# M1I326724-23-B Practical Computing – Group Assignment

April 2024


| Group Member | Student ID | Email |
|---|---|---|
| Mohammed Awais Yasin | S2216981 | myasin300@caledonian.ac.uk |
| Uwais Mahmood | S2215235 | umahmo301@caledo-nian.ac.uk |
| Irtaza Mahmood | S2326464 | Imahmo300@caledo-nian.ac.uk |
| Olivia Macdonald | S2376316 | omacdo200@caledo-nian.ac.uk |
| Romaisa Naeem | n/a | Rnaeem300@caledo-nian.ac.uk |

# Table of Contents

# Introduction

The team is comprised of Awais, Uwais, Irtaza and Olivia, the entire team were involved in the design and construction of the prototyped system. The purpose of the prototype is to sound a Buzzer and light up using an LED when a Loop has made contact with a Wire for a Buzz Wire Game. The system will also display the number of seconds the person playing the game has managed to play consecutively prior to contact between the Wire and the Loop, it will also log the number of times a player has touched the Wire with the Loop. The User Group for this system is the University Games Club.

The functional requirements are that the system needs to detect when the Loop and Wire touch and provide the appropriate response. The response which is required is that the LED should flash, and a buzz should be heard. Another requirement of the system is the ability of the user to connect to the internet which enables multiplayer support. Non-functional requirements include usability, performance, security, and reliability of the proposed system.

The assumptions which have been made for the current prototype is that the game is built for one-player and that it provides offline and online gaming capabilities and provides unlimited tries per player.

# Personas

Name: Rachael

Age: 19
Occupation: Psychology Student
Location: On-Campus,
Tech Literate: Moderate

Bio: Rachael is an outgoing student who enjoys being part of club activities and social events.

She looks for ways to add fun into her busy university schedule.

Core Need:
Rachael is trying to look for social events to be enjoyed with her friends, to help reduce stress. She enjoys games which are easy to play and that are entertaining.

Platforms:

Mobile, social media

Name: Mark

Age: 29
Occupation: Computer Science Student
Location: At home
Tech Literate: High

Bio: When not studying, Mark spends most of his time enjoying video games. He is always on the lookout for new exciting games which have a competitive background and can be played with and against others.

Core Needs: mark is very competitive who also enjoys coding and technology he plays games which require skills and that can be portrayed on a platform to showcase his amazing skills.

Platforms:

PC, Gaming console and online gaming websites

Name: Amy

Age:23
Occupation: Electrical Engineering Student
Location: University Accommodation
Tech Literate: Very High

Bio: Amy enjoys building and disassembling complicated electrical systems to gain a further understanding on their functionality and how to apply modifications to enhance them.

Core Needs: Amy is engineering student who enjoys researching the technology behind how different components interact. She enjoys games which can be updated and enhanced.

Platforms:

IoT Platforms

## Iterative Design Approach

The iterative design approach requires deconstruction of a large-scale project intro smaller sections which are manageable. The Buzz Wire game is a complicated system to implement, therefore using an iterative approach to deconstruct the requirements enables a focused approach. As such, the buzz wire game can be considered in various parts, including Wire/Loop and base, Buzzer and LED which activates when loop touches wire, display time before contact and display number of times contact was made.

### Understand the problem – Building wire/loop

The Wire/Loop is integral to the functionality of the system and acts as the primary interface between the gaming system and the gamer. The Wire/Loop is an extension of the circuit which acts as a switch whereby when the loop is in contact with the wire the circuit is complete which activates an LED light and buzzer. For this to work effectively, it is therefore a requirement that the Wire/Loop is constructed using a high electroconductivity material which enables the current to flow. The material is required to have a mailable but sturdy consistency which offers structural integrity to ensure that a minimal pressure is met. However, there is a clear requirement for the material to be mailable if it needs to be reshaped to reduce the chance of breakage.

The Wire/Loop needs to be connected to the circuit which enables connectivity with the Pico. Therefore, it is essential that consideration is given to the physical presentation (i.e., shape and size) of the wire, which ensures that the wire contains a suitable design enabling challenge for the players.

