Cardiff School of Computer Science & Informatics

Internet of Things Driven Cosplay

Author: Rhys Beckett

Supervisor: Charith Perera

Moderator: Richard Booth

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Introduction

This project aims to explore the potential impact IoT technology may have on the cosplay community, this shall be done by fabricating a costume that utilises such technology; then presenting the finalised piece to a focus group, that shall discuss the issues regarding the topic.

The costume in question shall utilise IoT technology to create multiple unique methods of interaction, including motion controls, audience participation and ambient conditions. These methods of data generation will be utilised to alter the state of actuators found on the costume.

Such technology has seen some rudimentary implementation amongst early adopters within the community. This project seeks to delve further into this combination, revealing further potential insights; that would benefit such individuals. It would also benefit the companies that have begun to market 'wearable' technology that can be utilised in the costume industry.

This project mainly seeks to understand how this technology would impact an individuals' experience at a public event, if they were to implement this technology. This includes both those that would wear such a costume, and those that would encounter and interact with the costume. This includes the impact of both casually attending an event, and competing in a professional setting.

The project will be considered a success if the main primary functionalities are implemented, as the system will be considered functional. The further secondary functionalities, including the audience participation and ambient conditions; are subject to time constraints.

Background

Cosplay

Cosplay is the fusion (portmanteau) of the words costume and play. It is both a noun and a verb. It can describe the performance art in which individuals wear costumes to represent a specific character; or it can also refer to the costumes themselves. Those who participate in the art, are referred to as 'Cosplayers' [2].

Individuals can engage in cosplay in a variety of different ways. Most participants mainly engage by attending conventions whilst in costume. These conventions vary in size and theme; they can be smaller, local events like 'Cardiff Film & Comic Con' or larger, international events like 'Gamescom'. In recent years, events like these have become increasingly popular; both drawing more attendees and spreading internationally. San Diego Comic-Con is one of the largest comic conventions in the world, with an attendance of over 130,000. This convention has consistently seen a 15% growth for the last 17 years, resulting in about $19 million in revenue as of 2017 [3].

Some individuals choose to fabricate their own costumes, those who do are eligible to participate in competitions. These competitions, commonly referred to as masquerades; are usually proportionate to the size of the convention/event that they are hosted by. Meaning, they can be small, friendly events or large, international competitions with hefty prize pools; like Twitchcon 2018, which had a total prize pool of over $70,000.

Cosplay is a visual art form that is usually displayed in very public, crowded venues. As such, depending on their skill; these artists tend to receive some recognition and fame within the community. Since the coining of the term 'Cosplay' in 1984 [1], this community has experienced exponential international growth. Due to the growth of this sub-culture, many of these individuals have successfully converted the hobby into a professional business model by capitalising on their social media recognition and influence. Usually through advertisement, and voluntary support like Patreon or Koffi.

Other industries have recently begun to exploit the influence cosplay has on popular culture; employing these influential individuals to both create costumes from their new/current product and attend marketing events in said costumes. This phenomenon isn't unique to cosplay alone, many other industries utilise the reach these influential individuals possess to effectively market their brand. Most notably for cosplay, larger development studios like Blizzard have begun to heavily involve these influencers in the marketing campaigns of multiple video games [4].

As the cosplay community grows and gains further popularity, it can afford to support more business. These businesses produce new materials and technologies that are usually cheaper, more efficient and better suited for costume creation. These advancements further improve the quality of newly fabricated costumes, it also allows the accurate replication of previously impossible costumes.

Internet of Things (IoT)

The Internet of Things refers to the interconnected network of devices that are capable of communication through the Internet. This includes a wide variety of devices from speakers, lamps, doorbells, washing machines and more. Basically, any device with internet connectivity can be considered IoT capable.

The term 'Internet of Things' was first coined by MIT professor, Kevin Ashton during a presentation at Procter & Gamble in 1999. He created the phrase in an attempt to convey the possible link between the RFID in P&G's supply chain and the Internet. At that time, nearly all the available data stored on the internet was originally captured by humans; which to his understanding, is a flawed method considering people have limited time, attention and accuracy. Instead, he envisioned that our computers, machines and devices could communicate, record and store all the relevant information and data autonomously; reducing waste, losses and costs. Such autonomy would allow these systems to observe and interact with the environment without too much human oversight. [5]

Since then, both the term and the technology has seen rapid industrial growth. The largest factors impacting this growth include, advancements in connectivity and network capabilities, improvement in cloud computing and a reduction in manufacturing costs. Some of the newest wireless technologies include Wi-Fi, Bluetooth and Z-Wave. The improvements to cloud computing provide an affordable cloud infrastructure that facilitates the seamless sharing and communication of data from individual devices to the cloud servers. Numerous technological advancements have led to the significant reduction in manufacturing costs, allowing smaller scale companies to embrace IoT solutions; increasing the variety and availability of products.

It is currently estimated that worldwide there are over 17 billion connected devices, with 7 billion of those being IoT related. It is predicted that this number will grow to 21.5 billion IoT devices by 2025 [6]. This is reflected in the market size, currently it is estimated to be $151 billion and is expected to grow to $1,567 billion by 2025.

IoT can already be applied in a variety of unique situations, from wearable technology, to city-wide projects. Even though these projects might differ in scale, fundamentally they are similar; consisting of sensors, transmitters, central control units and actuators. Usually a larger-scale project simply consists of more individual devices connected across a much larger network. These networks can be installed in any environment that can provide useful information, such as healthcare, industry and agriculture. Not only can these networks capture more data within the environment, they capture the data more consistently, accurately and reliably.

Relevance

Considering the rapid expansion of both industries and the tendency of creators to adopt new technologies and techniques, it was inevitable that IoT technology would slowly be incorporated into the cosplay community.

