Design Document

Needs Assessment

Client/Customer Definition

Challenges the Client is Facing

1. Disorder Recognition: Due to the subtler symptoms of dysthymic disorder compared to major depression, many adolescents may remain unaware of their condition, underscoring the importance of early detection.
2. Mental Health Stigma: Persistent societal stigmas around mental health can hinder youths from seeking assistance or openly expressing their emotions[3].
3. Inadequate Support Systems: Lack of understanding or awareness among peers, teachers, and sometimes even families can exacerbate feelings of isolation[4].
4. Access to Professional help: Geographical and economic barriers might prevent some youths from accessing specialized mental health care.

Demographic Attributes

1. Age: Canadian Youth aged 15-17.
2. Health Condition: Youth grappling with dysthymic disorder, which is a milder but long-lasting form of major depression[2].
3. Educational Status: Given their age range, it is reasonable to infer that they are enrolled in high school.

Geographic Attributes

1. Country: Canada
2. Population Count: Out of 1,200,000 adolescents aged 15-17, between 19,200 and 96,000 are affected by depression, representing a range of 1.6% to 8%[1].

Economic Attributes

1. Dependent Economic Status: Given their age, the majority of these youths are presumably reliant on their parents or guardians for financial support.
2. Potential Limited Access to Mental Health Resources: Economic disparities can influence access to quality mental health care[3,5].

Competitive Landscape

Social System: School Counseling Program

a. How it addresses challenges:
    1. Disorder Recognition: through this system, if students have mental health problems, school counsellors identify early signs of mental health issues[6].

    2. Mental Health Stigma: Counseling within schools helps normalize seeking help[7].
    3. Limited Support Structure: Counsellors work with teachers and parents to support students.
b. Shortcoming:
    1. Limited resources in some schools and not all schools have trained counsellors or mental health sections.

Economic System: Subsidized Mental Health Programs(Government or NGO(non-government organizations)-funded program)

a. How it addresses challenges:
    1. Early Detection: Subsidized programs frequently offer initial screenings, aiding in the prompt detection of conditions like dysthymic disorder.
    2. Stigma Reduction: These programs make mental health care more available, promoting its normalization and decreasing related stigmas.
    3. Affordable Care: By offering free or discounted services, these programs make professional mental health care attainable for many[9].
    4. Community Support: Many of these programs include community initiatives, establishing support groups and hosting activities that encourage communal backing[8].
b. Shortcoming:
    1. Wait Times: High demand and restricted funding can lead to longer waiting lists, delaying immediate care.
    2. Inconsistent Quality: The quality of care in subsidized programs can differ due to factors like funding, location, and management[10].
    3. Access Limitations: Strict eligibility criteria might prevent some needy individuals from accessing these programs[10].

Technological System: AI-powered Chatbots

a. How it addresses challenges:
    1. Disorder Detection: AI chatbots can identify keywords in conversations suggesting mental health issues like dysthymic disorder. Users can be alerted and advised to get assessed[12].
    2. Reducing Stigma: Chatbots offer anonymous interactions, making users feel less judged and more open.
    3. Constant Support: Chatbots provide 24/7 feedback, helping those without easy access to professional care[12].
    4. Support for the Isolated ones: Chatbots can be a primary contact for those lacking support, offering resources and a place to share feelings[12].
b. Shortcoming:

1. Surface Insight: Chatbots can identify patterns but lack human empathy and depth of understanding, relying solely on algorithms[11].
2. Not a Replacement: AI chatbots aren't a substitute for professional mental health care; over-dependence can delay vital care[11].
3. Risk of Errors: Chatbots may misunderstand user inputs, leading to unsuitable responses that could upset users.
4. Data Safety Issues: Chatbot interactions might be saved, leading to worries about data protection and potential misuse.

Requirement Specification

1. Data Recovery Time: The average data recovery time should not exceed 4 hours[13].
2. Data Transmission Speed: Data transmission speed should fall within a range of 1 to 100 megabits per second(Mbps)[14].
3. The ambient light sensor shall measure the ambient light in the range of 0 lux(total darkness) to 10,000 lux, where lux stands for illuminance (bright sunlight)[15].
4. Vibration Time: When activated, the system should vibrate for a minimum duration of 18 seconds, which corresponds to reaction times for more intricate decisions involving six to twelve choices[16].
5. User Interface(UI) Load Time: Upon access via web or app, the user interface should be operational and ready for user interaction within a maximum timeframe of 2 seconds[17].

