# DigIt: a wearable digital tap dance interface for musical and interactive performance

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***Abstract*—*This paper presents the concept and early development of a wearable digital tap dance interface designed to transform dance movement into expressive musical control data. Inspired by decades of experimentation in electronic tap performance, the proposed system uses modern inertial sensing, embedded processing, and Bluetooth Low Energy (BLE) communication to detect and classify complex tap dance movements in real time. Unlike many prior hobbyist approaches based primarily on force-sensitive resistors (FSRs), the proposed design focuses on motion-based sensing using a high-g accelerometer and inertial measurement unit (IMU), enabling recognition of a broader range of professional tap techniques beyond simple toe and heel strikes. The resulting motion data can be translated into Musical Instrument Digital Interface (MIDI) signals, allowing dancers to trigger and control arbitrary sounds, instruments, lighting systems, and other digital media. The project aims not only to create a functional prototype for performance and creative exploration, but also to investigate how wearable technology can deepen interdisciplinary collaboration between engineering, music, dance, and interactive art.***

## I. Introduction

Tap dance exists at the intersection of movement and music. Professional tap dancers think not only in terms of choreography, but also rhythm, dynamics, phrasing, and tone. Every strike against the floor produces both motion and sound, allowing the dancer to function simultaneously as performer and percussionist.

Electronic augmentation of tap dance has existed for decades in both popular culture and live performance. In the 1989 film Tap, the character played by Gregory Hines transforms traditional tap sounds into other instruments during a performance [1]. Since then, dancers and technologists have repeatedly explored ways to merge tap dance with digital sound generation and interactive media.

The motivation for this project comes from the intersection of the author's dual backgrounds in professional dance training and electrical engineering. Training with artists such as Dianne Walker and Derrick Grant, combined with academic work in embedded systems and hardware design, informs the system's dual artistic and technical perspective.

Modern inertial sensors, embedded processors, and low-power wireless communication now enable wearable systems capable of fine-grained movement analysis. This work explores how such technology can expand dance beyond acoustic constraints into a broader digital performance medium, enabling control of music, lighting, spatial audio, and interactive media in real time.

## II. Related Work

Electronic and augmented tap dance systems have been explored through both professional performance works and independent hobbyist experimentation.

Nicholas Young's tap-board based systems, popularized in collaboration with Michelle Dorrance, demonstrate real-time audio triggering from tap performance [2]. These works show the artistic potential of digital augmentation.

Hobbyist systems often rely on force-sensitive resistors placed under toe and heel regions [3]. While effective for basic contact detection, these approaches are limited in representing the full vocabulary of tap dance, which includes impacts and gestures using multiple edges and regions of the foot at varying orientations and velocities.

Recent developments in wearable sensing systems using inertial measurement units (IMUs) and accelerometers in fitness applications suggest an alternative approach based on motion rather than pressure. This project extends that direction by treating tap dance as a motion classification problem, combining impact detection with inertial tracking for richer gesture recognition.

## III. Technology

### *A. Prototype architecture and technical development*

The initial proof-of-concept was developed using an Arduino Nano 33 IoT [7] paired with an Adafruit BNO085 IMU module [8]. C++ firmware streams quaternion orientation data and raw acceleration data. Basic moving-average filtering and acceleration thresholding is used to detect impacts. Detected events are transmitted wirelessly over Bluetooth Low Energy (BLE) to external Python software capable of triggering digital audio playback. Similar software was created in Rust as part of a planned transition toward a more robust software stack.

This proof-of-concept validated real-time wireless performance but revealed key limitations: limited I2C bandwidth, insufficient accelerometer range for high-impact taps, and weak gesture discrimination during transitional motion. These constraints motivated a redesigned hardware platform focused on improved sensing fidelity and embedded performance.

The current hardware design is centered around the u-blox NINA-B302 wireless module [6], which integrates the Nordic nRF52840 microcontroller and Bluetooth Low Energy radio. This module was selected in part for its robust RF performance and production-ready wireless design, both of which are critical for reliable operation in performance environments containing significant electrical noise and wireless interference.

The sensing stack combines an ADXL372 high-g accelerometer [4] for impact detection with an ICM-20948 IMU [5] for full motion tracking. This dual-sensor architecture separates high-energy strike detection from general movement analysis, enabling more robust gesture classification.

The custom PCB also integrates lithium-polymer power management, USB-C charging, battery protection, a fuel-gauge, and an e-fuse for safety and reliability in performance environments.

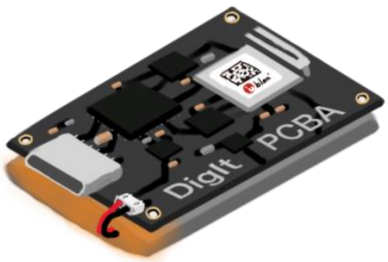


Fig. 1. Conceptual illustration of PCB and battery assembly.