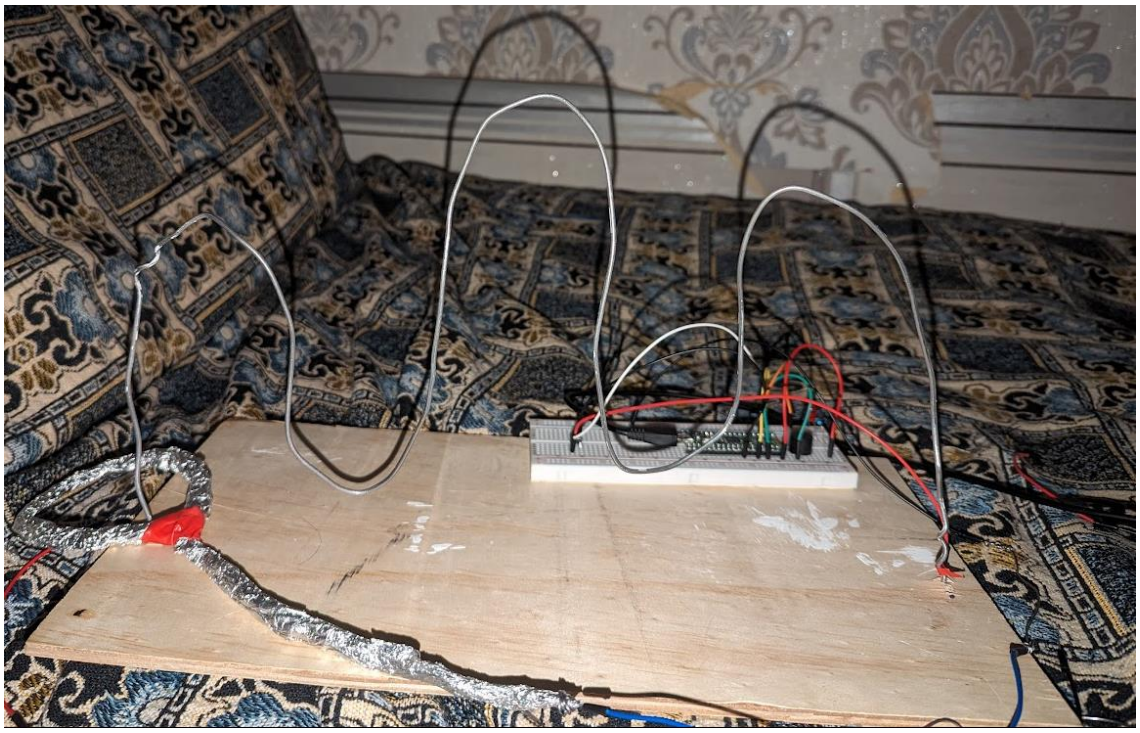
A foundation for the Wire/Loop system also needs to be constructed which will hold the circuitry. This foundation needs to be electrically insulative to prevent a bridge between start and end of wire.

### Design a solution – Wire/Loop

When considering the above analysis of the design challenges, the solution which was implemented was creating the ‘Wire’ using a metal clothes hanger, as it satisfies the composition of the material requirements including electrically conductible. The ‘Loop’ was constructed using Aluminium foil to enable ease of shaping. The circuit was connected using a jumper cable connected to the loop (when wire/loop contact is made) which in turn connects to the wire and another jumper cable then connects to the ground pin on the Pico. The design of the prototype utilises a moderate length, as to ensure that players of all abilities can engage with the game. The foundation is created from wood due to its availability and has electrical insulative properties.

The Wire/Loop can be considered as a long switch, as it can be in two differing states. Firstly, a state whereby the wire/loop are making contact – this can be considered as the ‘switch’ being in a closed position, where the current can flow, and the circuit is complete. Alternatively, a second state of inversion, whereby the Wire/Loop are not in contact and therefore, the ‘switch’ can be considered as an open circuit. Programming this will require the jumper cable which connects the Pico to the Wire/Loop to be defined as an input pin and a variable needs to be assigned to it which would enable the reading of value of the Wire/Loop (i.e. when circuit is closed pin.value() == 0, allowing current to flow or 1 when the circuit is open).

## Build a solution – Wire/Loop



## Test the solution – Wire/Loop

Test 1 – Manoeuvrability

Description – This test assesses the manoeuvrability of the loop around the wire infrastructure to ensure that it can move along the shape and maintain its shape.

Steps –

- Navigate the Loop from start to finish.

Expected outcome – Loop successfully navigates wire.

Actual outcome – Loop successfully navigates wire.

Pass/Fail – Pass.

Test 2 – Durability

Description – This test assesses prototype durability, ensuring the prototype is durable.