Analysis

Design

Depiction

Our system aims to support users who may be experiencing symptoms of depression by monitoring behavioral patterns and environmental factors that could impact mood.

- The PIR motion sensor tracks user movement and activity levels. Prolonged inactivity, especially during typical waking hours, could indicate fatigue or excessive sleeping which are potential signs of depression.
- The ambient light sensor measures light exposure in the user's surroundings. Lack of natural sunlight or residing in darker settings for extended periods can disrupt circadian rhythms and contribute to depressed moods.
- The RTC module logs the time of day. This allows the system to detect irregular sleep cycles or lack of activity during normal awake times.

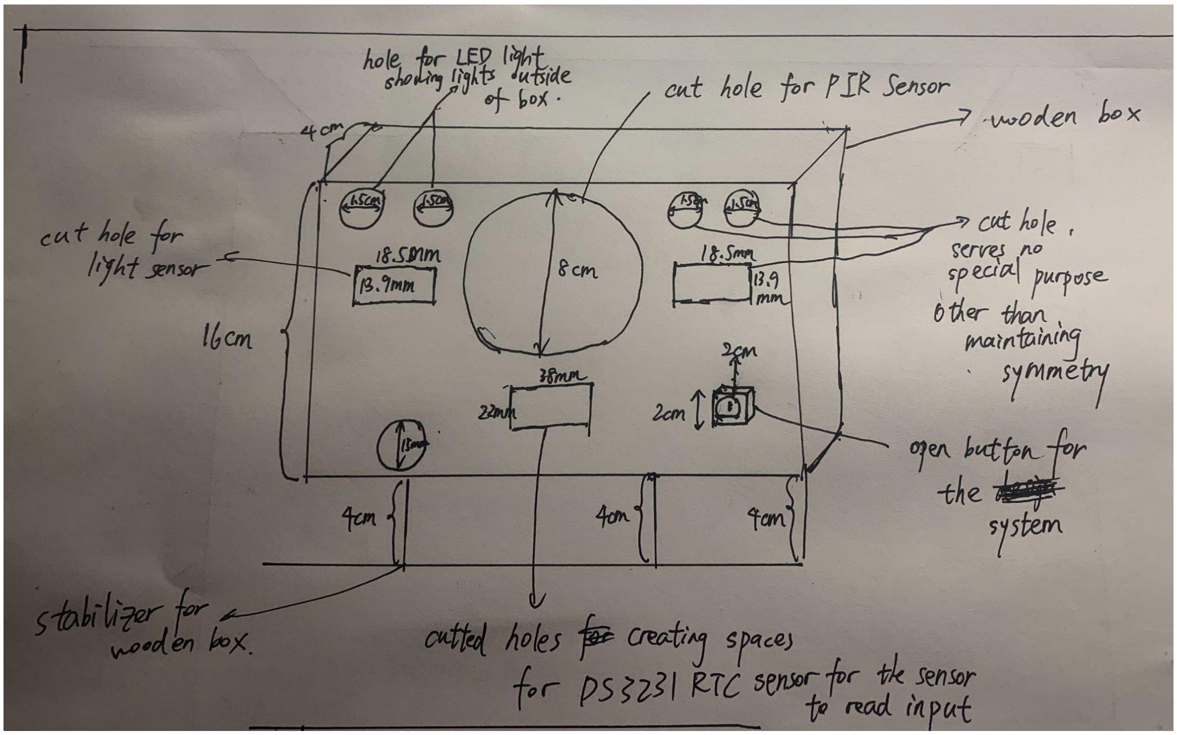
The device analyzes the sensor data, looking for patterns like low light exposure or inactivity that may correlate with depression. If concerning patterns are detected, a red LED illuminates to notify the user. A gentle vibration from the motor provides further alert. Otherwise, a green LED indicates normal operation. By monitoring these factors and providing feedback, our system aims to support users struggling with depressive symptoms. The goal is to encourage positive behaviors like increased activity and light exposure that may help improve mood and overall wellbeing.

