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Discussion of your approach to creating the instrument.

Having played drums for over 20 years my natural inclination was to look at an instrument that would be used to program more of the rhythmic elements of music production. In my experience, programming drums whilst using instrument such as a keyboard and methods within the DAW such as piano rolls somewhat felt uninspiring in comparison to how rhythm and drums are naturally played. In all cases it's not applicable to have a drum kit available to program every rhythmic sound, however there is something to be said for the feel and motion in which the natural instrument can inform the way a virtual instrument can perform.

Throughout history there have long been the implementation of drums and rhythm created by striking an object which would in turn release a sound. With this motion of striking, groups of people began to create rhythm aided by their natural body clocks which would then give them a sense of tempo. Fast forward to today with ability to program using a keyboard to create drums it can. For many years there have been developments of other musical tools that have helped the producer to recreate rhythm and drums through midi instruments such as the Akai's range of MPC's, Native Instruments Maschine along with various different drum pad products have helped to give more of a similar motion in playing in percussive parts.

Programming the various rhythmic elements of music production with midi instruments such as the MPC's and NI's Maschine have aided in providing a more rhythmical inspiring tool. Whilst the aforementioned products have bridge the gap of realism and inspiration they can also offer a greater sense of playing rhythm by, what I feel, is being able to use velocity a much more natural way. I sometimes find when programming drums with a midi keyboard that the velocity doesn't quite translate across how I intended it to. The ability to be able to handle and control velocity is quite an important aspect of a drummer's role within the music, this is something that I look for within an instrument that maybe a keyboard player may overlook in their approach to programming rhythm and especially drums. The ability to freely convey the emotion of a song is paramount in production and one of the way you achieve this with rhythm and drums is velocity.

Another aspect of music production and music performance I immediately thought of, when engaging in this task, was what made learning music fun for me. Growing up it was often mentioned by teachers that I could be heard making drum sounds with my mouth and banging on tables. I can recollect always finding an opportunity to create rhythm whether it be hitting my pillows, banging the floor, chair table or anything I could get my hands on to hurl them at. The joy at that time was being able to engage with something that was very tactile and not too technically advanced for me to engage in. I just wanted to hit things and an object to make a beat! Even today I still revert back to tap on surfaces whether it be a table, a chair or my own body to create that sense of rhythm. For me, there's still a joy to be had in using your creating rhythm through using your limbs directly. On occasions generating music has gotten very technical when things tend to get technologically advanced there can sometimes be a danger of over complicating the simple things and lose the intended joy of simplicity.

My aim in creating this instrument initially was to look at an alternative way of programming drums to that of the more conventional uses of the MPC's and products of this nature. As I delved a little deeper into the project I found that I was also looking to explore a more tactile way of creating rhythms and drums that was reminiscent of how I use my hands as a young child bang and tapping on things. For me, this would be something that could help to convey that sense of freedom of expression rhythmically. With all of these factors considered, my response to the task of creating an instrument was to look at using my hands and finger tips.

As well as having regular drum sounds in I thought it would be interesting to have a drum kit made up of a bank of audio files that I would have gone through the process of recorded and converting into samples to be triggers. Again going back to the idea of the instrument being tactile my approach was to have samples of everyday scenarios and objects that could be used to create rhythm.

With all of these factors considered, this led me on to the idea of creating an instrument that I could be played rhythmically with the touch of your fingers which would then trigger sounds within your DAW. In principle it would be an alternative method of recording drums to the previous products I've mentioned before, but with emphasis of the the product being more tactile than comparative products. With my idea to to create an instrument that can be trigger and one that was tactile; it was a logical process for me to make the instrument into a wearable glove. This would instantly make the instrument much more interactive and tactile, giving the user the ability to feel like the sound is being played directly from their limbs.

An overview of the principles behind how your instrument works

In order to achieve the desired results for the proposed midi glove instrument, I've decided to use the micro:bit chip and coding platform for it's ease of use and relatively short learning curve in regards to coding. In terms of hardware I would need two microchips per hand, one USB chord per hand to connect the a micro:bit chip to the USB socket of my laptop. To construct the components for the interactive glove I'll need one gloves, a battery pack, a second micro:bit chip, some conductive thread and some conductive fabric. This would process a sound by using a software cared Hairless MIDI and played through the software instrument EXS24 through my DAW of choice which would be Logic.

