The Candle Extinguisher

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Project Proposal

Team # 46

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1. Introduction

1.1 Objective

Candles have been used around the world for thousands of years. They were the main source of light before electricity and the common light bulb were discovered. Today candles are still used, not as much as a source of light, but instead to give off different scents. Candles come in all kinds of different shapes, scents, and colors, and can be found in almost every household. Many users believe that candles are a very simple and safe device, but there are many precautions that must be taken. When candles are left unattended, unexpected fires can occur. These fires can spread quickly and can easily destroy an entire house. Another issue that is often forgotten is the fact that candles need to have a cool down period and should not be burned for a long period of time.

Our goal is to create a device that can monitor the use of a candle. This will be used to ensure that the candle does not burn for too long and that it is safely extinguished. A majority of the fires started by candles occurs because the user simply forgets about the candle. The Candle Extinguisher does exactly what its title states, it will safely extinguish a commonly sized candle. Through our device, the user will be able to input a desired time (within a set range) that the candle will be extinguished. In order to accommodate the different candle sizes, the device is based around a one-gallon glass jar. Any candle that will fit into this jar will be extinguished. Once the inputted time has been reached, power will be sent to a motor that will rotate the lid to the top of the jar creating a seal. This seal will cut off oxygen and suffocate the flame of the candle. A thermal sensor will also be implemented to ensure that the flame has been successfully extinguished.

1.2 Background

As mentioned above, candles can cause many house fires. For the five year period from 2009 to 2013, candles cause an average of around twenty-five house fires every day. These fires have cost millions in property damage and haven taken the lives of many users [1]. Many of these fires occur when the user is asleep. With our device the user can have their candle safely extinguished while they are sleeping. Another reason why candle fires are so common, is due to drafts that may occur in the room. These drafts can cause nearby items to move into the path of the candle. This could then create an unwanted fire that can easily spread [2]. Since the Candle Extinguisher is based around a glass jar, unexpected items cannot be blown into the path of the flame.

Another key issue with candles that many users do not realize, is that candles should not be burned for more than four hours at a time [3]. Major candle companies stress the importance of this idea because candles need a chance to cool down. Constantly burning a candle for more than four hours can cause damage to the candle and can cause too much liquid wax to form on the surface. Most importantly candles should not be left unattended. With our device we still stress this idea. The Candle Extinguisher should not be neglected and should still be in the same room as the user.

1.3 High-Level Requirements

- Device must successfully extinguish the candle within two minutes after the desired time has been reached.
- Device must prevent user from burning a candle for more than four hours.
- Device must be below the price of $60.

