Northwestern University

McCormick School of Engineering
Department of Electrical and Computer Engineering

COMP_ENG_495: Wearable Electronics
Spring 2023

Step Up
Proposal Report

Team members: Adheik Dominic, Ben Ferreira, Diogo Costa, Shivi Shrivastava

Introduction

Our device aims to aim Irish Dancers in performing the traditional dance. Dancers face challenges in maintaining the proper arm position while performing. This gave us the opportunity to have a novel idea of using pressure sensors to help them keep track of their movement. This innovative approach offers a more objective approach than the traditional methods to help the dancers.
This document is proposing the need for our product called STEP UP. It explains the need for our device and how we plan to engineer it.

Significance

What is Irish Dance?

Irish Dance is the traditional dance form of Ireland. It is widely popular around the world and is performed on renowned stages by many people. There are many different forms of this dance, however, the post popular and practiced form is called the STEP DANCE. It is characterized by quick and precise footwork while keeping the upper body stiff and hands pressed to the sides. The technique is to not bend the elbows and keep the arms “attached” to the body. Irish Step Dance has a long history in Ireland and has been influenced by various cultures. It is enjoyed and embraced by people all over the world.

Why do we need this product?

As mentioned before, this dance requires us to have a stiff posture where we cannot move our upper body and need to keep our hands pressed against the sides of our body. To maintain this position, Irish dancers practice using sponges. They hold the sponge in their hands and keep them pressed against their sides in order to maintain their hand posture. However, using sponges can prove to be very inconvenient because the sponges can either slip through our hands or we may forget to keep the sponges on the sides and simply dance freestyle while holding them! To avoid these problems we wanted to bring a product that may be able to solve this problem. We

present a device that can alert the dancers when they don't keep their arms stiff and aids them in maintaining the correct dance form.

Innovation

The originality of this idea lies in its innovative application of pressure sensing technology to address a specific problem in Irish dance technique correction. We aim to do this by integrating a piezoresistor-based Wheatstone bridge and a microcontroller. This system provides objective feedback and corrective measures in real-time during dance performances. Unlike traditional methods that rely on subjective observations or visual feedback, this approach offers an easy way to monitor the position of dancers' arms. By detecting whether the arms are kept close to the body or not, the system can provide immediate feedback to the dancers enabling them to make necessary adjustments on the spot (in real time). This real-time feedback promotes self-correction and helps dancers develop muscle memory for proper arm placement which will result in improved technique and enhanced performance quality. The originality lies in the application of pressure sensing technology to Irish dance, offering a novel and effective tool for dancers and instructors to enhance training and performance outcomes.

Firstly, the use of a Wheatstone bridge provides a reliable method for measuring resistance changes in the piezoresistor. By comparing the ratio of resistances in the bridge, the microcontroller can accurately detect and quantify pressure variations. Secondly, the integration of a piezoresistor adds versatility to the system. Piezoresistive materials have the unique property of changing their resistance in response to mechanical stress, including pressure. This allows for highly sensitive and responsive pressure sensing. The piezoresistor can be embedded in the wearable device that we plan on using. Moreover, the use of a microcontroller adds programmability to the system. The microcontroller can continuously monitor the voltage across the Wheatstone bridge and process the data in real-time.The integration of data logging capabilities further enhances the system's functionality. By recording and storing data when pressure is absent, valuable information can be collected for analysis, diagnostics, or user

behavior studies. This can provide insights into the dancer's performance and help them keep track of their progress.The inclusion of a haptic motor in the setup adds an additional layer of user interaction and feedback. When pressure is not sensed, the microcontroller can trigger the haptic motor, providing tactile feedback to the user and likewise. This enhances the user experience by serving as an alert mechanism.