Figure 1: Visual Representation of the System's structure

Scientific or Mathematical Principle

(1) Ohm's Law & Kirchhoff Law

Ohm's Law is a law highlighting that the relationship between voltage, resistance and current is



$V = IR$. [18] We could also use an extension of the Ohm's Law to calculate the relationship between power and voltage, resistance, and current, which is defined as the following:

$$P = IV = I^2R = \frac{V^2}{R} \qquad [18]$$

Ohm's Law could be used to calculate the amount of voltage and hence energy at each component of the circuit to validate whether the product exceeds the 30W power requirement as specified in the "ECE 198 Requirements."

Kirchhoff Law, on the other hand, refers to a set of equations that restrict the values of voltages and currents. [33] It is usually divided into Kirchhoff Current Law and Kirchhoff Voltage Law.

The Kirchhoff Current Law states that at any point in the circuit:

$$\sum I_{in} = \sum I_{out} \qquad [19]$$

Kirchhoff Voltage Law, on the other hand, states that for any closed loop:

$$\sum V = 0 \qquad [19]$$

which could then be represented as

$$V_i - \sum_{1}^{n} V_n = 0$$

where V_1, V_2... V_n represents the voltage of n^{th} object in the circuit.

The Kirchhoff Law can be used to determine input energy needed from the STM32F401RE motherboard (See Circuitry Diagram inside the "Installation Guide" section. To achieve this, equations on loops that include the STM32F board can be listed out. Kirchhoff Law could also be used with the Ohm's Law listed above to set up equations showing the relationship of a few components inside a closed circuit loop, which would assist calculation about energy of components in circuits.

(2) Statistical distribution: minimum, maximum, mean, standard deviation. Make decisions based on the properties of the statistical distribution of information/data collected.

Standard deviation is a quantity that measures how spread apart data from each other is [20]. In this project's case, it represents how the the spread of sleeping pattern data in a given period of time. A higher standard deviation represents a higher disruptiveness of the sleep pattern, which then means a higher chance of depression. In a standard distribution model, a standard distribution of 1 includes 68% of all data sets while a S.D. of 2 includes 95% [21]. Therefore, an S.D. of 2 or higher possibly indicates a high variation in a person's sleep.

The Standard Deviation of data set t with n sets of data is defined as the following:

$$\sigma = \sum_{1}^{n} \sqrt{\frac{(t_n - \mu)^2}{N}} \qquad [22]$$

Where t_n represents the time that the person sleeps at the n^{th} date, μ represents the average of set t, N represents the total number of sets of data in set t.

To reduce the possibility of bias, the maximum and the minimum data in the data set, along with possible outliers will be removed during the calculation of standard deviation, in which they are defined or denoted as follows:

Maximum data = Max (T). If there is $a_{max}(a_{max} > 1)$ values in T that is equivalent to $Max(T)$. All data that is equal to $Max(T)$ will be removed. This rule also applies to $Min(T)$
Minimum data = Min (T).

Outlier Formula: t_n is considered an outlier of set T if and only if

$$t_n > 1.5\ \mathrm{IQR} + \mathrm{Q3}\ \text{ OR }\ t_n < \mathrm{Q1} - 1.5\mathrm{IQR}[23] \qquad \text{(Formula 2)}$$

Where

IQR (Interquartile Range) $= \ Q3 \ - \ Q1$ [22]

We define the set of outliers in T as S, where $S \in T$ and S has a size m.

Hence, the standard formula after adjustments would be:

$$\sigma = \sum_{1}^{n} \sqrt{\frac{(t_i - \mu)^2 - \sum_{1}^{m} S - a_{max} Max(T) - a_{min} Min(T)}{N - a_{max} - a_{min} - m}}$$

To calculate whether a data is deviated away from the 2 S.Ds, we apply following equations:

$$z = \frac{x - \mu}{\sigma} \qquad [22]$$

Where z refers to the number of standard deviation that x is away from μ. Substitute $z < 2$ and $z > \ - 2$ as the constraint in the above equation:

$x > \ - 2\sigma + \mu$ OR $x < 2\sigma + \mu$

Thus, if the user's sleeping pattern at a specific day falls into the range above, the system will identify the user as high possibilities of depression due to their disrupted sleep pattern, and hence the red LED light inside the system will shine.