This incorporation is still in its infancy, only being utilised by the most dedicated and ambitious costume creators. Currently most of this technology is limited to basic functionality, such as LED lightning or basic animatronics. Most of this functionality is achieved by utilising some of the more basic wearable technology.

However, as the technology continues to improve and become more widely adopted, new issues and concerns must be considered. Some of these issues are ubiquitous to IoT technology, such as privacy, security and safety; whilst there will be some new concerns that are unique to cosplay. These concerns are mainly due to the public nature of cosplay and how this technology may interact and impact the general public. Such concerns could include negatively affecting the disabled, creating distractions and congesting areas of high traffic. These issues and concerns will be further addressed in this report.

There are a myriad of individuals who have a stake in the development of this technology. As previously mentioned, this technology is already being utilised by a customer base consisting of some early adopters within the cosplay community. It facilitates the fabrication of costumes that were far too ambitious for previous technology, usually costumes that include complex lighting, movement and/or sound control. These customers are currently being supplied by companies that mainly focus on providing small electronics like Arduinos and Raspberry Pi's, however these companies have already begun to offer some wearable components that can be utilised in these costumes.

Approach

The purpose of this report is to explore the potential impact IoT technology may have on the cosplay community and industry. To facilitate this exploration, a costume that utilises the most modern IoT technology is required. Therefore, one of the first challenges encountered was choosing a suitable costume piece. This piece needed to satisfy a few given requirements, it must utilise some obvious actuators, said actuators must have multiple available states and the piece cannot be too complicated to fabricate. These requirements ensure that the costume piece can adequately react to multiple given inputs in an obvious and satisfying manner.

Considering the available time-frame, it was decided that individually addressable RGB LEDs would most efficiently satisfy the given requirements. As such, a science-fiction theme is most suitable for these specific actuators. After researching some potential settings and themes, the popular video-game series Destiny was chosen. This setting was chosen for multiple reasons, it contained a wealth of suitable costume choices, most of these costume pieces were designed practically and most importantly, this setting boasts a large, active cosplay community. This community could be utilised in a variety of useful ways, mainly by providing costume fabrication advice, project feedback and concept opinions.

Once the setting was confirmed, a specific costume piece needed to be chosen. To successfully illustrate the potential of IoT integrated costumes, an ambitious and unique armour piece was required. As such, the specific helmet titled ‘An Insurmountable Skullfort’ was selected.

Figure 1 - 'An Insurmountable Skullfort'

This helmet, though impractical to wear, utilises an entire array of LEDs in the face visor. This array perfectly satisfied the requirement for multi-state actuators. Also, due to the complexity of the piece, no other individual has attempted to replicate it; despite being very popular amongst the community.

Once the costume piece was chosen and actuators confirmed, the system required designing. Firstly, the electronic components needed to be selected. This selection began by exploring what electronics were already begin utilised by the community, fortunately creators within this community tend to be very open about the techniques they utilise. Even though most of these electronics tended to be too basic for the given specifications, this research did provide a good understanding of the available market and which brands to consider.

Eventually, the decision was made to utilise Adafruit Industries electronic components. They are an open-source hardware company based in New York, they design, manufacture and sell a variety of electrical components and tools; ranging from sensors, batteries, LEDs, microcontrollers and more. Fortunately, Adafruit also boast the largest collection of supporting content relevant to their products; this includes tutorials about almost every unique product, guides detailing multiple creative projects and blogs discussing current relevant news.

Most of the electrical components chosen were selected due to information provided from researching these tutorials and guides, they provided in-depth detail and concise comparisons. Firstly, of the available LED strips; even though the NeoPixel range is more popular and widely utilised, the 'DotStar Digital LED Strip – Black 60 LED – Per Meter' were chosen. DotStar is a newer, upgraded range that pushes data faster and requires no specific timing. They are available in 30, 60 and 144 LEDs per meter, the 60 LED strip was chosen as these LEDs were to be arranged in a matrix; meaning that the LEDs would need to be spaced evenly both vertically and horizontally. Therefore, even though more LEDs would have been more visually impressive; the horizontal space between the LEDs on the 144 strips was smaller than the minimal vertical distance, meaning that a square matrix would have been impossible.

Once the LED strips were chosen, next was deciding on the quantity required. After 3D modelling the helmet, it was possible to understand the space available to house said LEDs.

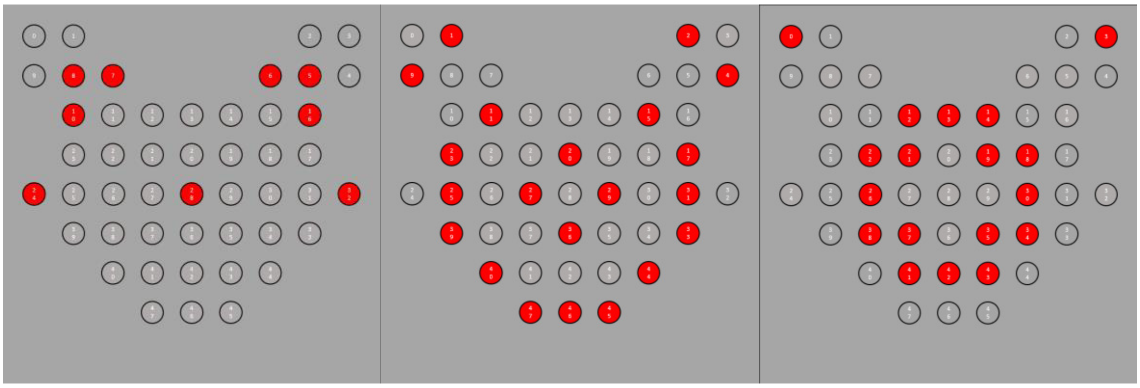

Figure 2 - Planned LED Matrix

The diagram illustrates less individual LEDs than portrayed on the original costume piece, this is because the chosen LED strips cannot accommodate that number in the given space. Either a smaller, thinner strip of LEDs was required, or the helmet would have to be scaled to an appropriate size. Neither of these options were viable, a thinner, higher resolution strip isn't available, and a larger helmet would look comical. Therefore, a smaller pattern that approximated the visuals of the original was required. Fortunately, a smaller pattern both meant supporting a smaller current draw and purchasing fewer LED strips; with a total of only 46 LEDs, a single 1 metre strip was required.