A circuitry system would need to be added to the micro:bit in order for the gloves to act as the trigger for sounds within my DAW; the circuitry that I require is an open loop circuit system. The principle of the open loop circuit would allow for multiple sounds to be place on different fingers allowing the instrument to be to triggered by multiple fingers simultaneously if need, this would also allow for the gloves to be able to produce a bank of sounds that we can refer to as the drum kit or rhythm kit. The concept of how the trigger could work would be for the finger tip to have a line of conductive thread sown along the length of the finger which would be connected to one of the pins of the micro:bit chip and extended to conductive fabric. The samples would be allocated to the relevant pins on of the micro:bit chip from using a code command within the micro:bit software. In order for the circuit loop to be closed there would need to be a grounding connection that would complete the flow of electricity. The grounding connection would be connected to the thumb; for the circuit to be complete and the sound to be triggered the finger would have to connect with the thumb which would trigger the sound that is attributed to the designated pin [Fig.1] [Fig 2] [Fig 3.].

The micro:bit has two connective capabilities, bluetooth and radio functionality, which enables the your laptop to connect with your micro:bit chip to transfer data between the two devices. One micro:bit would be attached to the computer as receiver by a USB chord whilst the other micro:bit would chip would be attached to the glove and the open circuitry on the glove. When the circuit closes the micro:bit would transmit data to the receiving micro:bit (connected to the computer). The receiving transmitter would then trigger the coding script attributed to the pin on the micro:bit (attacehd to the circuitry of the glove); his will then process the sample within the software instrument EXS24. The micro:bit first would have to be recognised as a midi instrument within the computers' built-in midi interface and this is done by the using the software Hairless Midi, which acts as a bridge, to allow the micro:bit to be connected to Logic X in order for it to be used as a midi instrument.

Some of the sounds that the midi drum glove will be triggering are of audio files that I have sampled myself, some of which are of me beatboxing, clapping or foley sounds. For the samples of myself beat boxing I recorded myself into logic and adjusted the EQ to bring out the elements of the sound that I thought was appropriate. Once the was done I then I then loaded the sample into the software instrument EXS24 in order for the midi instrument to trigger the sounds. Sampling foley sounds was a very similar process except I either needed to create the sound or I had to find the sound and record. Foley sounds are generally made up of environments and objects that don't pertain to music but have been recorded. For example an environment could be the soundscape of the street you live on, you'd set up your recording device and record the environment around you. For some of the sounds I am triggering I decide to venture out to a nature reserve, not to far far from where live. I then set up a recording device and allowed it to

capture whatever the environment sounded like. The audio would then be chopped up to the desired length to be processed (EQ'd, compressed, volume adjustments) in Logic and saved as WAV files ready to be placed into EXS24 as a sample source. Another sound source that I recorded and sampled was a plastic bottle full of coins, this was a similar process to recording myself beat boxing whereby it was receiving the audio signal into Logic to be processed and saved as WAV file in order to again be placed into EXS24 [Fig 4].

Details of issues you encountered while creating the instrument, and how you overcame or/ and adapted to these issues:

Components:

My initial prototype of the glove was a very crude and quick mock up for me to sketch out some ideas whilst thinking how I may approach the assembly of the glove. My initial materials used for the mock up were a pair of Mary Gold Washing gloves, some adhesive Cooper tape and micro:bit. The issue I had, with this very crude and early design, was that the adhesive tape was perfect for it's conductivity and got the job done in that regard. However, the wear and tare of the Copper tape was the issue. Whenever I would close or extend the my hand then copper tape would the tape would eventually lose it's sticking ability on the glove. Another sticking point for this very crude prototype was the fact that there was no flex on the copper tape and again whenever clenching or opening my hand this would cause the connection point between either the micro:bit or the triggers to be disconnected. This led me to looking for alternative components that could achieve the same level of conductivity whilst also being able to respond and cope with the different motions of the hand, this lead me on to conductive thread. The conductive thread allowed me to create a much more flexible connection between the micro:bit and triggers on the finger tips [Fig 5].