(3) Probability Distribution

Probability Distribution refers to the probability function over an interval where the y value represents the probability of a specific outcome at specific values of an independent variable (x value). [24] In the scenario of the project, we will measure the distribution of how likely a person is to have depression when they are inactive at a particular time in the wake time, in which people will need to be inactive for a longer period of time with a shorter probability of depression than in time with a higher probability of depression. The wake time is defined as from 11 pm to 8 am or 9 am (which we will take 830 am here)[25]. This means that the interval of the distribution will start a 8.5 and end at 23, with a center at 15.75.

Due to little data available regarding the distribution, we will assume that the probability distribution uses a standard distribution. This is because similar to a standard distribution where the highest probability was in the middle of the interval while the lower probability was located at the edge of the interval, people who sleep during the noon or afternoon tend to have higher chances of excessive sleeping (which is signs of depression) than others who sleep in the morning and during sunset as those people could be justified as late riser or early sleeper.

The standard distribution will be set as $\mu = center = 15.75$ while the distance from the starting interval and the mean should spread across 3 standard deviations. This is because 3σ covers 99.7% of all data based on the Empirical rule [21], which almost covers all possible data. Hence, $\sigma = \frac{15.75 - 8.5}{3} = 2.42$.

Using μ and σ, normal distribution formula defines that the probability of an event at $x = c$ in a standard distribution graph is:

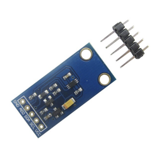
$$P(c) = \frac{1}{\sigma\sqrt{2\pi}} e^{\frac{-(x-\mu)^2}{2\sigma^2}} \qquad [26]$$

which gives the probability distribution for people with depression at a particular instance of time.

Costs

Manufacturing Costs

Material

Parts Name	# of Components	Pictures of Components	Technologies	Manufacturer(including geographical location)	Vendors/distributors(including geographical location)
DS3231 RTC Module	1		Integrated Circuit (IC) with I2C or SPI communication for timekeeping[28].	Adafruit Industries LLC, China	Amazon, Canada
MERQC Pyroelectric Infrared Sensor(PIR)	1		Pyroelectric sensor technology for detecting infrared radiation changes[29].	Adafruit Industries LLC, China	Amazon, Canada
BH1750 Light Sensor	1		Photodiode sensor technology with light to frequency or I2C communication[30].	Adafruit Industries LLC, China	DigiKey Electronics, USA

Vibration Motor	1		Electro-mechanical actuator with rotating offset weight[31].	Seeed Technology Co., Ltd, China	DigiKey Electronics, USA
LED	2		Light Emitting Diode[32]	Kingbright, Taiwan	DigiKey Electronics, USA

Implementation Costs

Installation Manual

1. Breadboard and Nucleo Board Setup:
    a. Place the Nucleo board on a flat, stable surface and ensure it is powered off.
    b. Connect the ground pin (GND) on the Nucleo board to the negative rail of the breadboard.
2. Connecting the RTC Module:
    a. Place the DS3231 RTC module on the breadboard.
    b. Use jumper wires to connect the SCL and SDA pins on the RTC module to the corresponding SCL and SDA pins on the Nucleo board.
    c. Connect the VCC pin on the RTC module to the 3.3V pin on the Nucleo board.
3. Connecting the PIR Sensor:
    a. Place the PIR sensor on the breadboard.
    b. Connect the VCC pin on the PIR sensor to the 5V pin on the Nucleo board.
    c. Connect the OUT pin on the PIR sensor to the A0 pin on the Nucleo board.
4. Connecting the Light Sensor:
    a. Place the BH1750 light sensor on the breadboard.
    b. Connect the SCL and SDA pins on the light sensor to the SCL and SDA pins used for the RTC module.
    c. Connect the VCC pin on the light sensor to the 3.3V pin on the Nucleo board.
5. Connecting the Motor and LED:
    a. Motor:
        i. Connect the motor terminals to the drain and source pins on the MOSFET.
        ii. Connect the MOSFET gate pin to a GPIO pin on the Nucleo board through a 1K Ohm resistor.

        iii. Connect the MOSFET drain pin to the negative rail on the breadboard.
        iv. Add a diode across the motor terminals to protect from back EMF.
    b. LED:
        i. Connect the cathode of the LED to the negative rail through a 220 Ohm resistor.
        ii. Connect the anode pins to separate GPIO pins on the Nucleo board.
6. Finalizing Connections:
    a. Connect all ground pins to the common ground rail on the breadboard.
    b. Double check all connections and voltage levels.