After choosing the LEDs, the appropriate microprocessor was considered; with the requirements being that the device must be capable of all the required connections, be as small as possible and support Bluetooth Low-Energy. As such, the Arduino-compatible 'Adafruit Feather nRF52 Bluefruit LE – nRF52832' was chosen. As an Adafruit Feather product, this chip is lightweight and portable, measuring only 51mm x 23mm x 8mm; which is adequately small enough to be housed within the helmet. Despite its small size, this chip is capable of being utilised as both a main microcontroller and a Bluetooth Low-Energy interface; meaning it can communicate with BTLE devices, process the incoming data and control any connected peripherals.

However, due to the smaller size of the device it can only output 3.3V; which is insufficient for this project. As such, the 'PowerBoost 1000' was required. This device is a DC/DC boost converter module that can be powered by any 3.7V Lithium Polymer battery, and convert the battery output to 5.2V; suitable for this project.

As an open-sourced company, Adafruit provide open access to all their code; including the scripts for their own BTLE application, which consists of both the Arduino code for this microprocessor and Android/iOS code for the mobile device. This provides a convenient foundation as the basic functionality is already implemented, allowing the focus on developing additional functionality. As such, the general structure of the program is dictated by the original code.

The additional functionality originally planned for the device were multiple unique forms of interactivity, including motion control, audience participation and ambient conditions. The flow of data would be similar for all methods of interaction. Firstly, data is generated within the BTLE connected mobile device via a specified human-machine interaction; motion control would begin with the sensors found within; these can be whichever sensor best suits the intended purpose, either the accelerometer, gyroscope, magnetometer or quaternion. Again, as a specific motion is made, data is generated; this data is then converted into a byte packet and broadcasted to the BTLE connected microprocessor.

Whilst lopping through an LED animation, this device continually listens for any new communication. Once it receives a packet, it is immediately parsed, and the containing content is stored globally. Usually this packet contains both an indicator that signifies a new command and the data relevant to said command. Once the device understands which command it has received, it can translate the given data into RGB colour values; ready to be utilised in the next animation stage. The microprocessor will then multiply the colour values by a strength value that is determined by the current elapsed time.

Implementation

Firstly, the electronic components were chosen and purchased as immediately as possible; since progress would be limited without access to the development platform. Whilst waiting for the electronics to arrive, attention was focused on fabricating the helmet. This process began with creating a 3D digital representation of the helmet within a modelling software; initially, this was attempted within the CAD design software Fusion 360. However, before the modelling could begin; scaled reference images were required. Therefore, photographs of the authors head were captured; including a ruler within the image that provides scale.

Figure 3 - Scaled Reference Images

Progress within Fusion 360 was initially promising. However, it became apparent that a CAD-based approach struggles when reproducing organic geometry; which was an issue considering the helmet mainly consists of organic curves. As such, the decision was made to begin anew within a different modelling software; specifically, Blender. Blender is an open-source 3D computer graphics software toolset, meaning it can be utilised in creating animated films, visual effects, art, video games and most importantly, 3D models. Unlike Fusion 360, Blender is not a CAD-based software; instead, it relies on vertices, edges and polygons to produce a 3D mesh. As this method of modelling allows the transformation of individual vertices, it is far more suitable for modelling abstract/organic models. Once familiar with the UI/UX of the new software, progress was smooth; in total, it took approximately 25 hours to reproduce the helmet digitally.