2. Design

2.1 Block Diagram

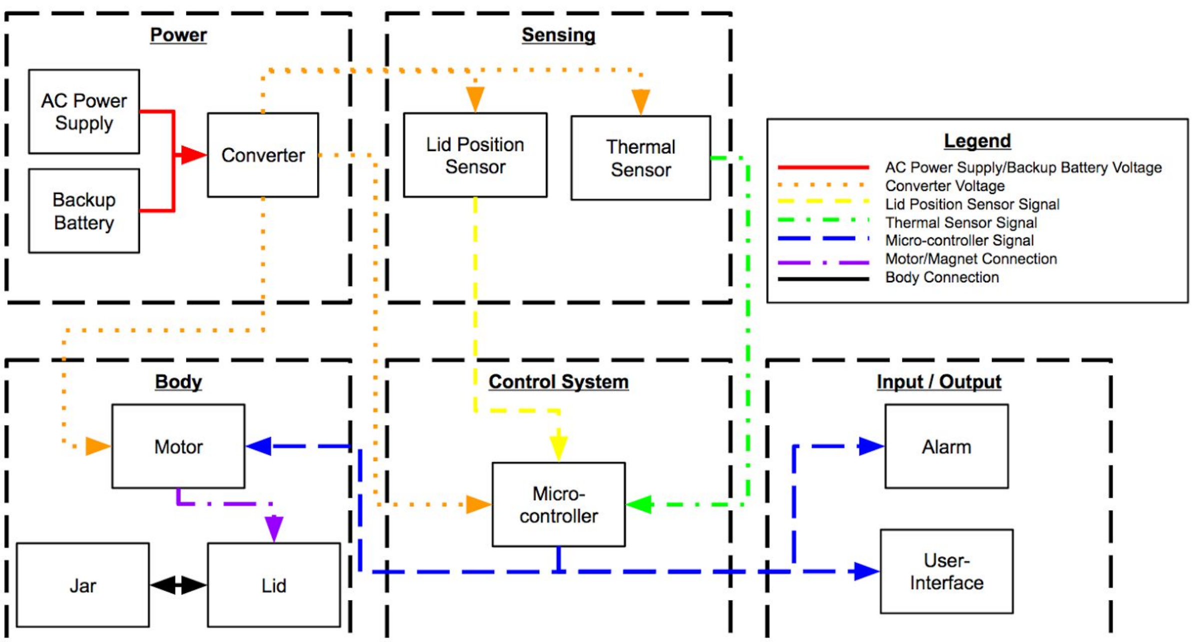

Figure 1: Block Diagram of the Candle Extinguisher

2.2 Physical Design

Figure 2. The Candle Extinguisher Concept Design

2.3 Block Description: Power

2.3.1 AC Power Supply

The power supply will take in power from an AC wall outlet rated for 120V at 60Hz. This power will then work with one of the converters to convert the AC power into DC power. The power from the wall outlet will be the main primary source of power for each component.

Requirement 1: Must be able to take in a range of 118V - 122V AC at 58 - 62Hz.

2.3.2 Backup Battery

The backup battery will provide the necessary power to the device to make all the electronics work properly when there is a power outage. The battery will need to be able to power the device long enough that it can automatically seal the container. The battery will have to power several electronic components, such as the motor, the sensors, and the microcontroller.

Requirement 1: The battery must last for at long enough to close the jar and form the seal while powering the other components.
Requirement 2: Battery must be able to withstand heat other components, the candle, and itself.
Requirement 3: The battery must not be a fire hazard.

2.3.3 Converter

The converter is needed to convert the battery voltage and wall outlet voltage to voltages that the other electronic components can use. Several converters may be needed depending on the voltage requirements of the components. A converter will also be needed to convert the AC voltage from the wall outlet into a DC voltage.

Requirement 1: The converter must be able to withstand heat other components, the candle, and itself.
Requirement 2: The converter must be able to convert the AC power from the wall outlet to 3.3V ±10% , 5V±10%, and 9V±10% DC power to be used by the motor, sensors, and microcontroller within their specifications. The current should be limited to 2.5±10%Amps.

2.4 Block Description: Body

2.4.1 Motor

The motor is a very important component to the candle extinguisher. The motor will be a servo motor that is controlled by the microcontroller. The motor will rotate the lid 180° in order to be placed on top of the jar. The motor also needs to be able to do the opposite so that the user can place a candle within the jar.

Requirement 1: Must be output at least 0.005 Nm to move the lid into either positions.

2.4.2 Jar

The main structural component in The Candle Extinguisher is a glass jar. This will be used to enclose the candle. When the lid is rotated to the top of the jar, oxygen will be cut off and will suffocate the flame.

Requirement 1: Jar needs to be made of glass so the entire candle can still be seen.
Requirement 2: Jar should have a one-gallon volume.

2.4.3 Lid

The lid will be attached to the top of the jar. The lid will be constructed of a lightweight material to lower the value of the starting torque required to move the lid. The lid also needs to have a high heat tolerance.

Requirement 1: Must be able to rotate 180°.
Requirement 2: Must create a good enough seal with the jar to extinguish the candle within two minutes.

