

Automated Wake-up Curtain

ECE 445 Project #55

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1. Introduction

1.1 Objective

Getting out of the bed sometimes can be a very tough problem especially for fresh college students who now have no parents around to wake them up. Sure, the typical alarms can do the job waking students up, however, their alarm sounds are very disturbing. Oftentimes not only the alarms will fail to wake the student up, but also the non-stopping clangorous sound could drive people around him/her such as roommates or neighbors crazy. Even using today's more advanced alarm system——cell phone, the same problems still persist.

To address this problem, we propose to use an alternative method to wake students up by introducing the automated wake-up curtain which has a built-in alarm clock letting users set a specific time to wake them up. When it's the time, the curtain will open automatically letting sunshine into the room, and its speakers will play morning meditation music to wake the user up. One can set the time through the corresponding Android Phone App. Since we want to guarantee that the user does get off the bed, one can only turn off the music by using the physical switch on the wall below the curtain. Besides the default Alarm Mode, the user can switch to Manual Mode via the App to simply control the curtain as a motorized curtain. Plus, there would be physical switches installed on the wall to control the curtain as well.

1.2 Background

Original Project Description:
2015, Project 27

As college students we all struggle to make it to class in the morning. There is no limit to the number of times we hit the snooze button. On top of all that we are expected to remember the huge list of things to do for the day. Our solution to this problem is the Smart Mat. This Smart Mat does not stop ringing until the person is awake and standing on the mat. Once awake, the person gets to hear his/her morning reminder that is set the previous night. This product would help any student get out of bed and kickstart the day.

The essential problem of the original projects aiming to solve is how to make college students wake up or get off from the bed. However, we feel like such a smart mat may not be suitable for college dormitories, since the room is typically not very large and the alarming sound may bother other students in the nearby dorms, especially people who have a “different sleep schedule” will be disturbed (Beth Skwarecki, 2019).

Besides simply solving the wake-up problem, we also take into consideration the fact that nowadays lots of students are busy working on their academics inside which can lead to a problem of lacking sunshine exposure. We believe sunlight is greatly beneficial to our bodies as it can provide us with vitamin D, so such automated curtains can at least provide some sunlight in the room without even thinking about that which can make the students more productive. According to a recent article, “If the lighting gradually gets brighter, like during a sunrise, our bodies are even more responsive and you'll feel much more refreshed (Alina Bradford, 2019)”. Thus, such automated curtains can be very suitable for college dorms.

Fundamental difference:

- the electronic equipment contained in the Smart Mat could negatively affect the user's sleeping experience. In comparison, the wake-up curtain we develop will not affect the user's sleeping quality because it is placed in the user's bedroom instead of the user's bed.
- The Wake-Up Curtain is more friendly to students living in student dorms and apartments. Most student apartments and dorms are too small to put the Smart Mat, but the students can replace the original curtain in the apartment with the Wake-Up Curtain, which does not require any additional spaces.
- The Wake-Up Curtain stops ringing when the user stands on the Curtain, but the alarm of the The Automated Wake-Up curtain can be turned off manually through a physical switch on the Curtain.
- The Wake-Up Curtain uses a corresponding Phone App to set time. Its opening and closing can be controlled by the Phone App as well. Such design allows the user to remotely control the functions of the product.

- Instead of traditional alarm rings, the Wake-Up Curtain can play melodic music to wake up the user. It is understandable that college students can often be stressful due to either academics or social problems, so we believe melodic music in the morning can give a good mood to the students and relieve their stress.
- The Wake-Up Curtain will be able to open and let the sunshine come in when it is time to wake up. We believe that the sunshine can help wake up the user as well as give the user a good feeling on the start of the day.
- The Automated Wake-Up Curtain uses a completely different mechanical design and actuator system than the Smart Mat. The users can control the functions of the Wake-Up Curtain both physically and remotely through Phone APPs, by doing so we are giving the user the maximum freedom to use and exploit the product. The users no longer need to stand up on the product to stop the alarm ring. They can easily turn off/on the product manually using physical switch.