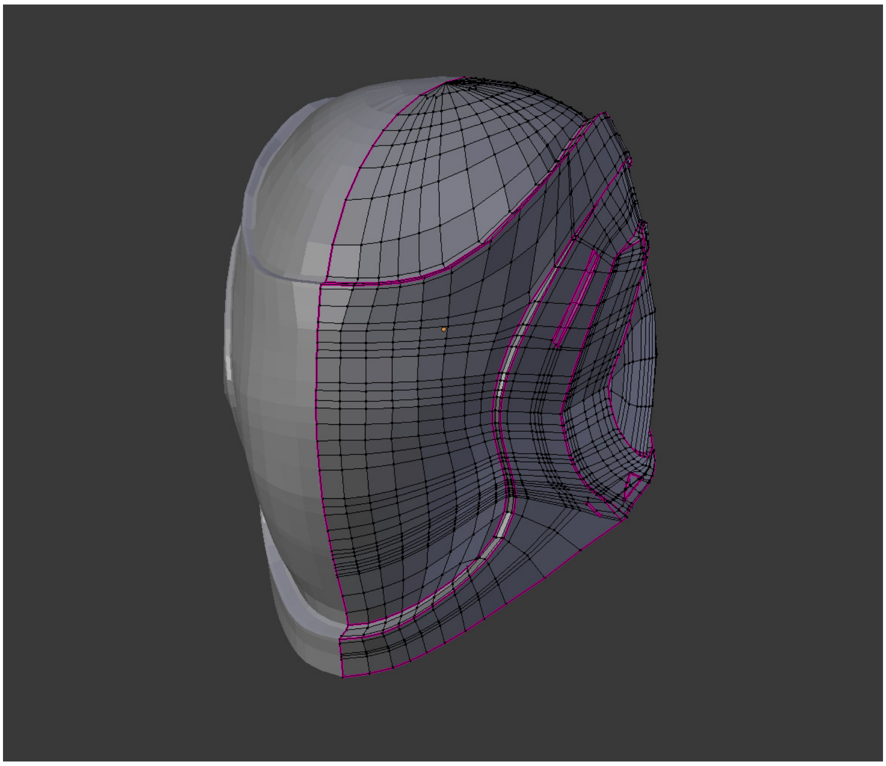

Figure 4 - Finished 3D Model

Once the model was complete, it could be separated into individual parts for further processing. Firstly, a transparent visor is required to allow the light of the LEDs to shine through the helmet. However, due to the unique shape of the piece, a generic visor could not be bought and utilised; instead, a visor would have to be fabricated. The most suitable method for producing such a visor would be vacuum forming a sheet of PETG plastic. This method involves heating a sheet of 'Polyethylene Terephthalate Glycol' over a mould that sits on a vacuum table. Once the sheet is warmed until malleable, it is lowered over the mould and the vacuum is introduced. This vacuum pulls at the plastic, forcing the sheet to contour to the mould surface. However, to utilise this method a positive mould, commonly referred to as a 'buck' was required. Fortunately, it was discovered that a PLA 3D printed object could survive the moulding process. As such, progress began on producing this piece.

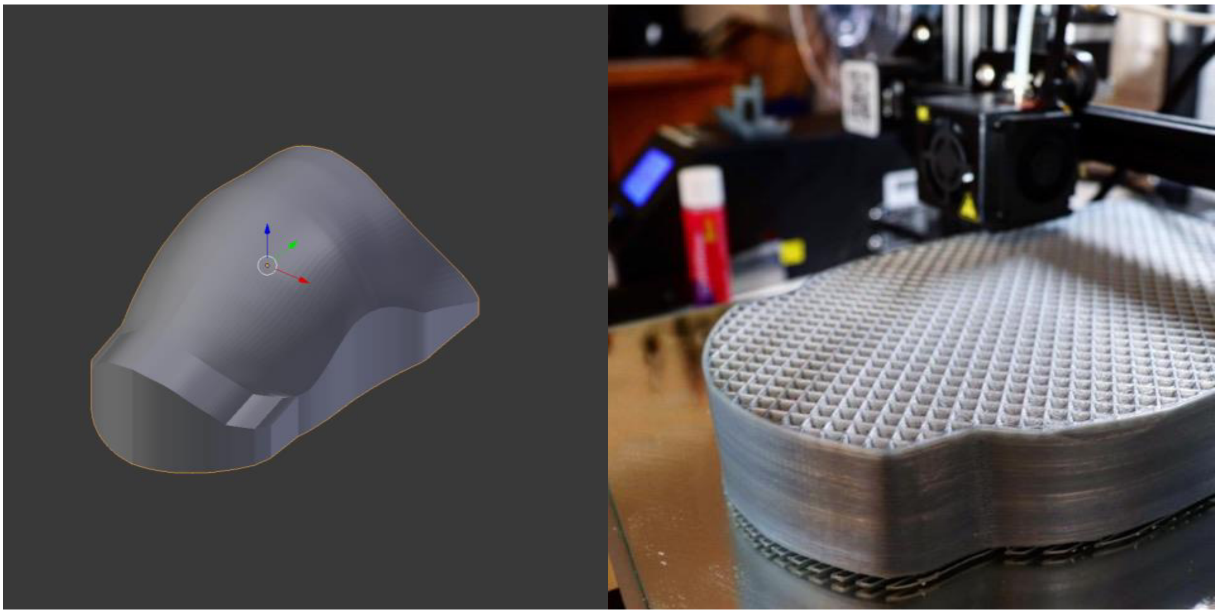

Figure 5 - 3D Printing Visor Mould

Creating the 3D model for the visor mould was simple, as the complex surface had already been modelled; as such, all that was required was separating the visor face, then transforming it into a printable object. However, to ensure that a PLA object can withstand the heat and pressure of vacuum forming; it must be robust. This involved tweaking multiple setting within the slicing software, including reducing the layer height, increasing the wall thickness, slowing the print speed and most importantly increasing the infill percentage and type. Once all these settings were confirmed, the software sliced the relevant file and printing could commence; in total, due to the robustness of the piece, it took over 3 days to complete.

Whilst the piece was being produced, a vacuum forming machine was located in Cardiff. Specifically, in 'The FabLab', which is an open access digital workshop found within the Cardiff Metropolitan University's School of Art and Design. Once the mould was complete, it was taken to this workshop. Even though PLA is meant to be able to withstand the vacuum forming process, the first attempt deformed the surface of the mould. Fortunately, it was repaired with some filler; after some testing, it was understood that the piece had been unnecessarily overheated. Eventually, after some trial-and-error, a suitable visor was produced.

