ECE 445
SENIOR DESIGN LABORATORY

PROJECT PROPOSAL

Moving Alarm Clock

TEAM 31

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Abstract

In comparison to the RFA, the proposal is a more detailed look into the project. High level implementation details, success requirements, and ethical considerations shall be discussed in the following proposal.

Introduction

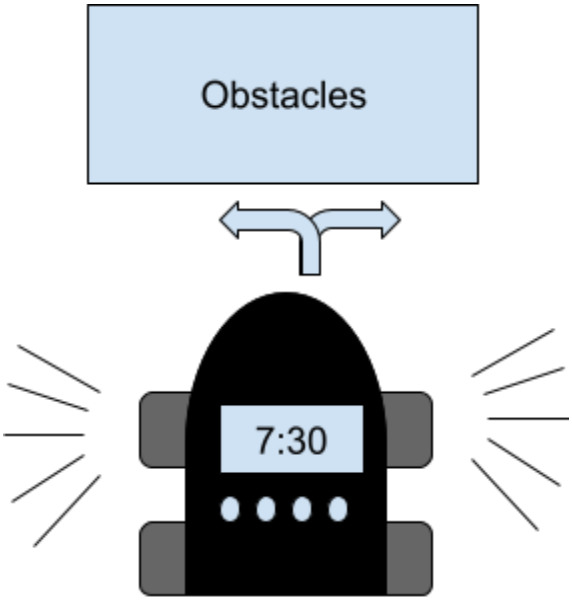
Problem:

Many people find it difficult to wake up in the morning. Studies show that nearly 70% of people regularly press the snooze button on their alarms. This is a significant problem as it delays people's schedules and gives them less time in the day. Studies show that those who wake up earlier are less likely to develop mental health issues such as depression and anxiety. Those who are unable to wake up from their alarms may be putting their mental health at risk. Additionally those who keep ignoring alarms may disturb others nearby.

Solution:

Our proposed solution to this issue is a moving alarm clock. This alarm clock will start playing the alarm sound at the same time that it starts moving. The user will have to chase the alarm clock in order to disable it. This will help them get exercise before turning off the alarm which will wake them up. Exercise raises core body temperature which helps wake people up in the morning, similar to a warm shower. It also gets the user away from their bed which can help decrease the urge to go back to sleep. The alarm will have a sensor that will detect obstacles in front of it and will turn away from them. It would be best if the user can't predict the path that the device will take so the device will randomly choose which direction to turn.

Visual Aid:



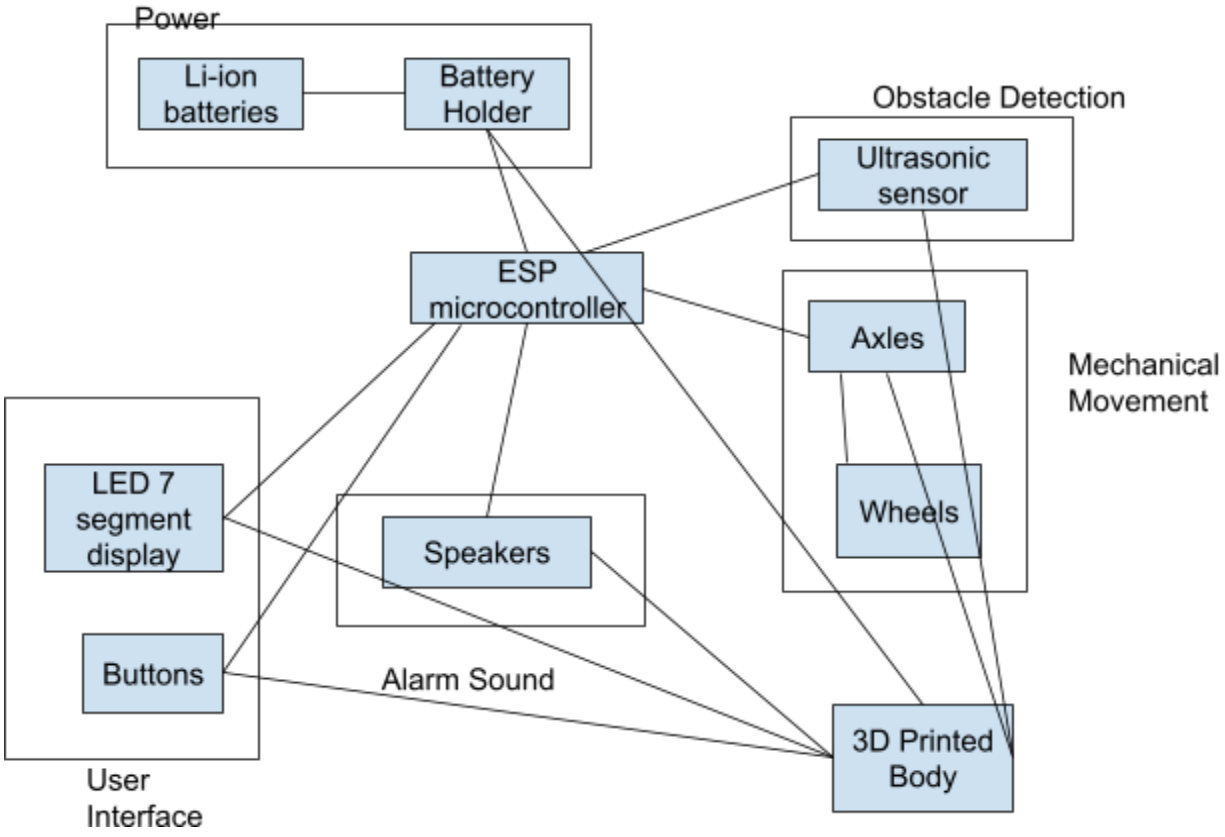
Moving Alarm Clock

High Level Requirements:

1. The first requirement is the alarm should ring within 10 seconds of the clock strikes the set alarm time. This is important because it is what causes the user to wake up.
2. The next requirement for success is the robot should start to move while the alarm is sounding. The robot should also be able to avoid crashing into walls and other obstacles using sensors.
3. The alarm sound system should also be able to be turned off if the user manages to catch the robot. This gives the user an incentive to get up and catch it, waking them up in the process.