Steps -

- Pick up wire/loop + foundation
- Raise wire/loop + foundation to a height of 1m

- Drop wire/loop + foundation onto floor

Expected outcome – It does not break.

Actual outcome – It did not break.

Pass/Fail – Pass

Test 3 – Read value

Description – This test assesses if the Pico can read a change in value when wire/loop make contact.

Steps -

- Make contact with wire/loop
- print(pin.value())
- Separate wire/loop
- print(pin.value())

Expected outcome –

- when wire/loop contact pin.value() == 0
- when wire/loop separate pin.value() == 1

Actual outcome –

- when wire/loop contact pin.value() == 0
- when wire/loop separate pin.value() == 1

Pass/Fail – Pass

### Understand the problem – LED/buzzer activate

The Games Club highlighted that the functionality of the LED and buzzer for contact is imperative. This problem can be divided into two types, software and hardware. The hardware challenge is to connect the LED/Buzzer to the Wire/Loop so that one affects the other. The other consideration is regarding how to limit the current which goes through the LED as it needs a resistor, however as the circuit includes the Buzzer this will have performance implications as the buzzer will produce reduced noise.

## Design a solution – LED/Buzzer activate

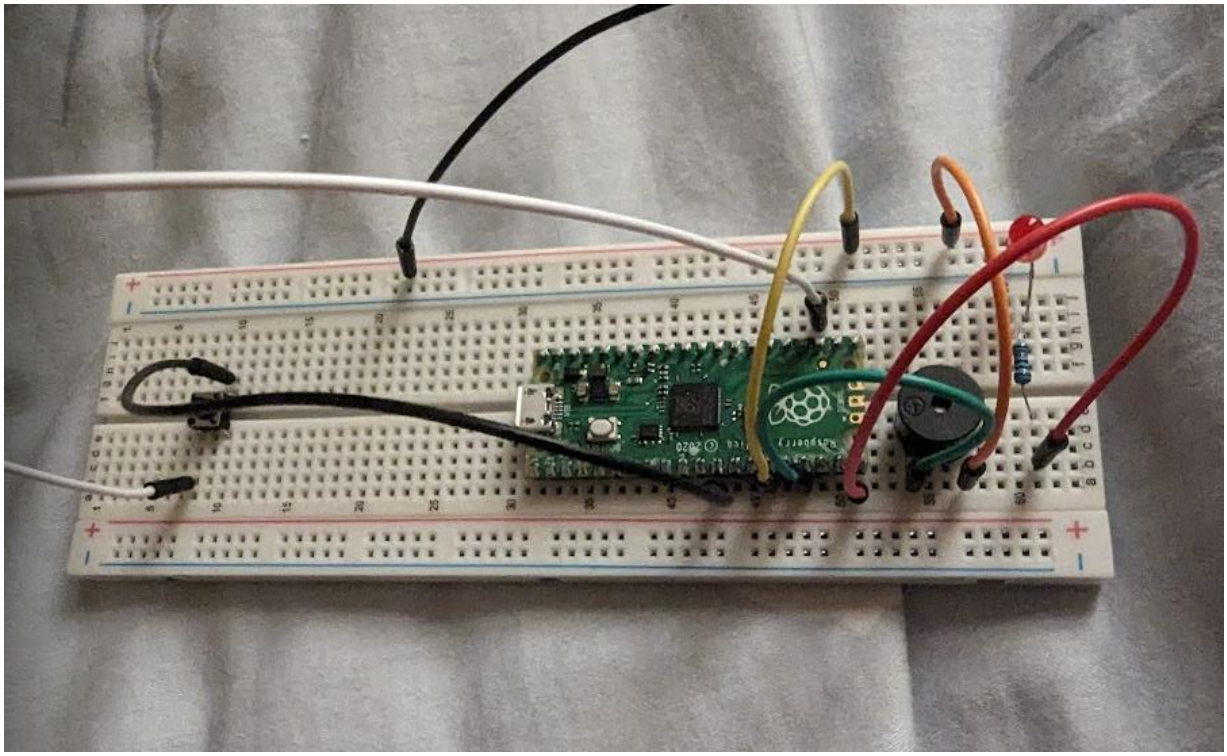
In connecting the LED/Buzzer to the Wire/Loop by connecting the resistor/LED and Piezo to the GPIO pins on the Raspberry Pico and assigning them a variable (Led and Buzzer, respectively), then using jumper cables the components can be connected to a power rail which will then, in turn, connect to the Loop using a jumper cable. This means that when the circuit is closed, the current flows from GPIO pins > jumper cables > components > jumper cables > jumper cable > loop > Wire > GND. The programming for this would require, the