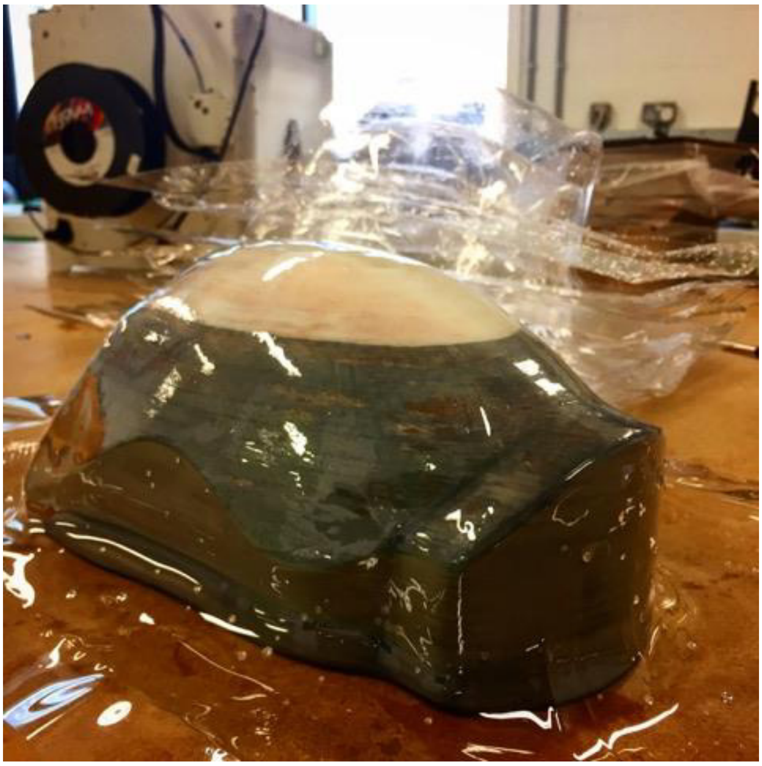

Figure 6 - Vacuum Formed Visor

After producing the visor, next was fabricating the helmet itself. It was decided that the helmet would be fabricated from EVA foam, 'Ethylene-vinyl Acetate' is a dense, foamlike material that is commonly utilised in the cosplay community. It is considered foamlike due to the micro air-pockets that are distributed throughout its structure, this allows the materials to be lightweight, malleable and relatively inexpensive; which are advantages that a 3D printed equivalent could not boast. As such, the first step towards fabrication, was producing accurate templates. Fortunately, there is a software called 'Pepakura' available for purchase, this software automatically flattens a 3D object into 2D templates; originally designed for paper craft, the templates are intended for cardstock. However, by editing multiple settings and tweaking the generated templates; they were eventually made fit for purpose. Once the templates had been produced and printed, the process of fabricating the helmet was simple; all that was required was cutting out the individual pieces, shaping them with either a heat gun or sanding tool, then lastly gluing them together with contact adhesive.

Figure 7 - Fabricated Helmet

The ordered electronics had arrived long before the fabrication had reached this stage. Therefore, once the fabrication had been complete, focus then moved to producing the electronic circuit. Without any previous experience, soldering the circuit proved challenging. Predicting this, an ‘Arduino Starter Kit’ had been included in the original purchase; this kit consisted of an ‘Ardunio Uno’, breadboard, jumper wires and a variety of miscellaneous electrical components. Confidence was first raised by following a few beginner guides to create simple circuits, the breadboard proved invaluable as it allowed the circuits to be built quickly and temporarily.

After confidence had been raised, soldering commenced; this began by testing a short length of the LED strip, which involved soldering jumper wires to the strip, then creating a temporary circuit. This test was successful, proving that both the soldering and written code were implemented correctly. With the success of the test, the soldering could begin in earnest. Regardless of the length, all but the last LED strip required 8 soldered connections; power, ground, data and clock, both in and out. Including the devices, in total there were over 50 connections to solder; which proved to be a daunting task. Progress was initially slow, however it improved with each successful connection. Eventually all the connections were soldered, and the LEDs had some basic functionality.

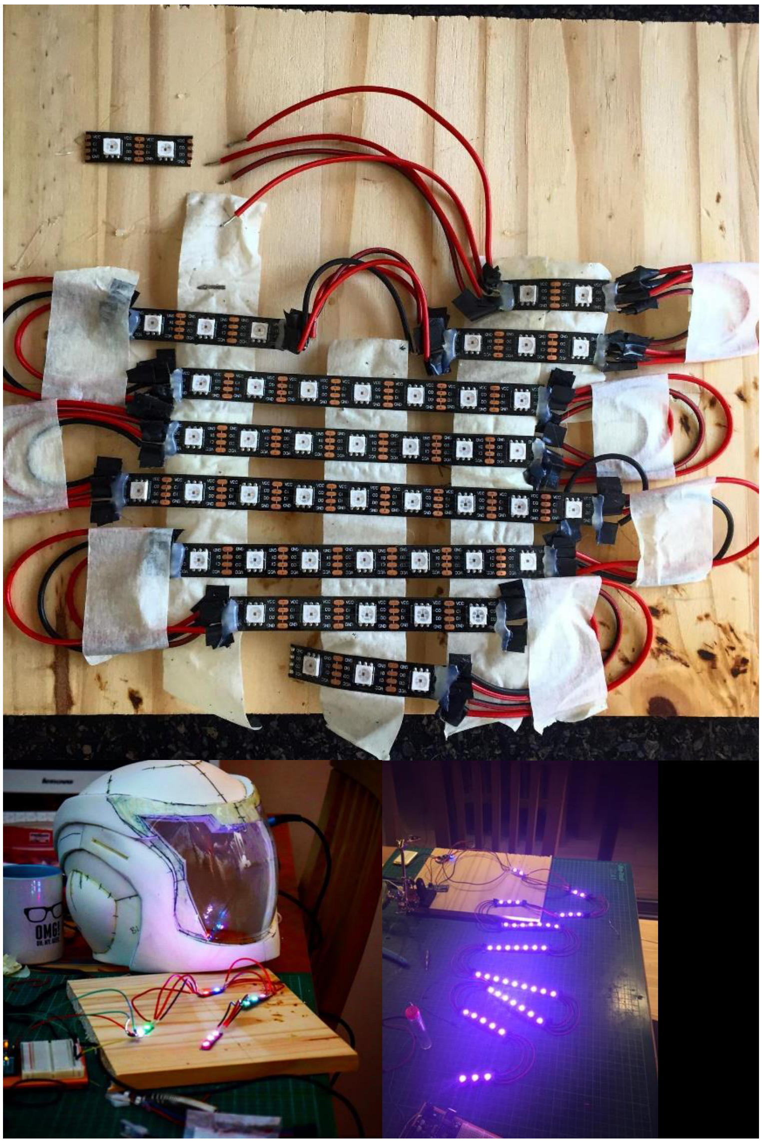

Figure 8 - Completed LED Circuit

Once the circuit was complete, work commenced on the developing the code. Firstly, the BTLE application developed by Adafruit was implemented on both the Arduino microprocessor and Android mobile device. Once installed, the system was tested; ensuring that the devices could communicate with one another. Whilst the microprocessor was connected to the computer, any incoming data packets could be read from the console monitor; as such, the sensor data sent from the mobile device could be visually confirmed.