1.3 High-level requirements

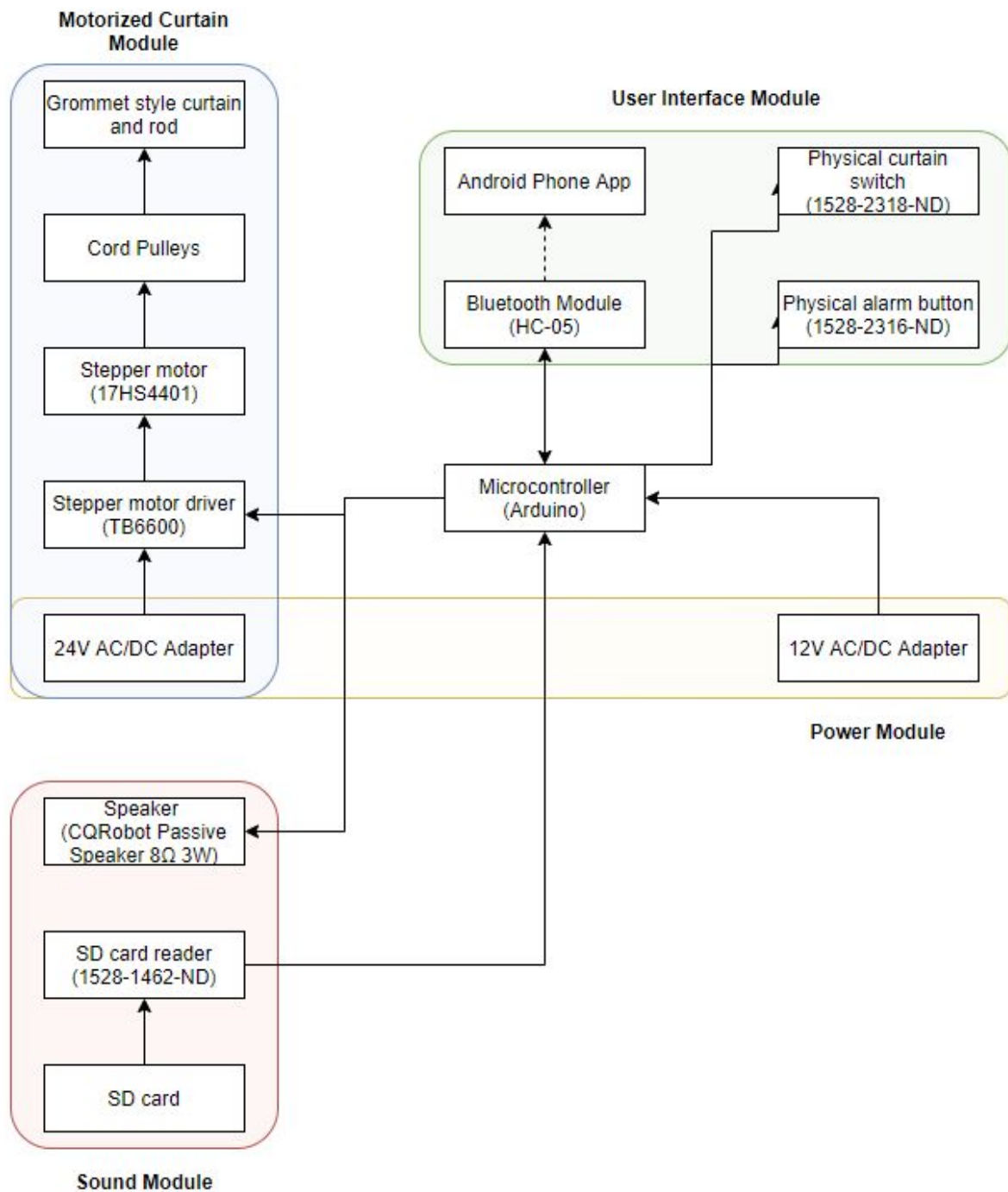
- The Alarm functionality can work intended as the user can set the time via Phone App and the alarm clock is accurate (+/-1 minute)
- Both the Automated Curtain and ring/music of the Automated Curtain can be opened and closed by physical switches as well as via Phone App
- The physical switch button on the wall can successfully turn off the alarm/music and the Automated Curtain
- The user can choose the volume and the type of music they want the curtain to play
- The timing system of the Phone App can adjust to the current time zone automatically

