Health-Care Neckband
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1. Introduction

1.1 Objective

Cervical spondylosis, also known as neck arthritis, is a common, age-related condition that affects the joints and discs in your neck\(^1\). Even though cervical spondylosis is more likely to be present in the elderly, more and more young people are now being diagnosed with cervical spondylosis because of sedentary lifestyle, incorrect posture and overuse of neck muscles. One of the noticeable points is that for most people, cervical spondylosis causes no significant symptoms in the early stages, so you could already be in danger of the condition but still not aware of it. When people realize that they have regular neck pain or stiffness, the condition is usually getting severe and requires physical treatment.

Our goal is to create a wearable neckband that tracks users’ daily neck movements. It could remind users via vibration or sound to relax and do neck exercises after sitting down for hours. The neckband also keeps track of users’ postures, and reminds them once they are in unhealthy postures. All the data will be collected and stored in the mobile app, users can check easily how they are doing everyday, and receive advice from the app based on the data collected. The neckband will be light, user-friendly, and comfortable to wear.

1.2 Background

When we conducted research on the influence of cervical spondylosis to young people, we are surprised to find so limited useful information online but only people saying how they had been diagnosed with cervical spondylosis at young ages, and concerning how that might influence their normal lives. That’s when we felt the need and urgency to build a health-care neckband for people to prevent or improve their neck health issues by changing their bad habits and starting new and healthier lives.

We are planning to put a dynamic gyroscope sensor system at the back of the neckband, so when users put the neckband on, the gyroscope will be comfortably attached to the back of their necks. The gyroscope measures the angle differences of each of the three axis to our pre-calculated value, and transfers data both to the microcontroller and the mobile app. The microcontroller computes the data, and contacts the feedback unit, while the mobile app keeps track of the collected data, and make them nicely organized to users.

The core value for our product is users’ health condition. As we noticed that neck health problems have long been overlooked by young people due to the lack of symptoms. Also, there’s only few products in such area in the market, and nothing is like our neckband. We feel the responsibility and need to strengthen people’s awareness toward their neck health conditions, and to build a product that are truly conducive to their health.
1.3 High-level Requirements

- working prototype that can successfully measure users’ posture and record neck movement
- The neckband should provide feedback to user via vibration once the user is in bad posture for a period of time
- The cost of building such a neckband should be affordable, ideally around $50.

2. Design

2.1 Block Diagram

![Figure 1. Block Diagram](image-url)
2.2 Block Description
Our design mainly includes three parts: Sensor, Control Unit and Power Unit. We’ll discuss purpose of each block in the following section.

2.2.1 Sensor
Gyroscope
• Measures the posture (rotation angles in 3 axis) of the neck;
• Sends data via Bluetooth to the Mobile Device/App;
• Sends data to the Microcontroller.

Mobile Device
• Receive data from the Gyroscope via Bluetooth;
• Analyze the data and display results (e.g. current posture, personal posture habit) on the app.

2.2.2 Control Unit
Microcontroller
• Receive data from the Gyroscope;
• Based on the pre-set standard, judge if the current neck posture is acceptable;
• Based on the acceptance and lasting time of the current neck posture, send signal to the Feedback Unit.

Feedback Unit
• Consist of LEDs and sound/vibration alarms;
• One LED shows if the battery is low, the other shows if the user is in correct posture;
• The alarm will sound/vibrate if the user is in an incorrect posture for a long time.
• Receives signal from the Microcontroller, and use the signal to control the LEDs and alarms.

2.2.3 Power Unit
The Power Unit provides power to other hardware components.

Battery
• We will be using 3.7V 100mAH rechargeable lithium battery.
• Protect circuit is needed to ensure safety of the circuit.

2.3 Requirement and Verification

<table>
<thead>
<tr>
<th>Module</th>
<th>Requirement</th>
<th>Verification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gyroscope</td>
<td>Accurately measures the posture (rotation angles in 3 axis) of the neck.</td>
<td>Test the gyroscope in different angles, record the output data and real data.</td>
</tr>
<tr>
<td>Component</td>
<td>Specification</td>
<td>Task</td>
</tr>
<tr>
<td>--------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>Microcontroller</td>
<td>The Microcontroller needs to correctly send signal to the feedback unit according to the input data.</td>
<td>Given testing input data, record the real output and expected output.</td>
</tr>
<tr>
<td>Feedback Unit</td>
<td>Correctly works given input signal.</td>
<td>Given testing input signal, record the real output and expected output.</td>
</tr>
<tr>
<td>Battery</td>
<td>Provide 3.7+/−0.2 V voltage</td>
<td>Use voltage meter to test the voltage provided by the battery,</td>
</tr>
</tbody>
</table>

**2.4 Risk Analysis**

The most important and the hardest part to implement is the data transmission from the gyroscope to the microcontroller. The gyroscope will send a large amount of data ever second and we need to have the microcontroller received the data completely and accurately. Also, we need to try different positions to place the gyroscope so that the data it measures could reflect the most accurate posture of the neck. Depending on the tests, we may need more gyroscopes.

**3. Ethics and Safety**

One of the greatest safety concern for our project is the battery. Just as every other wearable technology application, the safety of the users is always the priority. And because our device will possibly have direct contact to human skin, one minor mistake in the design could lead to severe harms to users’ health. Thus, we are dedicated to build a device that ensures the least possibility of electrical shock, burns and fire. To achieve the safety goal and obey the IEEE Code of Ethics #1, the power supply we use must adhere to the US safety standard UL60950-1.

Another concern is the accuracy of the data and computed result. Because our product aims to monitor users’ neck movement and sitting posture, inaccurate data will not only be ineffective for improving users’ health condition but also misleading and potentially harmful. In order to address this issue, we will test and calibrate our product carefully and strive to minimize error within 5 degrees. If we are unable to achieve the expected accuracy, we will re-design our sensor system by adding more sensors or place them in different positions.

We understand that privacy is a crucial part to users, and to ensure we are following ACM code of Ethics and Professional Conduct 1.7, we’ll take appropriate means to protect the data collected from illegal access or accidental disclosure to inappropriate individuals. All the data collected from users will not be used for other purpose without users’ consent.
Moreover, in order to follow IEEE Code of Ethics #5, we need to inform users of what groups of people our product is suited to and the potential consequence of using our product. We’ll provide proper documentations and warning labels to users to help them better understand and use our product.


References

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https://www.acm.org/about-acm/acm-code-of-ethics-and-professional-conduct