Whilst working through prototypes I noticed that may be a issue regarding the circuitry of the instrument and where it may be positioned. Whilst implementing the use of conductive thread I noticed that there would potentially be a short circuit if thread was sown thought the glove and as it would be touching hand before it reach the triggers ultimately stopping the sample from triggering. I found a pretty simple solution for this as it which was to place the conductive thread through a plastic tube allowing the thread to be protected from unnecessary triggering, enabling the circuit to stay open until the connection of the finger tips closed to trigger the sample [Fig 4].

Audio Bridge:

As I was building the initial instrument I was connecting the receiving micro:bit into the MIDI port and trying to look for the device within the audio MIDI settings and then trying to locate the device as an instrument within Logic. In my experience of using a variety of other MIDI instruments it was as simple as plugging into the MIDI port and the device being available to use. The micro:bit was able to be found in the Audio/ MIDI preferences tab within Logic.

Whilst looking into potential fixes for this I came across a forum (MIDI and micro:bit, 2020). My issue was that I'd assumed the MIDI data was being converted automatically and speaking to the the computers audio settings. What I eventually found out I needed to do was use a software called Hairless MIDI. This software allows the micro:bit to send and receive MIDI information to and from the computer. Once the software was installed I was the able to locate the micro:bit device within the Audio/MIDI settings tab. I then needed to find the device and the item within the IAC driver on the macbook settings, lastly the micro:bit would then show up as a MIDI instrument.

Wireless:

Initially I tested the circuitry wired to my laptop. This was initially done this way to verify that the coding done, via makecode, was adequate at a fundamental level. As I began testing I felt that if the glove had to be wired to the laptop it would undermine some of the principles in which I decided upon when considering my approach to creating an instrument and I felt wireless was the way.

The Micro:bit is built with radio and bluetooth compatibility which is a great element to have. I've opted to use Bluetooth as the wireless connectivity option because it would be a stable choice should I need to the upgrades in the future as bluetooth is a household wireless option. This connection requires two Micro:bit chips talking to each other via bluetooth. One micro:bit would be connected to the computer as a receiver via USB and sending the information on to be processed by the audio bridge previously mentioned. The second micro:bit would be attached to the glove and sending the MIDI to the receiver. This process gives the instrument a real sense of freedom in order to be played at the comfort of the user who wouldn't have to worry about cables lengths as this would potentially be different per user. This would also help to identify some of the initial principles the instrument was based around.

Finger Trigger Design:

The finger tips are an essential part of the design of the glove and need careful consideration along with prototyping. The fingers are the connection point whereby the inputs on the micro:bit are triggered. Initially there wasn't an alternative material I had in mind to replace the copper tape connections around the finger tips. This was a very crude way of achieving the results. It wasn't aesthetically pleasing as I'd have to be double wrapping the tape over itself, there were also elements of fraying towards the end of the tape. The other concerning factor for using copper was that it would make the finger tips become quite rigid as the copper would be taped to the fabric and it may lose its stick which caused me to have concerns over longevity.

My research led me to find the piezo contacts which I felt was a strong idea in principle. The piezo contact would give a strong connection between the two finger tips. Again the more I delved into the idea using the piezo contacts it may be a compromise in performance for the glove should this be the solution. The contacts may prove to be awkward in feeling for the user and would be a bulky construction.

Whilst making a purchase I came across some conductive fabric that peaked my curiosity. I decided to test the fabric out for its conductivity and whether it was a reliable material. I was pretty certain it would perform better ergonomically better than the previous options I'd considered as it can be easily manipulated into position with your finger tips. The conductivity levels, once tested, revealed that the fabric was consistent in triggering the samples. For me this was quite a straightforward conclusion to make, I decided to use the conductive fabric as the trigger component, mainly for the ergonomic and user comfort qualities it possessed [Fig .