2. Design

The main features of the product includes:

- automatically open the curtain when the alarm is activated
- allow user to open/close the curtain via manual switch and phone app
- allow users to set wake-up time through phone app
- play melodic alarm music to wake up the user
- alarm can only be turned off with a manual switch that is not accessible on bed (to ensure that the user is off bed) (deactivate the alarm function via manual switch)

2.1 Block Diagram



2.2 Functional Overview

Motorized Curtain Module

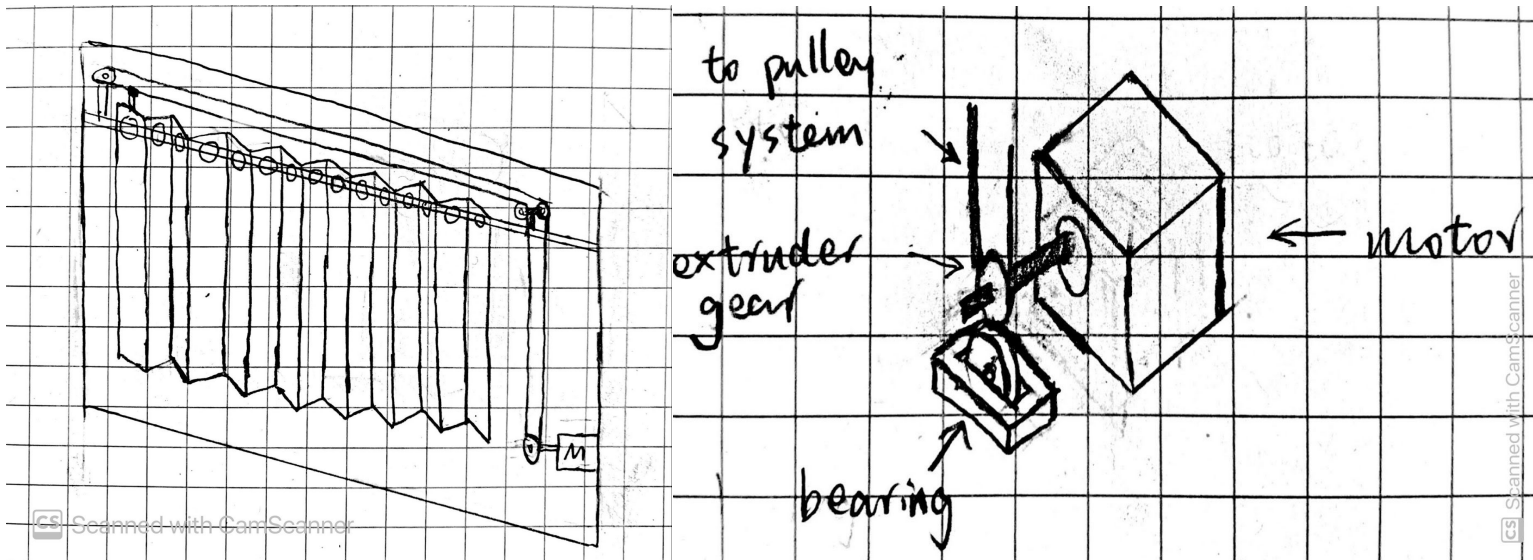
- Motorized Curtain that can automatically open and close
- Subcomponents:

- Grommet style curtain and rod
- Pulley system that folds and extends the curtain
 - 3 pulleys are used to move the leftmost part of the curtain to fully fold/unfold the entire curtain
- Stepper motor and Stepper motor driver that drive the pulley system
 - Stepper motor (17HS4401)
 - Stepper motor driver (TB6600)
 - Stepper motor driver is the interface between stepper motor and the control module
 - 9-42V DC is needed to drive the stepper motor
- Supplementary mechanical components (extruder gears, bearings, etc.)
- Quantitative Requirements
 - The process of fully fold/unfold the curtain should be within 20 seconds

Fig1. Curtain schematic diagram

Fig2. Motor schematic diagram

User Interface Module



- Subcomponents
 - Bluetooth Module:
 - Bluetooth module (HC-05) is used to communicate between our microcontroller (Arduino) and Android Phone App.

