Passive RFID-based Music Player Textile

Asif Shaikh
Faculty of Medicine and Health Technology
Tampere University
Tampere, Finland
asif.shaikh@tuni.fi

Shiva Jabari
Faculty of Information Technology and Communications Sciences
Tampere University
Tampere, Finland
shiva.jabari@tuni.fi

Ruowei Xiao
Faculty of Medicine and Health Technology
Tampere University
Tampere, Finland
ruowei.xiao@tuni.fi

Adnan Mehmood
Faculty of Medicine and Health Technology
Tampere University
Tampere, Finland
adnan.mehmood@tuni.fi

Juho Hamari
Faculty of Information Technology and Communications Sciences
Tampere University
Tampere, Finland
juho.hamari@tuni.fi

Oğuz Buruk
Faculty of Information Technology and Communications Sciences
Tampere University
Tampere, Finland
oguz.buruk@tuni.fi

Johanna Virkki
Faculty of Medicine and Health Technology
Tampere University
Tampere, Finland
johanna.virkki@tuni.fi

Abstract— **Music has always been an important way of expressing ourselves. Creating music from bodily interaction has gained lots of attention: Various gestures, body touch, movements of hand and foot are used as inputs for creating music. The traditional identification and sensing technology, passive ultra-high frequency (UHF) radio frequency identification (RFID) technology, can also be turned into a music player textile for creating music with simple touch or gesture on clothing. When the player touches a specific integrated circuit (IC) copper pad with finger, the unique ID is read by the reader and translated to music via our music software. With this preliminary version of the music player textile, it is possible to play drum and piano. In the future, the technology can be applied to daily clothing for educational musical purposes such as teaching music to kids, as well as professional musical purposes such as performers (showmen and hosts) and lecturers to have playful performances.**

Keywords—Passive UHF RFID, textile-based interaction, wireless music play, music maker

I. INTRODUCTION

Music has always been a way of communicating our emotions and feelings and expressing ourselves. Reviewing the literature, we not only witness several advances in music production techniques and instruments, but we also see a novel form of music interface, i.e., human body. Skin contact, body touch and gestures as a way of music communication are getting attention. "Freqtric Drums" can be mentioned as a good example of communication tools using skin contact as an interface [1]. Sony's Motion Sonic is a wearable band that uses hand gestures to play instruments like guitar, piano, and music effects [2]. Previous studies utilized a camera-based system to create music, in which the user's hand or foot movement was converted into auditory and visual output, and the system was used as a music-making tool for physical rehabilitation [3]. This camera-based system also allows children with severe physical disabilities to play and create music [4]. Some commercial music video games, such as Nintendo's Wii Music, provide a smart controller for playing music; Rocksmith and Guitar Hero are video games where you can play guitar; Rock Band, Sing It, and Sing Party are

some games for karaoke [5],[6]. Arduino, 3D printing, wearables, and fruit touch are some more ways used to create music solutions [7]. Lei Yu, Co-Founder of DrumPants, made a wearable device that can be worn on pants or other desired body location, where the user can tap to play the intended beat and music [8]. Mogees play is another device, which can be attached to any surface and play music based on vibration detection [9]. However, these devices require batteries and complex electronics, which makes them costly and not maintenance-free. Alternative ways of making bodily music are needed; using RFID technology can also be a very effective, approachable and accessible way that would add to this body of literature because these features can also enable the implementation of more high resolution and complex bodily instruments that would lead to wide range of ways for producing music through the interaction between body and clothing. Therefore, this study is an exploration of an alternative way of bodily music method in order to develop a battery-free textile-based music player by using passive UHF RFID technology. We introduce a music player textile, where the player "activates" a specific IC by touch, to create music via our music software.

II. DESIGN AND MANUFACTURING OF MUSIC PLAYER TEXTILE

A textile-based RFID touch pad is made using commercial electro-textile material, nickel-plated Less EMF Shieldit Super Fabric (Cat. #A1220). The used antenna system is based on an earlier work [10] and in this study only the touch pad length is changed. Fig. 1 shows the antenna and touch pad dimensions.
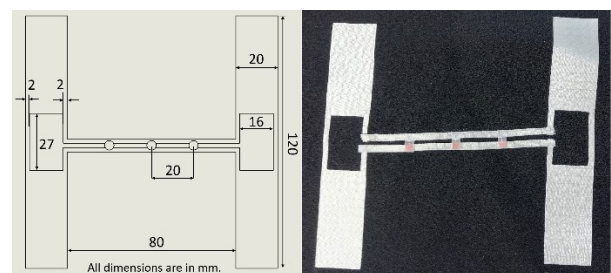

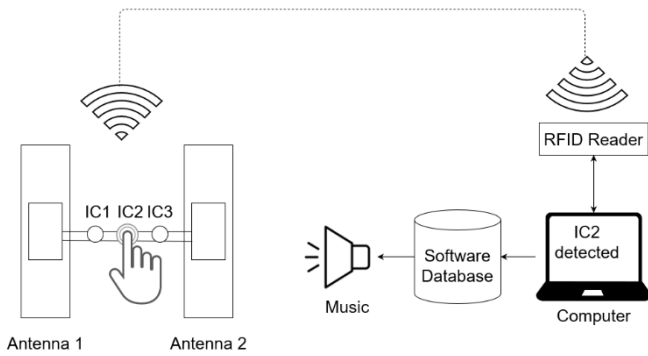Fig. 1. Music player textile design (left) and a ready-made prototype (right).