User Guide

1. Ensure the Nucleo board drivers are installed before connecting via USB.
2. Position the device in a frequently occupied room, on a stable flat surface.
3. In monitoring mode, the device tracks light and motion levels. Prolonged darkness or inactivity triggers the red LED and vibration motor.
4. Green LED indicates normal conditions. Red LED and vibration suggests potential depressive behavior - consider increasing light exposure, activity levels, or engaging in hobbies.
5. The device will automatically revert to green when conditions improve. To manually reset, briefly disconnect and reconnect the power.
6. Inspect connections regularly. Disconnect from power when making changes.
7. This device provides environmental feedback only, not medical advice. Consult a health professional with any concerns.

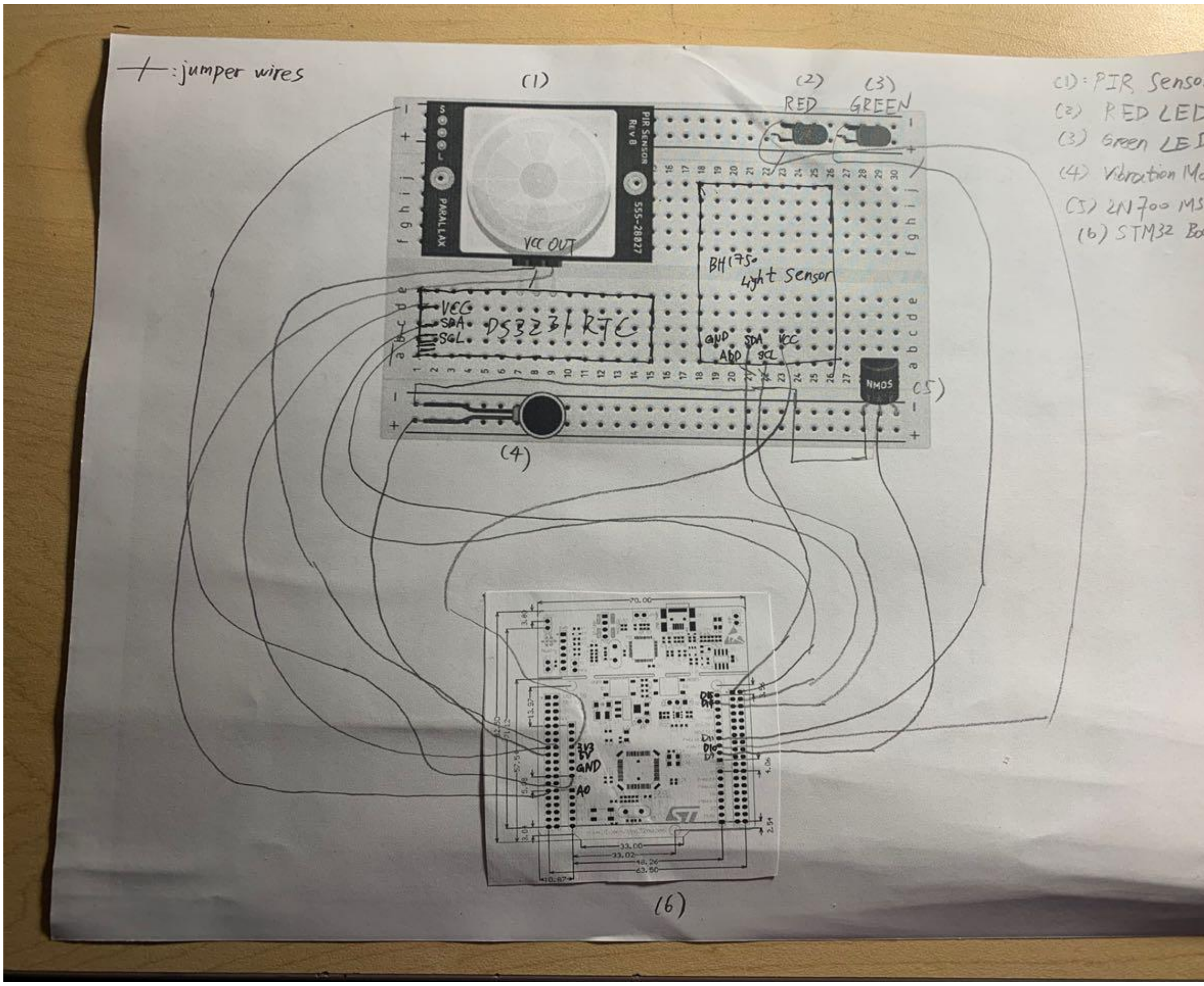


Figure 2: Internal Circuit Structure of the System

Risks

* The chosen power and energy are determined by the ECE198 Project Requirement as displayed in the provided screenshot.

Power and Energy

The design must not consume, transfer, discharge, or otherwise expend more than 30W of power at any point in time and within any component of the design during its operation. This includes all forms of energy, including but not limited to: electric energy, electric potential energy, mechanical kinetic energy, or mechanical potential energy.

The design must not store or otherwise contain more than 500mJ of energy at any point in time. This includes all forms of energy, including but not limited to: electric energy, electric potential energy, mechanical kinetic energy, or mechanical potential energy.

Note that the power and energy restrictions apply only to the system that the project group designs and implements. It is permissible for the system to be designed to interface with other systems with higher power or energy levels. However, project systems are not to be connected to other systems unless a full safety review is conducted by the teaching team; and implementation demos will be run without connection to external systems.

Any design component that connects directly to a building electrical supply outlet (110V AC outlet) must be CSA approved. See UW Safety Office for further reference.

Energy Analysis