After communication had been confirmed, the animations were developed. Initially, progress was promising; the individual stages of the animation were recognised, then translated into sets that contained relevant LED addresses. After that, all that should have been required to replicate the intended animation was to brighten/dim the sets at specific time intervals. However, this did not work to plan. Instead of being smooth, there was a regular delay that would interrupt the animation.

After some research, it was clear that the delay occurred whilst the microprocessor stopped to listen for a new BTLE command; the delay directly corresponded to the ‘timeout’ variable tied to this listen function, the longer the timeout value, the longer the animation interruption.

As initial troubleshooting, this timeout variable was set to a variety of different values. It was understood that the smaller the value, the shorter the listening period. As all this code was contained within the microprocessors main loop function, reducing the listening period meant reducing the ratio of time the device spent listening for a new command. If the timeout value matched the specified length of the animation, then the ratio of time spent listening would be 1:1.

Immediately, it was understood that two of the project priorities were counterintuitive; these two being, the animation must be as smooth as possible, and the system must be as responsive as possible. For the animation to be smooth, the timeout value must be negligible; meaning the ratio would heavily favour running the animation. However, if such a ratio were to be implemented, then the device would only stop to listen for a couple milliseconds of every second; making such a system almost completely unresponsive, a command could only be heard due to luck and good timing. Conversely, for the system to remain responsive, the ratio must heavily favour listening. However, that ratio would only allow the animation to run once after every timeout interval; leaving the LEDs frozen for the majority of the time.

This issue would be resolved if the device could animate the LEDs whilst simultaneously listening for a new command; as such, research began on multithreading on the microprocessor. However, it was immediately obvious that such a solution would be impossible; this is because an Arduino has no operating system and can only run a single program at any given time. Once apparent, research began on an alternative solution. Swapping to a Raspberry Pi had been considered, however other solutions needed to be attempted before trying to change a core piece of the project.

Eventually, after further research, an article was discovered. This article entitled ‘Multi-tasking the Arduino’ explains that even though the traditional multithreaded approach cannot be applied, there are other alternatives [7]. By exploring this article, and other similar; a solution began to coalesce. This solution, though incredibly successful, proved to be both challenging and time-consuming. It involved drastically modifying the code such that the microprocessor was never delayed or interrupted, meaning the device could run as efficiently as possible.

This process began by removing any and all ‘delay()’ functions found within the code. As explained by the article, even though the ‘delay()’ is a convenient method of making the microprocessor wait; it is considered a ‘busy wait’, meaning that the device cannot do anything during that specific delay. Which is highly inefficient considering the amount of processing the device is capable of completing during these extended milliseconds; especially as these delays are within the loop, meaning a large portion of every second is spent idle.

Once the ‘delay()’ functions were removed, an alternative method of timing was required. Such an alternative utilises the ‘millis()’ function, it return the current clock value; allowing for precise timings. By implementing a resetting time variable, the different stages of the animation could be triggered based on the increasing value of the variable; once the animation had completed a full cycle, the time variable would be reset to 0.

Even though both of these steps had been implemented in the animation code, the device still did not function as intended; somehow the microprocessor was still being hindered from running constantly. After further research and exploration, it was understood that not only was ‘delay()’ and it’s ‘busy wait’ a problem; any kind of loop that stalled the microprocessor was a hinderance. As such, any loop found had to modified; including those discovered within the code of the original Adafruit script. Meaning, that even though one of the reasons this device was chosen was due to the convenience of the available source-code; it had to be thoroughly understood and improved anyway, negating the original advantage.

To produce the smoothest animation possible, the LEDs needed to slowly transition between states; rather than instantly switch. Whilst utilising the ‘delay()’ function, this process was cumbersome; requiring the developer to calculate the intervals and brightness of each individual step within the transition. However, once the code had been modified, a new method was required. Taking full advantage of the situation, ‘millis()’ was utilised in this new transition. Now that the device is aware of the current time, it can calculate the difference since last update; as such, it can be utilised as a percentage to calculate the current strength of the LEDs.

This process of discovering an issue, understanding the underlying problem, researching the plausible answers, then implementing the most suitable solution was a time-consuming process. Even though the project was meant to include an audience-based interaction, resolving this issue reduced the time available to complete the project. As such, that addition, secondary interaction was temporarily shelved.

However, once all the code had been modified and every hinderance to the microprocessor had been removed; the system works incredibly well, the available animations are as smooth as possible, and the communication is incredibly responsive. Meaning the device is incredibly satisfying to utilise.

Figure 9 - Completed Circuit and Helmet

Even though this project utilises the open-source application from Adafruit as a foundation, most of the code within the Arduino was either created from scratch, or modified in some way; however, the Android application had remained untouched. In an effort to understand the scripts involved, some small modifications were made to the application. The original colour picker only allowed the choice of static colour, brightness and hue; to further tailor the application to this project, a speed value was implemented as a variable bar. Adding the bar to the application was rather simple, only requiring a rudimentary understanding of the Android IDE; which was simple to learn. However, sending this information proved quite challenging; it required a much deeper understanding of both the original application and BTLE communication. After much research and exploration, by editing multiple files within the application; this new packet can be successfully sent reliably.