Fig. 2. Working principle of the music player textile system.

As shown, two dipole antennas are used with three NXP UCODE G2iL series RFID ICs (a wake-up power of −18 dBm, 15.8 µW). Each IC has two copper pads (each 3×3 mm^2) for easy attachment. When the player touches the other IC copper pad with finger, it makes the circuit complete and the IC readable for an RFID reader, as explained with details in [10].

III. Playing Music

Fig. 2 shows the working principle of the music player textile system. When the user touches one IC copper pad, the IC gets "activated", read by the RFID reader, and detected by a developed basic music software, which plays specific beat or sound. The relation between the ID and music note/beat is defined in the software database. In this first setup, we used three different music notes of piano and drumbeats. Selecting which instrument to play is done by placing the desired audio file to the software database in .wav format.

IV. Practical testing of music player textile

Thingmagic Mercury M6 RFID reader is used at the European standard frequency range (865.6-867.6) MHz. A circularly polarized RFID reader antenna connected via a connecting cable to the M6 reader. The M6 reader's operating power is 28 dBm. Testing is done in office environment. During testing, the music player textile is 80 cm away from the reader. The system is successfully tested by two individuals. The only noticed challenge during this preliminary test is that it takes nearly two seconds for the software to respond. Fig. 3 shows the setup in an office environment while Fig. 4 shows a close-up of the IC activation by touch.

V. Conclusions

We introduced a music player textile using passive UHF RFID-based interaction. In our solution, two dipole antennas were used with three passive RFID ICs. The user can touch the IC copper pad to activate the specific ID, and the developed music software will play the related note/beat of music. Because of simple design and cost-effective manufacturing, our music player textile platform can be used on daily clothing or any other textile around us. The next step is to develop antennas with improved touch design including more gestures, which can be applied to daily clothing. A full-fledged music cloth instrument can be developed by which we can play sounds using various touch patterns such as taping, double taping, swiping, and covering/uncovering.
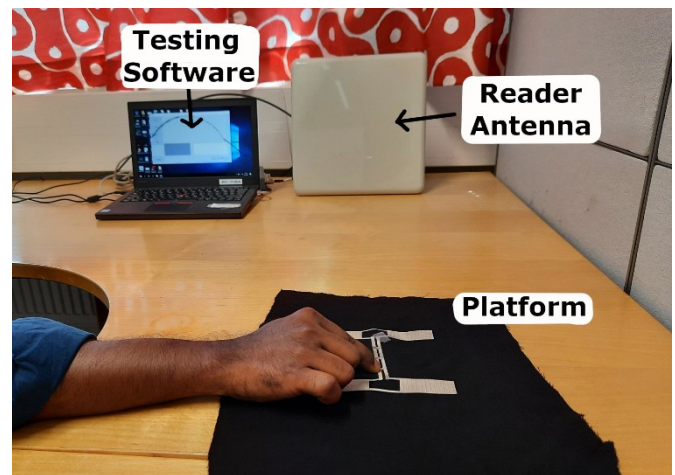

Fig. 3. Testing music player textile system in an office environment.

Fig. 4. All IC copper pads are initially separated from the antennas (left) and a specific IC can be "activated" by touching the copper pad, which will connect the IC to the antennas (right).

References

[1] T. Baba, T. Ushiama, and K. Tomimatsu, "Freqtric drums: a musical instrument that uses skin contact as an interface," Proceedings of the 7th international conference on New interfaces for musical expression, 2007.

[2] "Motion Sonic Teasear website," Motion sonic. www.sony.net/Products/motionsonic (accessed Jun. 30, 2021).

[3] M. Gorman, A. Lahav, E. Saltzman and M. Betke, "A Camera-Based Music-Making Tool for Physical Rehabilitation", Computer Music Journal, vol. 31, no. 2, pp. 39-53, 2007. Available: 10.1162/comj.2007.31.2.39.

[4] C. Tam, H. Schwellnus, C. Eaton, Y. Hamdani, A. Lamont and T. Chau, "Movement-to-music computer technology: a developmental play experience for children with severe physical disabilities", Occupational Therapy International, vol. 14, no. 2, 2007, pp. 99-112. Available: 10.1002/oti.227.

[5] A. Mercer, "Game play to music play-video games in the music room," The Canadian Music Educator, vol. 50, no. 3, 2009, pp.45.

[6] J. Jenson, S. De Castell, R. Muehrer and M. Droumeva, "So you think you can play: An exploratory study of music video games", Journal of Music, Technology and Education, vol. 9, no. 3, 2016, pp. 273-288. Available: 10.1386/jmte.9.3.273_1.

[7] A. Hughes, "Maker music: Incorporating the maker and hacker community into music technology education", Journal of Music, Technology & Education, vol. 11, no. 3, 2018, pp. 287-300. Available: 10.1386/jmte.11.3.287_1.

[8] "DrumPants - play music from your body!," DrumPants. www.drumpants.com (accessed Jun. 30, 2021).

[9] "Mogees - transform anything into a musical instrument," Kickstarter. www.kickstarter.com/projects/mogeesplay/mogees (accessed Jun. 30, 2021).

[10] A. Mehmood, V. Vianto, H. He, X. Chen, L. Ukkonen, and J. Virkki, "Passive UHF RFID-based user interface on a wooden surface," In 2019 Photonics & Electromagnetics Research Symposium-Fall (PIERS-Fall), 2019, pp. 1760-1763