Reflection upon the results of your instrument

I'm pretty pleased with the results of the drum glove and the fact that I was able to conceptualise and then bring the idea to light even in a primitive form. The performance and results shown are an indication as to what the potential could be, while there are elements that could be dramatically improved, the results show that should these improvements be made they it could be an strong alternative MIDI instrument.

A particular aspect that really pleased me was the integrating of the fabric for the triggering finger tips points. Not only did it do a good job with performance technically, it also aesthetically enhanced the the presentation of the glove and prevented it looking too mechanical.

The MIDI glove performs to the basic idea I had in mind for the project. Upon reflection there's more scope for improvement to be had with the glove allow it to be functional as other commercial products within its market. One aspect of the MIDI glove that I feel could do with improving is the sense of velocity. Currently the velocity is set at 127 consistently for every trigger. More research is needed to determine what could be done to amend this aspect of the MIDI

drum glove. One of the possible ways in which this could be done is by using the piezo pressure sensors underneath the fabric to transfer the change in velocity data through MIDI information. My initial decision not to use piezo contacts was because how far the extruded out beyond the finger tips and would present a higher level of discomfort than the using the conductive fabric.

I also noticed that upon making the connection with the finger tips to play the sample there was some latency in the time it would take for the sample to play, again more research is needed to determine how this may be improved. I also noticed that if I play two crotchets consecutively then the second crotchet would not trigger, this is again an aspect of the instrument that I could further look into. Once these aspects of the of have been ironed out I believe it would definitely take the MIDI love instrument to a more competitive level.

The aspect of the MIDI drum glove that most pleases me is in regards to the instrument is that conceptually I had in mind to make a instrument that played totally different to any instrument currently commercially available. I believe this was achieved as it does offer a totally different playing experience any drum/ percussive related instrument, the playing experience offers a more organic and tactile approach in that the body of the instrument is channeled through the user as opposed to an external hardware. In my opinion it appears to give the user that much more immersion into the groove of the song as the MIDI drum glove plays as more of an extension of the body as opposed to play something which is a completely different entity.

Comparison to competitors on the Market

As previously mentioned there are products on the market that offer the same base function as a drum/ percussive instrument s the drum glove. The first type of instruments that come to mind is the AKAI MPC and the Native Instrument Machine, there are many more drum pad products on the market but the products previously mentioned lead the way and are the industry standard in the market. These MIDI instruments have sixteen drum pads the user would play into compared to the eight triggers I have available. These instruments also have a dedicated sequence and sampling features that come with the software that's bundled in with the hardware unit. This gives the instrument a broader scope on being able to manipulate and stack samples from the hardware as well as the software. The only comparison that could be between these commercial products and the MIDI drum glove is that they are both percussive MIDI instruments, with the biggest difference between the MIDI instruments being the way they are played. Akai's MPC has been around since the early 90's meaning the technology is well tried and tested [Fig 4].

Another MIDI instrument I took great inspiration from, in form, was Imogen Heaps MI:MU glove. This is an instrument that controls much more than facets within the music on the fly as opposed to the MIDI drum glove. Although this product has a familiar outlook on how they wanted the user to express themselves, the MI:MU is very much a gesture based instrument as opposed the drum glove which is a trigger based and percussive instrument via touch. Withe the MI:MU you have an instrument that has a dedicated software for the product and has a strong emphasis the live performance. MI:MU glove hardware features a WIFI - connected block at the leading to embed flex finger sensors, a vibration motor and LED lights that respond to a host of bends and gestures [Instruments and Gloves, 2020]. This product is technologically advanced compared with the MIDI drum glove, this is very down to the functions that both products are required to undertake. MI:MU has been designed to operate within a designated software that controls parameters within host DAW, these parameters that can be manipulate via MI:MU include panning, reverb, cutoff, pitch and oscillators functions.Tis asl done by hand motion and gestures. The gestures are also able to control sounds as well as the synthesis of them. The complexity of MI:MU automatically puts itself within a different technological market and while this glove can aid in music production it's real strength is in music production as it lends itself to the artist being more visually expressive. The MIDI drum glove is less technologically advance then the MI:MU although the MIDI drum glove has borrowed some some of elements of the design from the MI:MU [Fig 5].