Design

Block Diagram:



Subsystem Overview

The design is split into 7 different subsystems: Power, User Interface, Mechanical Movement, Obstacle Detection, Alarm Sound, Physical Housing, Microcontroller subsystems.

Power System

The device will be powered by rechargeable batteries to enable untethered movement for the alarm actions to be performed, essentially removing a space constraint because no power cords are needed. The batteries provide enough power to handle continuous motor operation, sensor activity, and the alarm sound for the necessary duration.

User Interface System

The use of a LED screen for the user to input time information will be the primary method for the user to interface with the system. The alarm configuration will then be easily navigated, especially when it comes to setting up wake up times and adjusting features. The visual feedback from the LED display screen will help the user confirm their inputs and display set up features.

Mechanical Movement System

A motorized base with omnidirectional wheels is present in the vehicle, allowing for free movement in each direction. There is also an accelerometer present to enable unpredictable movement around the room, making the user put in the effort to chase it down. In addition to the ultrasonic sensor and obstacle detection, the combination of motors will enable smooth, dynamic movement, enhancing the effectiveness of the alarm by making it more challenging to deactivate.This combination of motors and sensors will enable smooth, dynamic movement, enhancing the effectiveness of the alarm by making it more challenging to deactivate.

Obstacle detection System

Utilizing ultrasonic sensors to detect obstacles nearby and enable smoother and safer movement around obstacles. Real-time data will be provided to the microcontroller, enabling the device to adjust its movement path when obstacles are detected, preventing collisions or getting stuck. Detecting obstacles and moving around them form a necessary part of the overall system's function, thereby making it an important system.

Alarm Sound System

There is a speaker controlled by the PCB and microcontroller to produce the alarm sound at a given user-specified time. The microcontroller will trigger the speaker based on the programmed alarm schedule, ensuring that the activation occurs on time. The sound system will be designed to produce a loud, attention-grabbing alarm, making it difficult to ignore. The sound of the alarm will continue until the user deactivates it.

Physical Housing system

There will be a 3d printed durable housing that will make sure that the internal electronics are shielded from damage during movement and impact. The microcontroller, sensors, and motors are essential to the overall system and therefore needs to be protected. The housing will be designed in such a way in order to absorb maximum impact and still keep the product lightweight and usable.

Microcontroller System

The microcontroller system will utilize an ESP32 microcontroller which will handle all core operations, including motor control, alarm activation, sensor input, and user interface interactions. It will also ensure smooth interaction between the LED / user interface and the functionality of the device, ensuring seamless integration while optimizing performance.

Subsystem Requirements

Power System

1. The battery system must have 1A of current draw and a 3.3 +/- 0.1 V power source
2. There must be 2 lithium ion batteries with a charging capacity of 400mA and be chargeable using a USB type C charger

User Interface System

1. A battery display system must be present with a low battery warning when the system has less than 2 hours on charge.
2. To allow for easy navigation of the alarm configuration, a display with a minimum resolution of 128x64 pixels must be provided
3. The interface system must allow for accurate time input with a maximum response time of 100ms to confirm each user interaction on the display.

Mechanical Movement System

1. The vehicle should be able to travel at a speed of 4 m/min at minimum in order to enable necessary movement.
2. The accelerometer should trigger random changes in direction at least every 3 seconds to enable movement unpredictability

Obstacle detection System

1. Obstacles must be detected within a range of 30 cm to allow the device to adjust its path in time and avoid collisions.
2. The response time of the machine shall be less than 100ms to avoid accidental collisions

Alarm Sound System

1. The alarm sound must be around 80 db to match the sound level of a typical alarm clock.
2. The alarm system shall produce the sound to within 10 seconds of the user set time.

Physical Housing system

1. The 3d printed housing system must remain intact within 10 meters drops without causing damage to components inside.
2. In order to remain lightweight, the housing must weigh no more than 300g to ensure that the clock can be usable

Microcontroller System

1. The response time for real-time motor control and sensor input processing must be within 50 ms to ensure smooth functioning

2. Less than 80% of the microcontroller's CPU usage shall be used while supporting simultaneous operation of the motor control, alarm activation, obstacle detection, and user interface

Ethics and Safety

There are a few small ethical concerns with this product. The product could wake up people other than the intended user. This is also a concern with a regular alarm, although the motion of the alarm may move it within earshot of someone who wouldn't hear from a real alarm. This issue is not in control of our design as it is related to how the user uses the product. We would warn any user to be mindful of others around them as they use this. Another ethical and safety concern is the user may get hurt while trying to disable the alarm. This may happen if their hand gets caught between the wheel and the frame, or if the device runs over a part of their body. In order to prevent issues like this we will make sure that the user can safely put a finger within the space between the wheel and the frame. We can do this by either putting a flexible/soft material, such as rubber, in this space or by making a large enough gap between the wheel and the frame to fit a finger or hand safely. We will also ensure that the device weighs less than 4 pounds so that the user does not get injured from having a part of their body run over.

References

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