Results and Evaluation

Eventually, the project developed to the point where no other functionality could be implemented in the time still available. As such, the system was finalised in its current state, and progress began on evaluation. At this stage, the system is capable of directly changing the colour, brightness, hue and speed of the animation; it is also capable of interaction via motion controls, either via the accelerometer or the gyroscope. As such, all the primary functionality of the project has been successfully implemented; only those interactivities considered secondary were not. The audience interaction was not developed as it was much too complex a task to even consider completing in the remaining time; even though the ambient interaction would have been simpler to develop, it was not implemented as it was agreed that such an interaction would not have enough of an obvious impact to warrant the time and effort spent in development.

As this project investigates the potential impact IoT technology could have on the cosplay community, it was decided that the evaluation should be done via a focus group. A focus group brings together a collection of individuals with knowledge on the given topic; these individuals are presented with a product, then encouraged to not only provide feedback, but to also discuss and debate the topic amongst one another. This discussion not only provides immediate qualitative feedback on the product, but depending on the conversations held; can provide invaluable insight into the opinions and thoughts of individuals within the community.

Throughout the development of the project, multiple posts were made to a variety of social media pages attempting to recruit individuals for the group. Without any incentive, this recruitment was slow. However, by the chosen date 6 individuals had agreed to attend; of which, 5 actually did.

Once everyone had arrived, the focus group commenced. It began with a short demonstration of the project, including all the device's functionalities. Then, everyone was given an opportunity to both interact with, and wear the helmet themselves; so that they may better understand the system. After that, they were asked to fill out a short questionnaire; this included demographical data and a couple short qualitative questions. Once they had completed that, a discussion was held; the group was encouraged to converse amongst themselves, guided by a variety of short, open questions from the author. These included some obvious questions, considering how such technology could impact an individual's experience whilst attending an event; and some more abstract questions, exploring the potential moral issues that could arise when utilising such technology. In total, this focus group lasted for over 2 hours.

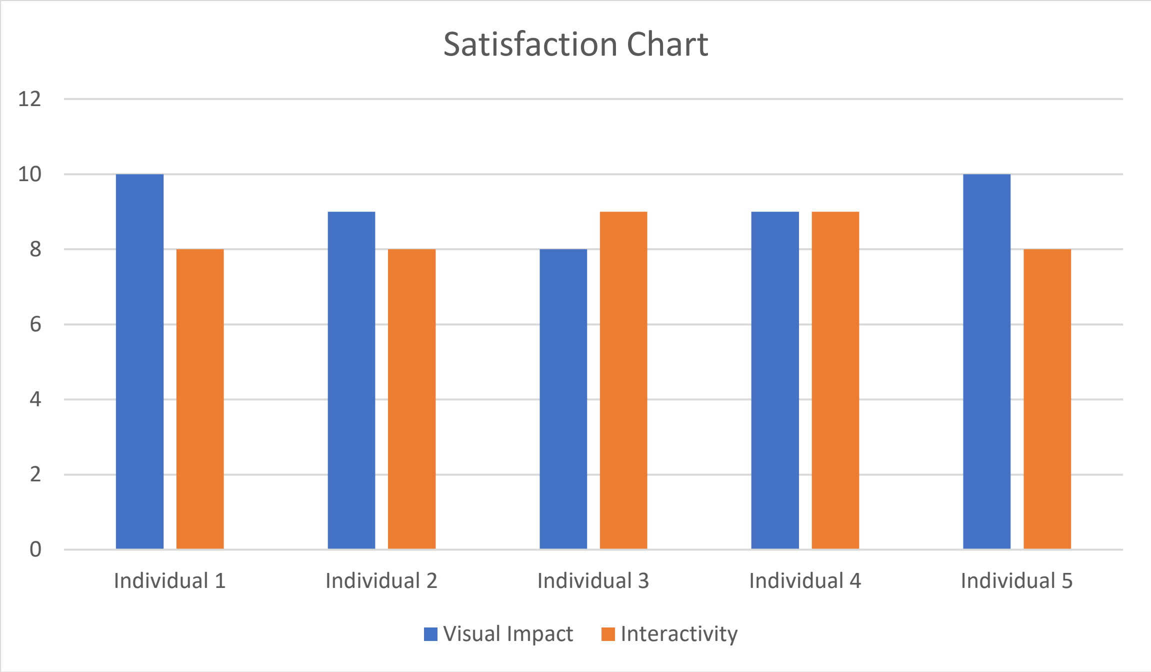

Figure 10 - Chart Illustrating Satisfaction

The chart above illustrates the individual answers provided to the questions regarding their satisfaction of both the visual impact of the helmet, and the interactivity of the system. The questions were formatted as a scale of 1 -10, with 10 being most satisfied. As such, it is evident that these individuals were clearly impressed with the project results; the lowest given mark given being an 8. However, there is room for improvement; overall, these individuals were most satisfied with the visual impact of the helmet, giving a total score of 46. Whereas the interactivity was given a score of 42; which is understandable, especially considering that the finalised system did not implement all the originally planned functionality.

Similar to the results of the questionnaire, the conversations held during the discussion were positive; everyone was very impressed with both the project in its current state, and it's future potential. Some individuals even commented on the retail value of such a device, believe there to be an unexploited market for such technology.

When considering the impact of a similar device at a public event, the individuals' thoughts and opinions were mainly focused on its ability to draw attention. Depending on the opinions of those involved, this can be either an advantage or disadvantage. If the individual wearing the device seeks attention, then it is a huge advantage; capturing the focus of most around. However, if they don't seek attention; then the drawn crowd would be an irritation, yet such an individual would be very uncommon at these events.