Business Plan

The MIDI drum glove has a wide scope in which this product could be placed within a target market. From a producers standpoint in mind, it can appeal to the creators side of music that is looking for an alternative MIDI instrument. The product can also be marketed to the level of any producer whether they be an experienced, intermediate or beginners. This product could also be implemented in a live setting which could see it being used by performers. The MIDI drum glove also has an elementary quality to it due to its tactile nature and I believe that it could be used at grass roots level of music. It could be used as a tool to introduce children into the world of music production. It's not as complex to learn as her instruments which lends itself to the a young market as well as the advanced professionals.

This could be funded under the Abbey Road Studios Incubator program. The Abbey Road Studio has been a leader in creating programmes that have aimed to help the development of the next generation of music technology by giving the recipient a wealth of opportunities to network, test and develop the project whilst also supporting the recipient with needed networking opportunities alongside delivering sustainable business models and strategies. I believe a program like this would definitely aid the MIDI drum glove to further make enhance and build upon the results that have been achieved so far in order to make it a viable alternative instrument for the user who is looking for a more immersive experience.

Conclusion

There's evidence to suggest that the MIDI drum glove has been a successful project to embark on in regards to the potential within the product for it to become a viable alternative instrument within todays current market. The more organic element of the instrument may be a big appeal for some users as it forces the you to engage as an extension of your body.

Figure 1.



Figure 2.

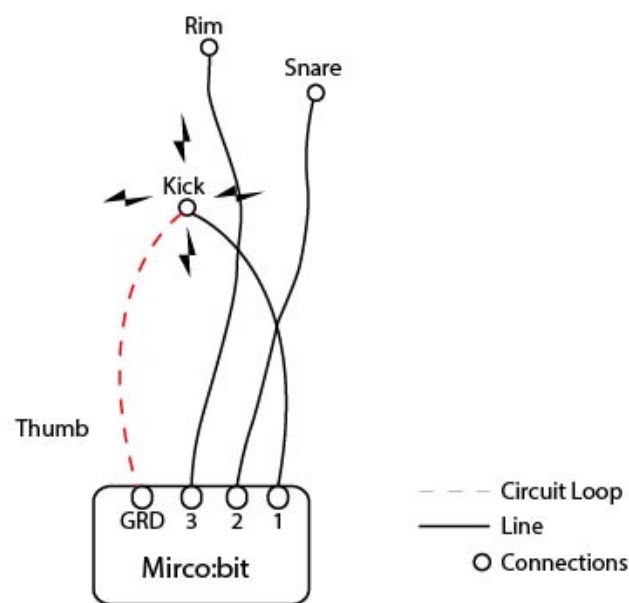


Figure 3.

