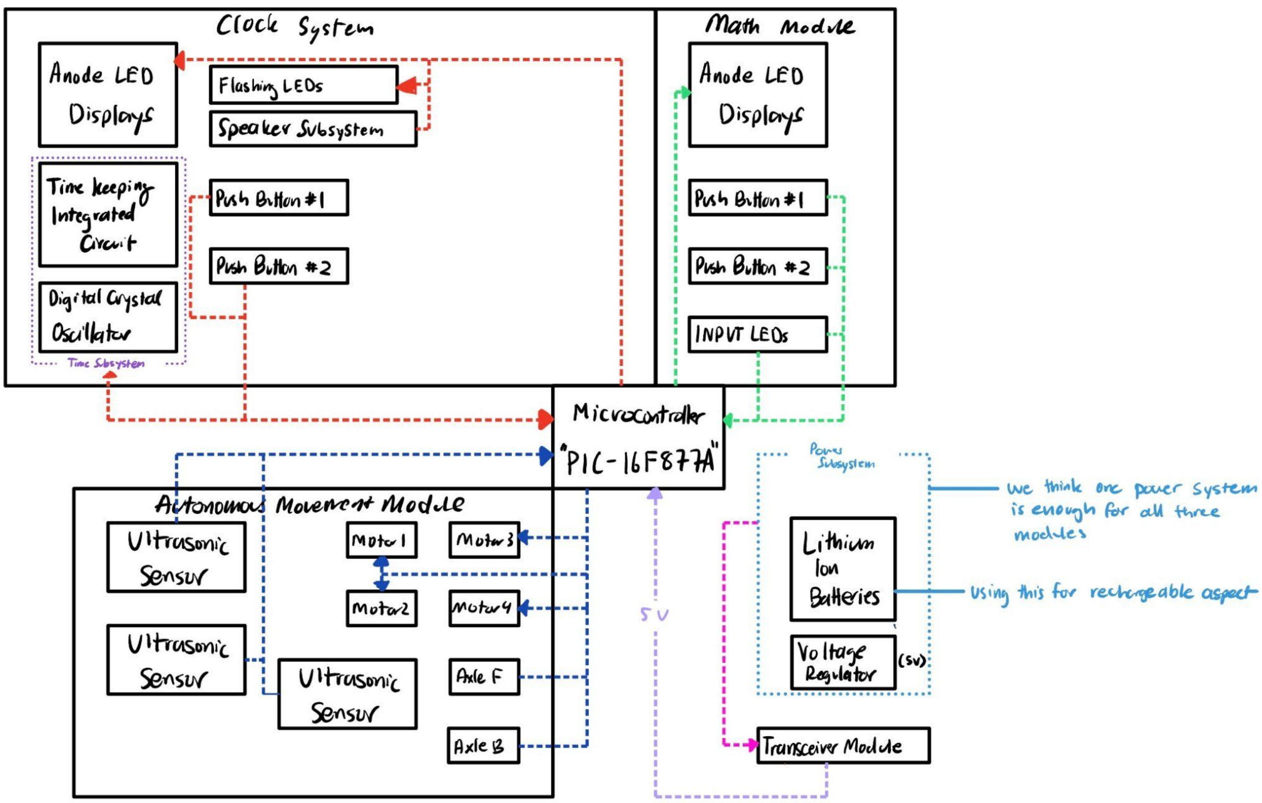
1. The device has the functionality of a normal alarm clock. It will have the ability to set the time, set an alarm, and produce an alarm sound.
2. The alarm clock can navigate the room and avoid obstacles using the ultrasonic sensors.
3. The device will display a hexadecimal addition problem on a hex-display, accept user answers to the math problem, validate the answer, and then turn the alarm sound off.

**Visual Aid:**



# Design

**Block Diagram:**




**Subsystem Overview:**

1. **Alarm Clock Subsystem**

   The alarm clock subsystem is used to display the time and also is used to set/turn off alarms that have been set. In order to keep track of time properly, we have introduced a **time subsystem** which consists of a time-keeping IC and a digital crystal oscillator. The clock subsystem also contains 2 push buttons for setting the time and the alarms and these buttons establish a connection to the time subsystem.

2. **Autonomous Movement Module**

   The autonomous movement module is responsible for making the alarm clock move around without running into external objects. In order to generate a comprehensive mapping of its environment, we will be mounting multiple ultrasonic sensors which will all be interfaced with the PIC16F microcontroller (Microchip Technology). This module also contains the four motors which will each power the four wheels on the car respectively.