Comparably, such a device can also impact the experiences of those in the immediate vicinity; both in a positive or negative manner. If the individual is interested in such costumes, then it's a pleasure to view and interact with. However, there will be individuals with no interest; they will instead be hindered by the crowd that forms.

If this technology were to be utilised in cosplay competition, it was mostly agreed that such a costume would perform well; regardless of the level of competition. Smaller, local events would be overwhelmed by the visual impact, whilst larger, profession events would appreciate the complexity of the project. Also, such a system could be tailored for such an event; creating forms of interactivity that would shine onstage, allowing for a further advantage.

These individuals were then encouraged to discuss if such technology is worth implementing, considering the time, effort and costs involved. After a short conversation, the group came to the opinion that such technology enhances most of the factors involving the costume. Meaning, that not only are the benefits enhanced; i.e., the visual impact and interactivity. So are the negatives, such as the complexity and cost. Depending which costume the individual wishes to replicate, the utilisation of this technology allows for another layer of creativity to be applied. Meaning, for smaller, less complicated costumes; such technology would be unnecessary. However, for larger costumes; this technology can improve almost every aspect. Allowing for a myriad of advantages; such as increase success at competition, improved social media influence and more.

Beyond the obvious impacts of this technology, there were other, more abstract topics that were discussed. Including the affect such devices might have on those that suffer from disability. It was agreed, that if tailored, this technology could be utilised to mitigate specific disabilities; perhaps an individual who suffers from partial deafness could utilise a series of microphones scattered across a costume. However, there could be unfortunate accidents involving the unintentional interaction between the device and a disabled individual; the flickering of the LEDs on this helmet could, if erratic enough; possibly trigger an epileptic fit. Fortunately, one of the main strengths of these devises is the responsive interactivity; if such an individual expressed their discomfort, the device state could be quickly altered to accommodate their needs.

After the group had thoroughly discussed their opinions regarding the previous topic, the idea of the functionality that implemented audience participation was explained. Once they understood, they were encouraged to discuss any issues that may arise from utilising such a technology. Originally, the group did not believe that this functionality could create any significant issue. However, if the LEDs were utilised as a matrix that allowed scrolling text; then allowing open access to the public could cause trouble. They agreed that the individual wearing the device is just as liable for the content displayed, as those that wrote it. Meaning, they would be punished for any problematic content; as they facilitated the public distribution of the message.

Their opinions are supported by the event that occurred at Seattle University in June 2018. A YouTuber by the name Jammal Harraz was live streaming video footage from the classroom. He utilised a text-to-speech function that allowed individuals watching to broadcast a message of their choosing from a speaker hidden within his jacket. One such viewer decided to broadcast a fake bomb alert and subsequent countdown, which led to everyone within the room fleeing. Shortly after, the police identified and arrested Jammal off campus; he is currently facing up to 10 years in prison and a fine of $20,000 [8].

To ensure that no such situation can occur again, the group recommended limiting the choices available to the audience. This would most likely either involve a whitelist of words, a collection of pre-approved sentences and states or utilising an individual to screen and approve messages before they are displayed.

Even before the legality of the issue can be considered, the group considered and agreed that this system could only display messages and images that conformed to the events guidelines. Considering these are public events, held by private companies; they reserve the right to remove anyone from the premises. As such, care should be taken to not cause offense.

Future Work

In future, the missing functionalities should be implemented; these being both the audience participation and the ambient conditions. These will provide a deeper, more well-rounded understanding of the possible devices that could be developed in future; allowing for a better consideration and discussion of the potential impacts such technology may have on the community.

Beyond improving this specific device, other systems could be developed. These systems could involve different costumes, actuators and sensors; again, allowing for a wider understanding, perhaps even sharing a different viewpoint of the issue.

If given more time, an individual could fabricate the entire costume; by doing so, they would be able to participate in the cosplay community, either through competition or casually attending events. This would allow for collection of data, insights and opinions; producing a far more robust answer.

Conclusion

Overall, this project went well. Despite the various hinderances, the primary functionality was implemented very successfully; producing an incredibly responsive system that is visually impactful, and incredibly satisfying to utilise.

After that, the focus group was also held successfully. The individuals of the group were very impressed by the project and provided excellent insights. Many topics were considered, and multiple viewpoints were raised. The fundamental question of the project, ‘How would the implementation of IoT technology impact the cosplay community’ has received an answer.

Over the course of the discussion, they developed the opinion that IoT technology enhances cosplay. A project including such technology would be more complex, take longer to complete and be more expensive. However, it would also allow for more creativity, be more visually impactful and implement multiple forms of interactivity. Beyond the individual costume, such technology would raise the standards expected from higher quality creators; especially those that costumes that contain interactive elements.

Reflection on Learning

This entire project has been a challenge in autonomy; meaning, even from the very beginning, a sense of self-discipline was required. Initially, this was difficult to achieve; working from a personal computer meant overcoming frequent distractions. It would take a lot of willpower to chose work, instead of relaxation; especially whilst the deadlines were few and far between. To overcome such an issue, more frequent, smaller deadlines were self-imposed; these ensured that there was always a sense of urgency. This proved invaluable during the early stages of the project, ensuring that much of the foundational progress was completed quickly.

Eventually, this imposed schedule started to become rote; a sense of self-discipline was beginning to develop. By initially working at least a couple hours a day, an individual can become accustomed to the work. These couple hours were slowly extended each day, over the course of the project this practise eventually developed; until it was common to work the equivalent of a regular career. Hopefully, this self-discipline can continue to be utilised and honed in future.

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