2.5 Block Description: Input/Output

2.5.1 User Interface

The user interface will be mounted on the bottom of the candle extinguisher. There will be an LCD screen which displays the time remaining on the alarm system. The LCD screen will have an on/off button, arrows to increase/decrease time, arrows to increase/decrease brightness, and a button to start the timer. The user will enter the amount of time they want the candle extinguisher lid to stay open. This information will be transmitted to the microcontroller for how long to keep the lid open on the device.

Requirement 1: Ability to increase and decrease brightness of the backlight from 0 nits to 400 nits.
Requirement 2: Ability to increase time on alarm for up to four hours.
Requirement 3: Constantly display the time remaining on the display.

2.5.2 Alarm

The alarm will be triggered once the allotted time on the user interface has expired and the thermal sensor detects a flame. There will be an audio alarm and also a visual alarm. If the thermal sensor detects, the microcontroller will send power to the audio buzzer and the screen will flash rapidly.

Requirement 1: Audio buzzer must emit a sound that can be heard twenty meters away.
Requirement 2: Screen flashes rapidly when the alarm goes off
Requirement 3: Alarm will always go off if it is triggered by the microcontroller

2.6 Block Description: Sensors

2.6.1 Lid Position Sensor

The lid position sensor is a pressure sensitive sensor that will detect if the lid is open or closed. The sensor will be on the edge of the lid. When the sensor is pressed, the lid is closed, when the sensor is not pressed, the lid is open. The lid position sensor will communicate with the microcontroller.

Requirement 1: Detects when the lid is closed and communicates with the microcontroller.

2.6.2 Thermal Sensor

The thermal sensor will detect if a flame is present in the candle extinguisher. Once the initial alarm goes off, the microcontroller will communicate with the thermal sensor to determine that the flame has been extinguished.

Requirement 1: Detect the difference between when a candle is lit and when there is no lit candle.
Requirement 2: Must detect wavelengths from 760 nm to 1100 nm.

2.7 Block Description: Microcontroller

The microcontroller will be the brains in our device. The chip chosen will be the Atmega328 taken from an Arduino development board. The microcontroller will be placed on our design PCB board and will be connected to the rest of our components. This microcontroller is needed to carry out all of the functions of The Candle Extinguisher. This microcontroller will communicate with the user interface to determine how long before the candle needs to be extinguished. Once the time has been reached the microcontroller will send power to the lid motor to rotate the lid to the top of the jar. After this has been achieved, the microcontroller will communicate with the thermal IR sensor to ensure that the flame has been successfully extinguished. Lastly, the microcontroller will also communicate with the lid position sensor.

Requirement 1: Needs to have at least four output pins
Requirement 2: Needs to have at least three analog read input pins
Requirement 3: Needs to turn on and communicate with the thermal sensor five minutes after the candle has been extinguished.
Requirement 4: Needs to turn alarm on within two minutes if thermal sensor detects a flame.
Requirement 5: Needs to enforce two hour cool down period if same candle has just been extinguished.

2.8 Risk Analysis

The block that provides the most risk to our implementation is the motor block. If the motor doesn't work properly, the user will not be able to use the device. The motor moves the lid into position in order to create a seal on the top of the jar. The motor will powered by the power supply and also by the backup battery if needed. The motor can fail in a couple of different ways. The motor can burn out from excessive use. Another issue is that the motor may not be able to provide enough starting torque. Lastly, the motor may have issues communicating with the microcontroller. It is a necessity to test the motor with the microcontroller to ensure that the motor achieves its goal.

The other components of The Candle Extinguisher are also very important, but if the motor is not working properly, then The Candle Extinguisher cannot successfully extinguish candles. It is of the utmost importance that the motor can successfully move the lid into position on top of the jar.