1. Reference Standard Indication:
   The reference standard that provides the baseline power level for our design is the CSA approval for devices connecting directly to a 110V AC outlet.

2. Analysis of Significant Energy Storage Potential in the Design:
   a. PIR Motion Sensor: This component operates in the milliwatt range, with no significant energy storage.

      Features:
      - Long range
      - Wide angle
      - Low consumption
      - DC 3.0-5.5V power supplier

      Specifications
      - Input Voltage: DC3.0-5.5V
      - Current: 100uA(max)
      - Output signal: 0,VCC (Output high when motion detected)
      - Sentry Angle: 120°
      - Connector:3Pin 2.54mm pitch
      - Size： L36*W26*H21(mm)

   b. Ambient Light Sensor: Like the PIR sensor, the light sensor consumes minimal power and does not store energy.

Technical Details

LTR-329ALS-01 Specifications:

- I2C interface with up to Fast Mode @ 400kbit/s with address 0x29 (cannot be changed)
- Ultra-small ChipLED package
- Built-in temperature compensation circuit
- Low active power consumption with standby mode
- Operating temperature range from -30 C to +70 C
- RoHS and Halogen free compliant
- Light Sensor close to human eye spectral response
- Immunity to IR / UV Light Source
- Automatically rejects 50 / 60 Hz lighting flicker
- 6 dynamic ranges from 0.01 lux to 64k lux
- 16-bit effective resolution

Product Dimensions: 25.4mm x 17.7mm x 4.6mm / 1.0" x 0.7" x 0.2"
Product Weight: 1.8g / 0.1oz

c. RTC Module: It utilizes a coin cell battery, but the stored energy is well below the limits specified.

• Technical Details

Dimensions (without battery):

- Length: 30.4mm/1.2in diameter
- Height: 14.1mm/0.55in
- Weight: 4 g
- This board/chip uses I2C 7-bit address 0x68

Classification:	"Lithium Coin"
Chemical System:	Lithium / Manganese Dioxide (Li/MnO_2)
Designation:	ANSI / NEDA-5004LC, IEC-CR2032
Nominal Voltage:	3.0 Volts
Typical Capacity:	240 mAh (to 2.0 volts) (Rated at 15K ohms at 21°C)
Typical Weight:	3.0 grams (0.10 oz.)
Typical Volume:	1.0 cubic centimeters (0.06 cubic inch)
Max Rev Charge:	1 microampere
Energy Density:	198 milliwatt hr/g, 653 milliwatt hr/cc
Typical Li Content:	0.109 grams (0.0038 oz.)
UL Listed:	MH12454

d. LEDs: LEDs are low-power components that do not store energy.