- Phone app that allow user to:
 - Switch between Manual Mode and Alarm Mode
 - Alarm Mode: automatically open the curtain when the alarm is activated
 - Manual Mode: open/close the curtain via App
 - Set the desired wake-up time
 - Remotely open/close the curtain
 - The latency should be within 1s
 - activate/deactivate the alarm function
 - Effectively making the product a motorized curtain with remote control
- Physical curtain switch (1528-2318-ND)
 - Push button switch connected to the control module electronically
 - Allow user to manually open/close the curtain
 - The latency should be within 1s
- Physical alarm button (1528-2316-ND)
 - Push button switch connected to the control module electronically
 - Allow user to manually turn off the alarm
 - Placed at a location that cannot be accessed from bed to ensure the user leave the bed
 - The latency should be within 1s

Sound Module

- Subcomponents:
 - Speaker (CQRobot Passive Speaker 8Ω 3W, JST-PH2.0 Interface)
 - Plays alarm music to wake the user up
 - Should produce sound level of 80dB at 5ft from the human ear
 - SD card reader (1528-1462-ND)
 - Allows the control module to read the file containing music to be played
 - SD card
 - Stores the file containing music to be played

Control Module

- Microcontroller (Arduino) processes the input and output from the User Interface Module and Bluetooth Module to set the alarm time, trigger it to go off, and to control the curtain's movement
 - Input Signals: alarm time, mode selections

- Output Signals: alarm activation, motion control of curtain
- Microcontroller activates Motorized Curtain Module and Sound Module accordingly based on the user's instruction

Power Module

- 24V AC to DC adapter to power the Stepper motor driver and the Stepper motor.
- 12V AC to DC adapter to power the Microcontroller (Arduino)
- Microcontroller (Arduino) will power the Sound Module and the User Interface Module

2.3 Risk Analysis

The block that poses the greatest risk to successful completion of the project is the interface between the pulley system and the motor. The most significant uncertainty about this is whether there is going to be enough friction force generated between the pulley rope, extruder gear and bearing. If not, the speed of the curtain will become really slow, or the automated curtain will not function at all.

Other supplementary mechanical components play important roles in the electro-mechanical system. The motorized curtain module should be attached on the wall near the floor, where it is unlikely to affect the user's daily activity. This requires a reliable pulley rope that is long enough to extend from the upper part of the wall to the lower part, robust enough to endure the wearing between extruder gear and bearing, and elastic enough to prevent the pulley system from getting loose.

Also, there must be a robust custom made outer shell that holds the motor submodule together. In addition, the pulley system must be firmly fixed on the curtain rod or on the wall.

3. Ethics and Safety

We fully considered the safety issues in our design of Automatic Curtain. As a product to be used frequently in people's daily lives, the Automatic Curtain must be completely safe and comfortable to use. Since we are using a power module with more than 24V, users should use the Automatic Curtain as carefully as using other electronic devices that may cause electric shock. In addition, our design must make sure that there are as least as possible sharp angles in the physical design of the Automatic Curtain. Such concern is due to the fact that users are very sleepy and careless when they just wake up, and they may be hurt by the sharp angles in the external physical design of the Automatic Curtain when trying to approach and close the curtain. Children are another reason for us to avoid sharp physical design. It is very dangerous to place an electronic device with sharp design in bedrooms where children can get hurt easily. Such design follows #9 of IEEE Code of Ethics "to avoid injuring others, their property, reputation, or employment by false or malicious action".

We are also responsible for the ethics of the Automated Curtain. As we know, traditional alarm clocks and even cell phones will produce very loud noise which may annoy the user's roommates or other people. Our design will try to reduce such problems by adapting melodic music instead of annoying alarms to wake up the user, and the opening of the Automatic Curtain will allow the sunshine to come in so that the user can wake up more quickly without disturbing others. Unfortunately, we are unable to solve this problem completely because the type and volume of the wake-up music are chosen by the users.

In conclusion, we believe that the design of Automatic Curtain is a nice try to combine a traditional alarm clock with a curtain and a product to wake up the users in the most tender and soft way while reducing the adverse effect on others as much as possible.

Reference

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