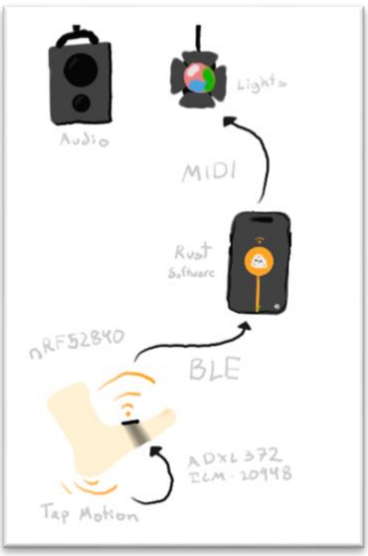


Fig. 2. High-level system architecture showing sensing, wireless communication, and MIDI translation pipeline.

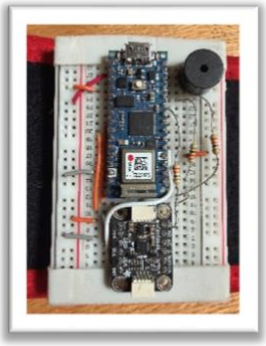

Fig. 3. Early breadboard prototype used for initial impact detection and BLE communication experiments.

### B. *Wearable design and artistic applications*

A central design goal of this project is reducing the size and rigidity of existing electronic tap systems, which often rely on external tap boards or heavily modified footwear.

The system is designed to fit inside footwear — or operate on barefoot performers — allowing dancers to choose footwear based on artistic intent.

Because the system outputs generalized digital control data rather than fixed sounds, dancers could potentially trigger arbitrary instruments or sounds, control lighting and projections, spatially modulate music, or interact with multimedia installations.

The system may also allow tap dancers to practice more quietly using headphone-based audio feedback, potentially making tap dance more accessible in apartments, dormitories, or shared living environments.

More broadly, the system enables experimentation across dance styles by removing dependence on traditional hard-soled shoes or fixed tap surfaces. This supports hybrid choreography and interdisciplinary performance, aligning with trends in cross-disciplinary training and dance fusion. It also opens rhythmic and sonic expression to other movement forms—such as ballet and contemporary dance—allowing them to function as active musical agents within performance.

The author hopes to release software tools or APIs that allow other artists and developers to experiment with custom mappings and creative extensions.

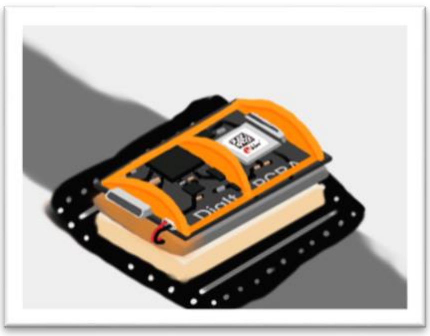

Fig. 4. Conceptual layout of the wearable, showing possible placement of the enclosure skeleton, PCBA, battery, foam, leather exterior, and elastic strap.


Fig. 5. Conceptual illustration of the enclosed wearable.

### C. *Current status and future work*

At the time of writing, the project is transitioning from a proof-of-concept to custom hardware. Initial schematic development for the PCB power system has been completed, and sensor integration is under active development.

Future work will likely explore gesture classification, latency optimization, miniaturization, mobile integration, multi-device synchronization, stage system control, and potentially embedded machine learning for movement recognition.

Applications may also exist in sports analytics, rehabilitation, accessibility technology, and movement research. However, the primary motivation of this work remains artistic expression and interdisciplinary creative collaboration.

## IV. Responsible Innovation

This project is motivated by a belief that technology should expand human creativity and connection rather than replace it. The goal of the proposed device is to provide artists with new tools for experimentation and interdisciplinary collaboration, ultimately fostering human connection.

Sustainability, serviceability, and repairability are key priorities. The hardware is designed for long operational life in high-impact environments, including vibration, sweat, and electrical interference. Efficient power design and robust components aim to reduce energy consumption and electronic waste.

## V. Author Bio(s) / Experiences

The author recently completed both bachelor's and master's degrees in electrical and computer engineering at Northeastern University, with academic and professional experience in embedded systems, electronics, programming, and hardware development. During this time, he completed multiple engineering co-op placements in industry and developed experience leading technical and creative projects.

Alongside engineering, dance has been a defining part of the author's life. He trained competitively and eventually joined a pre-professional dance company, studying tap dance with respected artists in the tap dance community, such as Dianne Walker and Derrick Grant. This long-term involvement in both artistic and technical disciplines strongly shaped the direction of the proposed work.

The author has also managed a student painting business recognized nationally for quality and growth, and led the design and development of an artificial intelligence travel-planning startup.

His broader vision motivating this work is the establishment of a community where artists, scientists, engineers, and designers can live and work together while developing meaningful interdisciplinary projects that blend creativity, technology, and human-centered design. This project represents an early step toward that larger goal by exploring how technical systems can support artistic expression and human connection. More importantly, it serves as an opportunity to learn the practical processes required to transform experimental ideas into reliable, manufacturable products that can meaningfully reach and impact people. The author views this work not as an isolated device, but as the beginning of a longer interdisciplinary journey. The experience gained through developing this project, particularly in hardware design, product development, manufacturing, and sales is therefore just as important to him as the final device itself.

## VI. Acknowledgements

The author would like to thank the many teachers, choreographers, engineers, classmates, collaborators, friends, and family members whose support and inspiration contributed to this project. Special thanks are also given to the broader tap dance community, whose creativity and experimentation continue to push the boundaries of rhythm and performance.

## VII. References


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