3. **Math Module Subsystem**

The math module system is responsible for displaying a hexadecimal addition problem and verifying if the inputted answer is correct. If the answer is inputted incorrectly, then the alarm should not be turned off and should continue to ring until a valid answer is provided by the user. This subsystem is connected to the alarm clock subsystem - the result of the addition determines if the alarm should be switched off or not. The math module subsystem also contains push buttons which allow the user to input a 2 digit hex answer (one push button for tens digit, one for ones digit) and an LED display which allows the user to see what they've just inputted.

4. **Power Subsystem**

   The power subsystem is responsible for supplying power for the rest of the aforementioned subsystems and this is how it is connected to the rest of the subsystems as well. It consists of lithium ion batteries which were chosen due to their rechargeability advantage, and a voltage regulator. The power subsystem is also connected to the transceiver module which is used to communicate how much power/voltage is supplied to the PIC microcontroller.

**Subsystem Requirements:**

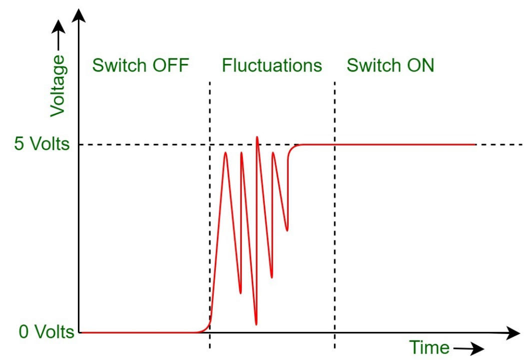
1. *Alarm Clock*: This subsystem satisfies the high-level requirement to have a functional alarm clock. The alarm clock consists of 3 subsystems: a "real-time clock", push buttons for setting the time and alarms, as well as a LED HEX display to show the time. The alarm clock runs on a 5V power supply. The microcontroller interfaces with all three subsystems of the alarm clock. The microcontroller will ***read*** input from the push buttons. The microcontroller will ***read/write*** information from the RTC. Based on input from the push buttons the microcontroller will ***write*** the time in the RTC subsystem and on the clock cycle the microcontroller will ***read*** the current time. The current time will be ***written*** onto the LED display by the microcontroller. Outside of basic function, an added feature will include a dimmed preview of the time using a photoresistor to control ambient lighting (Photoresistors).
2. *Autonomous Movement Module:* This subsystem satisfies the requirement to have autonomous movement. This will consist of multiple ultrasonic sensors that are placed evenly because they each roughly get less than 30 degrees of coverage (Peppers+Fuchs). The reason we are using multiple ultrasonic sensors is to make sure that no blindspot is being missed. These sensors will connect to the Microcontroller and send the data to it. From there, the data that is being sent to the Microcontroller is now distributed to the 4 motors and axles that turn the car if necessary.
3. *Math System:* This part of the system is the simplest as it has a few Anode LED Displays (similar to the Clock) on the opposite side of the product. These displays show the Hex addition problem and in order to register input, there will be two push buttons - one that increments the "tens" digit

(_x), and one that increments the “ones” digit (x_). It will loop from 0 to F on both and then start back over at 0 so there is no need to decrement buttons. To visually show this input, we are doing input LEDs as well so that the user can see the number while clicking the buttons.

**Tolerance Analysis:**

When using multiple ultrasonic sensors in the same system, there is an interference that happens when they are firing in similar ranges so it affects how it reads what is nearby. This interference is called cross-talk or noise (Inc, M. B.). We think this could cause the robot to be fidgety around objects and have more uncertainty when avoiding objects. One way we were thinking of tackling this was to fire off sensors at different times so that they are not interfering with each other. We plan on setting up a timer so the microcontroller chooses sensors in an order extremely quick so it can tell what is in front of it.

Another issue we think would arise when building this product is how the signal input is relayed to the system. When turning on the alarm clock, we don’t want the signal to have noise interfering with the actual power causing it to turn on multiple times (shown in the image to the right (Switch Debounce in Digital Circuits)). The graph on the right shows that the signal bounces between 0 and 5 volts multiple times before fully reaching 5V, which could cause some flickering in our LED display and the circuit to act unusual for the first few seconds of turning on (Contributor, T. T.). Adding a debouncer should help “debounce” the signal so it does not turn on until it actually hits 5 volts. This way the signal is not interfered with and properly turns on when the user prompts it to.




## Ethics and Safety:

In terms of ethics and safety, we are sure that there are minimal risks related to this project. One issue that arises is the speed of the car. We do not want this car going so fast that it hurts any living object or even causes inanimate objects to fall and break. The alarm clock noise should be kept at a respectable volume so it does not harm the user’s ears, yet still wakes them up when sleeping. Privacy wise, we are not using any equipment that keeps track of long-term data.

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