Part Number	Emitting Color (Material)	Lens Type	Iv (mcd) @ 20mA [2]		Viewing Angle [1]
			Min.	Typ.	2θ1/2
WP7113SURDK	Hyper Red (AlGaInP)	Red Diffused	1300	2300	30°
			*400	*750	

e. Vibration Motor: While it might contain mechanical kinetic energy when in operation, its typical consumption is in the milliwatt range, and its energy storage is negligible.

Summary Of Specifications	
Technology Type:	BRUSH
Diameter (mm):	8.0
Thickness (mm):	2.1
Rated Voltage (Vdc):	3.0
Operating Voltage (Vdc):	2.7~3.3
Rated Current MAX (mA):	85
Typical Current (mA):	61
Rise Time (ms) MAX *:	90
Fall Time (ms) MAX *:	50
Rated Speed (rpm, MIN):	10000
Vibration Force (Grms):	0.30

* at 50% of Maximum G force

Packaging Spec	
Part Packaging:	Plastic Tray
Qty per reel / tray:	100
Quantity - Master box:	4000
Size - Master Box:	45*28*19CM
Weight - Master Box:	5.9KG
ECCN:	EAR99
USA HTS TARIFF:	8501.10.4060
25% Exclusion Code:	9903.88.67
25% Ex. Code Valid:	thru Dec 30 2023

3. Quantification of Maximum Total Energy Stored:
    a. Electrical Energy: The energy within the circuits during operation is primarily the energy needed for the sensors, LEDs, and motor. These, when combined, fall far below the 500mJ threshold.
    b. Chemical Energy: The RTC module's battery might contain chemical energy, but coin cell batteries typically store less than 500mJ.
    c. Mechanical Energy: The only component with potential mechanical energy storage is the vibration motor. However, given its small size and short operational time, it's safe to assume it does not exceed the limit.

Risk Analysis

1. Negative Consequences of Using the Design as Intended:
    a. Safety: Users might undergo undue psychological distress. There's also a risk of a user seeking unnecessary medical interventions based on device readings, which could lead to unwarranted medical expenses and potential side effects from treatments.
    b. Environment: The device, being electronic, will eventually become electronic waste. If users discard the device prematurely because of misinterpreted results, this could contribute to increasing e-waste.

2. Negative Consequences from Using the Design Incorrectly:
    a. Safety: Users might be alarmed unnecessarily due to inaccurate readings, leading to anxiety or stress.
    b. Environment: Incorrect positioning may lead to frequent false alarms, which might reduce trust in the device, prompting users to discard it, thereby contributing to electronic waste.

3. Negative Consequences from Misusing the Design or Unintended Use:
    a. Safety: Misdiagnosis can lead to inappropriate treatments or a lack of essential treatments, jeopardizing the user's health.

    b. Environment: Tampered or misused devices might be rendered unusable, leading to premature disposal and increasing electronic waste.

4. Possible Malfunctions of the Design:
    a. Sensor Failures: Prolonged use, exposure to extreme temperature or humidity, or manufacturing defects might affect sensor performance.
    b. LED Failures: LEDs might malfunction due to internal component issues, preventing them from illuminating during crucial alerts.
    c. Battery Failures for the RTC: Over time, the battery might deplete, causing the RTC to give wrong timestamps or cease to function.
    d. Motor Malfunctions: Wear and tear, internal defects, or external damage might affect the vibration motor's performance.