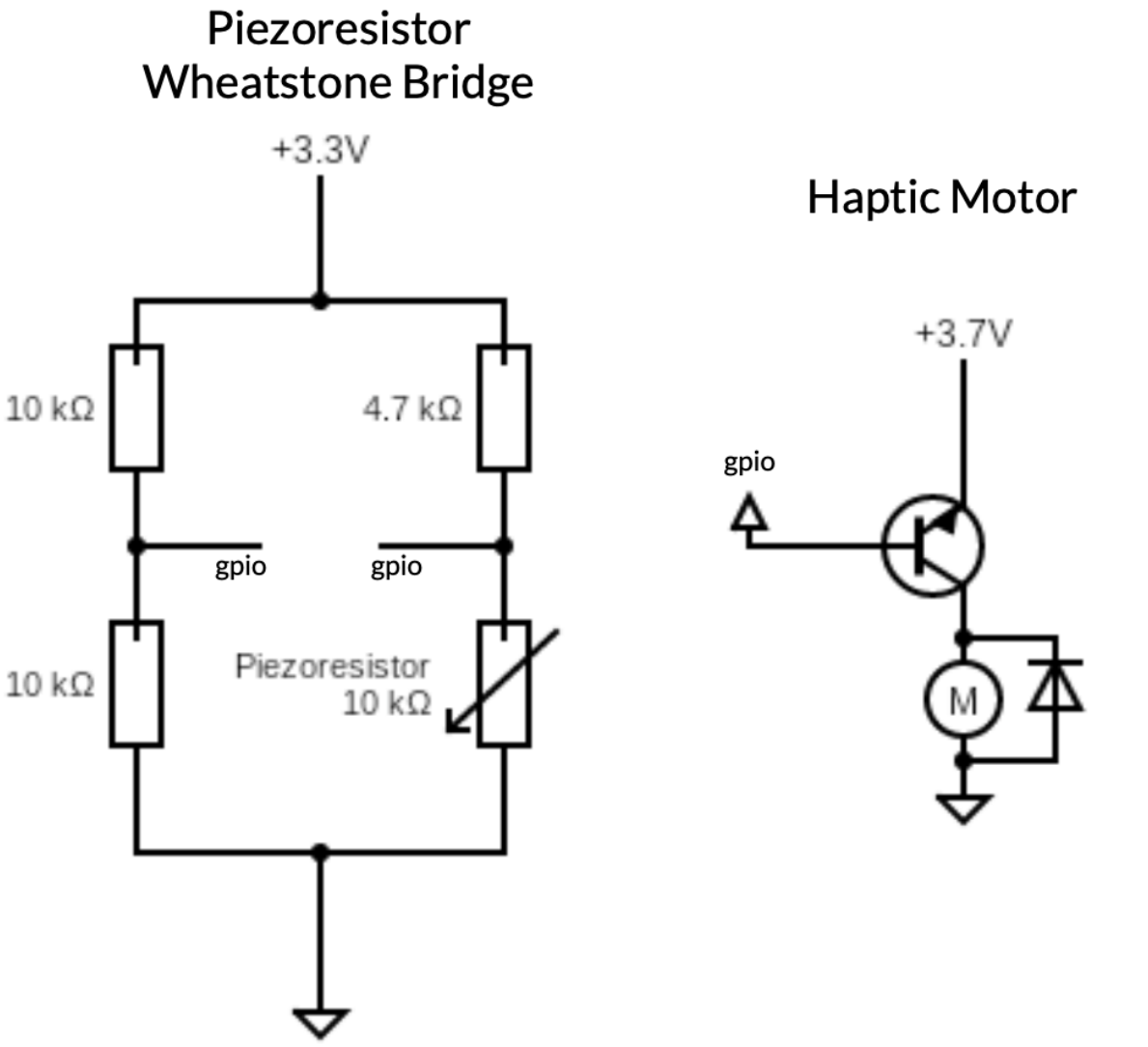
In summary, the combination of a Wheatstone bridge, a piezoresistor, and a microcontroller in a pressure sensing system with data logging and haptic motor capabilities presents an innovative solution. This setup enables precise pressure detection, intelligent processing, data analysis, and enhanced user interaction. This innovative integration of technologies opens up new possibilities for pressure sensing and user interaction.

We are planning to incorporate all of the above components into rings which preserve the originality of the Irish dance and goes hand in hand with the Irish dance attire.The Step - up rings can be designed in various styles and materials to suit different preferences and aesthetics. They can be easily adjusted to fit different finger sizes, ensuring a comfortable and secure fit for each dancer.The utilization of rings as the wearable device introduces several advantages. Firstly, rings are compact and lightweight, making them comfortable for dancers to wear during performances or practice sessions without hindering their movements. The integration of the pressure sensing system into the rings allows for seamless and continuous monitoring of the dancers' arm position. The piezoresistor, as part of the Wheatstone bridge configuration, can be incorporated into the ring's structure, ensuring that it comes into direct contact with the skin or the dancer's arm. This proximity facilitates accurate pressure sensing and minimizes any potential signal loss or interference.The microcontroller, which controls the Wheatstone bridge and processes the pressure data, can also be placed within the ring. This microcontroller can provide real-time analysis of the pressure readings, enabling immediate feedback to the dancers. Its compact size allows for integration without compromising the aesthetics or comfort of the wearable device.

The use of step - up rings as a wearable device for the pressure sensing system not only preserves the originality of the idea but also brings practicality, comfort, and customization to the table. By