3. Safety and Ethics

Candles should always be attended and have someone present in case of a problem. The Candle Extinguisher will come with warnings to inform the user that they should not leave the candle unattended. However, the user can ignore these warnings and still leave the candle unattended, causing the risk of fire to increase. There is not a solution to prevent the user from leaving the room and leaving the candle unattended. The features built into the Candle

Extinguisher will help keep the user safe. The time limit on the Candle Extinguisher will make sure that the candle does not burn for time periods greater than four hours. The container surrounding the candle will also help mitigate the risk of the flame spreading to a nearby flammable object. There will always be risks and we unfortunately cannot account for everything. We believe though that the features offered with the Candle Extinguisher provide safety for the user.

Due to the nature of the product, there is the issue of fire and the fire causing damage. The important first step in dealing with this problem is addressed in the IEEE Code of Ethics #1: “to accept responsibility in making decisions consistent with the safety, health, and welfare of the public, and to disclose promptly factors that might endanger the public or the environment.”[4] To follow this code, the Candle Extinguisher will need to be made to comply with the rules for health and safety with both the fire and the electronic components. The Candle Extinguisher will also need to provide warnings of the danger of fire provided with the product.

Another issue that arises is the result of an injury occurring. Fire can be dangerous in certain situations if the correct conditions occur, resulting in injury to a person or property. This product could then be used maliciously by someone to cause this event to occur, going against the IEEE Code of Ethics #9 “to avoid injuring others, their property, reputation, or employment by false or malicious action.”[4] While this event could occur, we believe that the probability of the Candle Extinguisher being used maliciously is very low, and that the standard use of this product makes the pros outweigh the cons. The warning of fire and not to misuse the product in combination with fire will be included with the product.

As mentioned before, there are both positive and negative aspects to the Candle Extinguisher. Positive points include the ability to have candles lit for the desired amount of time and for an extra safety of extinguishing a forgotten candle. Negative points include the risk of the fire spreading outside of the candle. This follows #5 in the IEEE Code of Ethics: “to improve the understanding of technology; its appropriate application, and potential consequences.”[4] The goal is to improve the understanding of technology working in combination with candles to provide a safe and enjoyable experience for the user. Potential consequences have been addressed and will be handled accordingly.

The project and design process will address these issues in several ways. The first issue is in the design process. While designing and testing the product, the proper safety will be taken in both dealing with the electronics and with fire. The next issue is the product. We will address this issue in two ways. The first way is providing warnings to the user through a provided means, such as a pamphlet or on the product itself. The second way is by having different ways of the product addressing the issue of fire, through means such as the lid rotating and suffocating the flame, if the power fails, then the backup battery will power the motor to rotate the lid in order to put out the fire, preventing the user from burning candles for too long within a time period, an alarm to warn the user if the fire is still not extinguished, and having the electronic equipment as protected as possible from the fire and heat to prevent them from becoming too hot and failing.

Finally, since the product is using not only electronics, but the candle itself, the product will have to meet all candle safety and regulatory standards. The candle will have to follow ASTM standards for candles, specifically the following few mentioned. Cautionary Labeling Standard (ASTM F-2058)[5] addresses that the product will have to provide a label with the appropriate warnings. Heat Strength of Glass Containers Standard (ASTM F-2179)[5] will address the all specifications pertaining to the container. Finally, Candle Accessories Standard (ASTM F-2601)[5] will address the procedures and practices that must be followed since the Candle Extinguisher is an accessory to the candle.

References

[1] "Candle Fire Safety." NFPA - Candle Fire Safety. N.p., n.d. Web. 06 Feb. 2017.

[2] "Candle Safety Rules | NCA." National Candle Association. N.p., n.d. Web. 06 Feb. 2017.

[3] Karol, Aaron. "Basic Candle Care." Basic Candle Care. N.p., n.d. Web. 06 Feb. 2017.

[4]"IEEE IEEE Code of Ethics", *Ieee.org*, 2016. [Online]. Available: http://www.ieee.org/about/corporate/governance/p7-8.html. [Accessed: 06- Feb- 2017]

[5]"Candle Safety Regulations & Standards | NCA", National Candle Association, 2017. [Online]. Available: http://candles.org/industry-standards/. [Accessed: 06- Feb- 2017]