5. Consequences for Specified Failure Mechanisms:

a. Sensor Failures:
    - Safety:
        - Misreading: A malfunctioning sensor can lead to inaccurate readings. This might indicate that a person is showing signs of depression when they are not, or vice versa, leading to either unnecessary concern or a lack of crucial intervention.
        - Missed Detection: In some cases, sensor failure might mean no data is recorded at all, potentially missing out on genuine signs of depression, leading to worsened mental health due to lack of timely intervention
    - Environment:
        - Waste: If a sensor fails and is not replaceable, users might dispose of the entire device, contributing to electronic waste. This is especially problematic if the device's other components are still functional.

b. LED Failures:

- Safety:
    - Lack of Alert: LEDs serve as the primary visual indicator. If they fail, users might not receive crucial alerts about their behavior, potentially missing out on timely interventions.
    - Misinformation: In cases where the LED provides false signals (e.g., green when it should be red), users might be given a false sense of well-being.
- Environment:
    - Waste: Non-functioning LEDs can render the device less useful, leading users to dispose of it prematurely, again contributing to electronic waste.
    -

c. Motor Malfunctions:

- Safety:

- Lack of Physical Alert: The vibration motor is a secondary alert mechanism. If it fails, especially if paired with an LED malfunction, users might miss out on alerts entirely.
    - False Security: A non-vibrating device might be misconstrued as a sign of no alerts, especially if the user is visually impaired or not in a position to view the LED indicators.
- Environment:
    - Waste: A malfunctioning motor, if deemed integral to the user experience, might prompt the user to dispose of the device, contributing further to electronic waste.

Testing and Validation

Test Plan (teddy bear)

Test 1	Test setup: The test will be conducted from 1pm - 3pm. The motion sensor faces towards a teddy bear on a table. The teddy bear shall be placed on a chair that is in front of the table. Environmental Parameter: The brightness of the room must reach or exceed the equivalency of a 18V LED light inside a standard traditional double room. Test Inputs: The video track of the teddy bear on a table will be the input collected from the PIR sensor. Pass Criteria: All conditions must be satisfied in order to pass Test 1: (1) The red LED light flashes, and the motor vibrates within 2-8 hours. (2) The green light shall not flash throughout the duration of test.
Test 2	Test setup: The test is conducted from 1pm - 3pm in a room with sufficient light. The motion sensor should be on a table facing towards the teddy bear. The teddy bear will be placed on the chair in front of the table at the start of the experiment. For every 30 minutes, a person will take away the bear from the chair, move the bear for 1 minute, and put the bear back in the chair again. Environmental Parameter: The brightness of the room must reach or exceed the equivalency of a 18V LED light inside a standard double room. Test Inputs: The image/video-track of the teddy bear moved by a human every 30 minutes and the bear on the chair will be the input.. Pass Criteria (All conditions must be satisfied): (1) A green light should be on as this action is a normal operation that does not imply possible depression. (2) The red light should not be on.

Test 3	Test setup: The test starts at 2 a.m. and ends at 14 p.m. The sensors will be placed on the table facing the teddy bear while the teddy bear will remain on a bed Environmental Parameter: There should be no external forces (like winds) that moves the teddy bear from their original position. During the morning, the brightness of the room should be 300 lumens per square feet, which is equivalent to the brightness of a classroom [27] Test Inputs: Video track of the teddy bear on the bed collected by PIR sensor. Pass Criteria: (1) A red light should be on as it represents an excessive sleep. (2) The green light should not be on.
Test 4	Test setup: The test will be conducted between 2 a.m. to 6 a.m. The motion sensor is on the table facing a teddy bear. The teddy bear will sit on a chair and a human will takes it away and put it back on the chair again every 30 minutes. Environmental Parameter: The brightness of room should be less than or equal to 0.0001 lux (lumens per square meter), which is equivalent to the brightness of an overcast night. [27] No sunlights or external light should appear inside the room throughout the duration. Test Inputs: The video of the bear sitting on the chair and moving by human every 30 minutes, recorded by the PIR sensor. Pass Criteria: (1) The red LED light shall buzz as it represents a sleep disorder. (2) The green light should not buzz.
Test 5	Test setup: The test will be conducted between 2 a.m. to 6 a.m. The motion sensor is next to and faces towards a teddy bear on the bed Environmental Parameter: The room's brightness is less than or equal to 0.0001 lux (humans per square meter) [27]. Test Inputs: Video track of teddy bear on bed, collected from the PIR sensor Pass Criteria: (1) a green LED light should be activated as the sleeping behavior at 2 a.m. to 6 a.m. is normal. (2) The red light should not buzz.

Note: A teddy bear is chosen as human tests are prohibited.

References

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