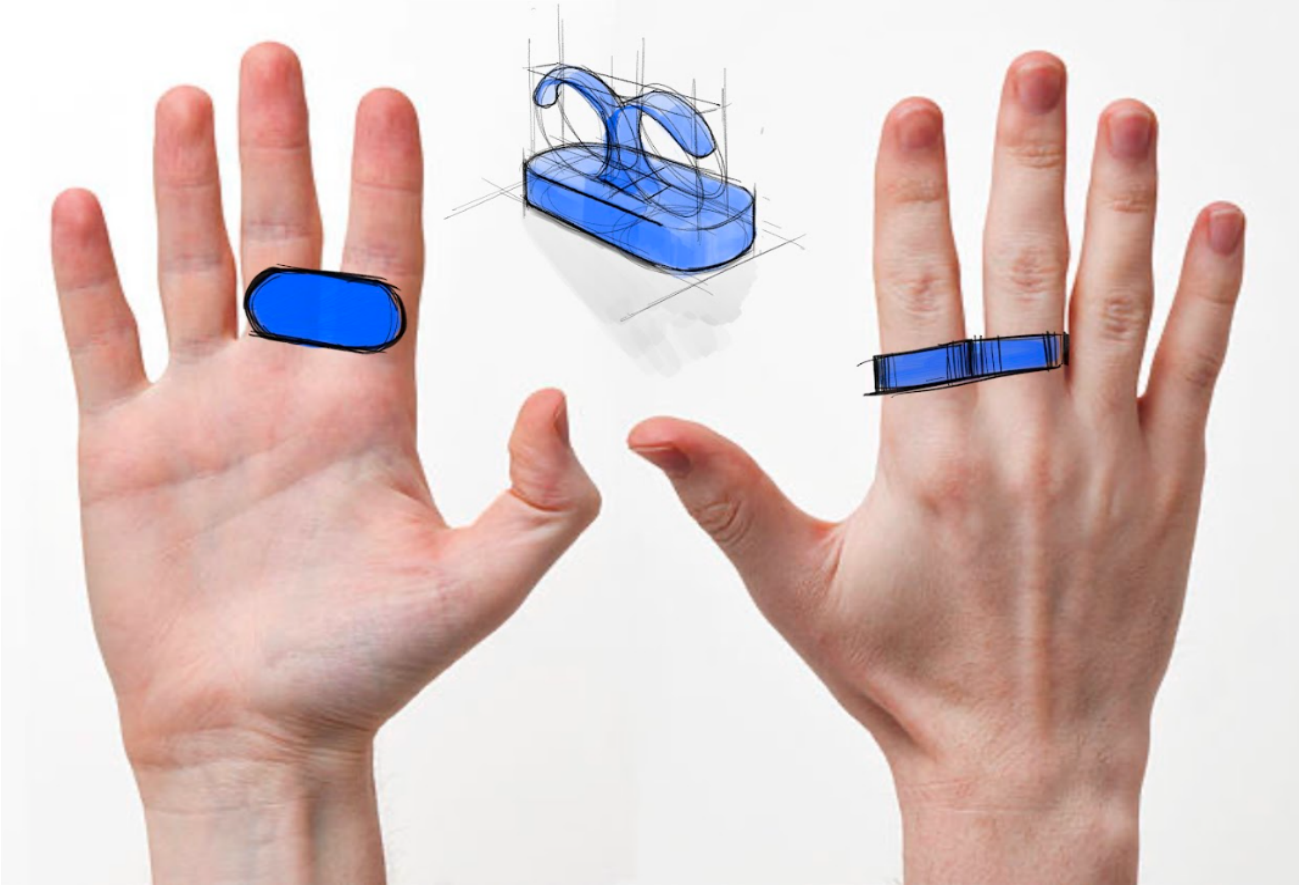
embedding the technology into rings, dancers can seamlessly incorporate the system into their training routines and performances without sacrificing their freedom of movement or style. This wearable approach ensures that the pressure sensing system remains unobtrusive, while providing the necessary feedback and corrective measures in real-time, contributing to improved Irish dance technique and performance quality.

Approach



Our engineering approach is guided by 2 main facts: simplicity, and functionality. The goal is to allow for the maximum functionality without sacrificing an inconspicuous form factor. To achieve this, we are employing a wheatstone bridge along with a piezoresistor to allow for pressure to be sensed and quantified by a microcontroller. The microcontroller will then activate a haptic motor to generate feedback for the user. This allows for adjustable pressure levels to be set to trigger the haptic motor. This will all be powered by a 3.7 volt button battery.

In the future, we may move to a microcontroller less design, utilizing a comparator, and potentiometer to maintain adjustability while still providing core functionality while reducing power consumption.



In terms of physical design we are focused on making a device that is easy to hold onto, discrete and that helps with providing immediate feedback without hindering the movements of the dancers. Our initial design incorporates the sensor onto an open ring like model that helps it keep in place while being suitable for most different hand sizes. More so, it allows to ‘hide’ the sensor

on the palm of the hand, making it discrete in case it is used during a performance. Further consideration will be given to the physical design once we are able to get some direct user feedback.

Conclusion

In conclusion, the proposed device called STEP UP offers an innovative solution to the challenges faced by Irish dancers in maintaining proper arm position during traditional dance performances. The use of pressure sensing technology in the form of a Wheatstone bridge and piezoresistor, combined with a microcontroller, data logging capabilities, and a haptic motor provides real-time, objective feedback to dancers, enabling them to make necessary adjustments and develop muscle memory for proper arm placement. The integration of these technologies into rings offers a compact, lightweight, and comfortable wearable device that does not hinder the dancers' movements. The STEP UP rings can be designed in various styles and materials to suit different preferences and aesthetics, and the device offers a novel and effective tool for dancers and instructors to enhance training and performance outcomes.