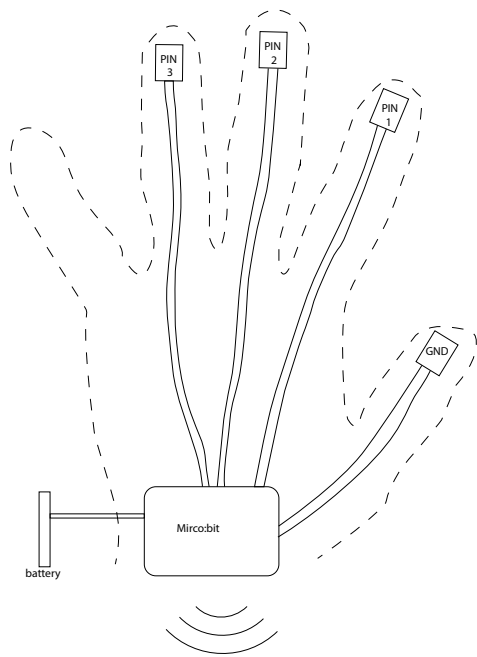


Figure 4

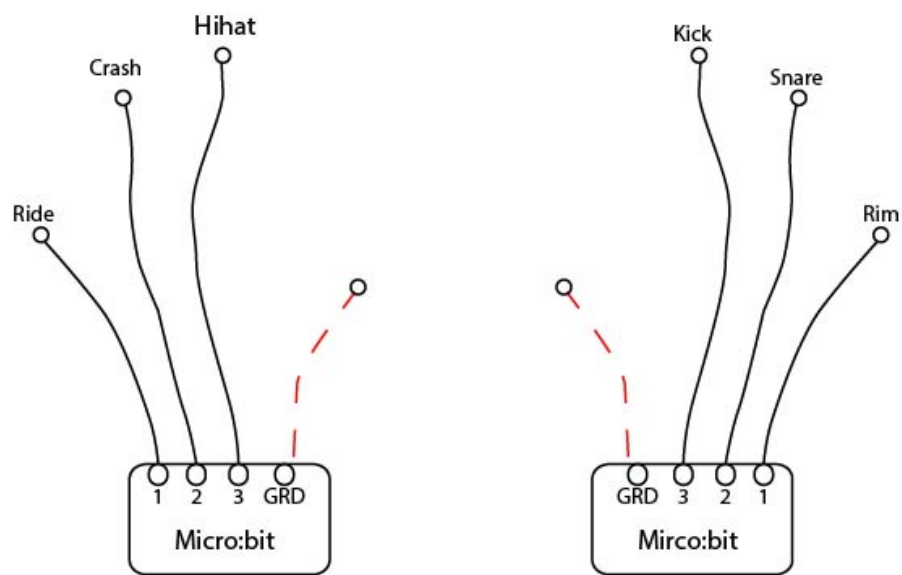


Figure 5.

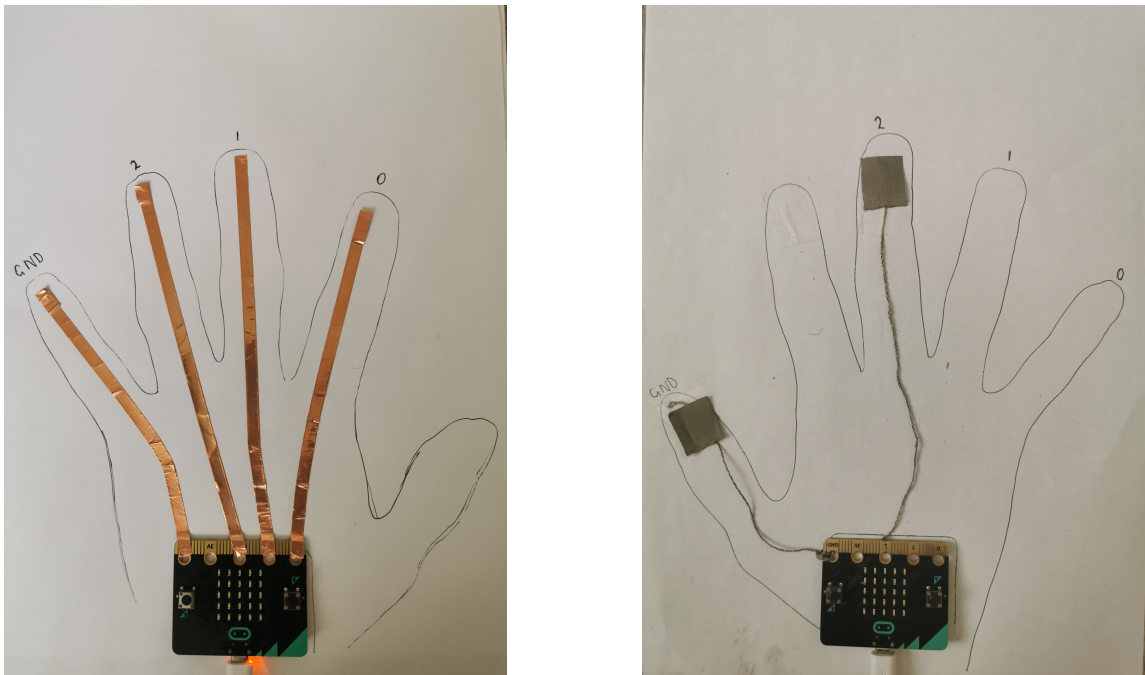


Figure 4



Figure 5.



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