LED/piezo to activate when the circuit is closed. This can be achieved using the conditional statement:

```
if wire_loop.value() == 0:
        led.value() = 1
        buzzer.value == 1
else:
        led.value() = 0
        buzzer.value = 0
```

To solve the problem of resistance limiting Buzzer sound the piezo can be connected in parallel. This is because the resistance in branch 1 (resistor/LED) doesn't affect branch 2 (piezo) which means that the sound output from the piezo will not be affected.

## Build a solution



Test the solution –

Test 1 – LED/Buzzer activate

Description – This test assesses if contact between Wire/Loop activates LED/Buzzer

Steps -

Make contact with wire/loop

- print(led.value())
- print(buzzer.value())

Separate wire/loop

- print(led.value())
- print(buzzer.value)

Expected outcome –

- When wire_loop.value() == 0:
- led.value() == 1
- buzzer.value() == 1

- When wire_loop.value() == 1
- led.value() == 0
- buzzer.value() == 0

Actual outcome –

- When wire_loop.value() == 0:
- led.value() == 1
- buzzer.value() == 1

- When wire_loop.value() == 1
- led.value() == 0
- buzzer.value() == 0

## Understanding the problem – Display time lasted before contact

This problem can be divided into two smaller problems, calculate the time lasted before contact and print time lasted before contact.

## Design a solution – Display time lasted before contact

In calculating the time 'lasted', the time library will be utalised. This library will be used for time-based functions in the programme. A timer will begin when the game starts, this will be completed using the time.ticks_ms function. This timer runs in milliseconds from when it is first called so it can be used to assign a variable (Start_Time). A conditional statement defined previously, calling the time.ticks_ms again to start a timer when the circuit closes. Then time.ticks_diff (End_Time, Start_Time) can be used to calculate the difference in time in milliseconds. To display this time, the print statement can be used:

print("You lasted " + (time_lasted / 1000), " seconds"

The time 'lasted' is divided by 1000 to convert it to seconds.

## Build a solution – Display time lasted.

```
def time_lasted():
    '''Prints time lasted before contact'''
    # Starts a timer when wire/loop contact
    end_time = time.ticks_ms()
    # Time lasted is calcuated using the difference between start of game and wire/loop contact
    time_lasted = time.ticks_diff(end_time , start_time)
    # Time lasted is printed
    print("You lasted", (time_lasted / 1000), "seconds")
```

## Test the solution – Display time lasted

Test 1 – Display time lasted.

Description – displays time lasted when wire/loop make contact

Steps:

- Start Game.
- Wait 5 seconds.
- Contact wire/loop.

Expected outcome:

- You lasted 5.000 seconds.

Actual outcome:

- You lasted 5 seconds.

Actual outcome:

- You lasted 5.179 seconds.

Actual outcome:

- You lasted 5 seconds.

## Understanding the problem – Display how many times contact was made

This problem can be divided into two smaller problems, firstly, to count how many times Wire/Loop contact was made, and, Display how many times Wire/Loop contact was made.

## Design a solution:

To count how many times Wire/Loop contact was made a line can be added to increment counter when Wire/Loop made contact to the conditional statement from before. To prevent time_lasted from repeatedly being displayed the loop can be broken after time_lasted is displayed once and create a similar conditional statement this time without displaying time lasted. To prevent times_contact from incrementing multiple times from one Wire/Loop contact, time.sleep_ms can be used to simulate a 1 second delay after each contact. To prevent times_contact from repeatedly displaying a implement a button with an IRQ that will run a function to end game and display number of times contact was made.

## Build a solution

```
# Function to handle game end
def game_end(pin):
    '''Prints number times wire/loop contact, thank you message and then exits programme'''
    # Access global variable
    global times_contact
    print("The loop made contact " + str(times_contact) + " time(s)")
    print("Thanks for Playing")
    sys.exit()
```

**Test the solution**

Test 1 – display number of times contact was made.

Description – display number of times contact was made.

Steps:

- Start game.
- Contact wire with loop.
- Separate wire/loop.
- Contact wire/loop.
- Press button.

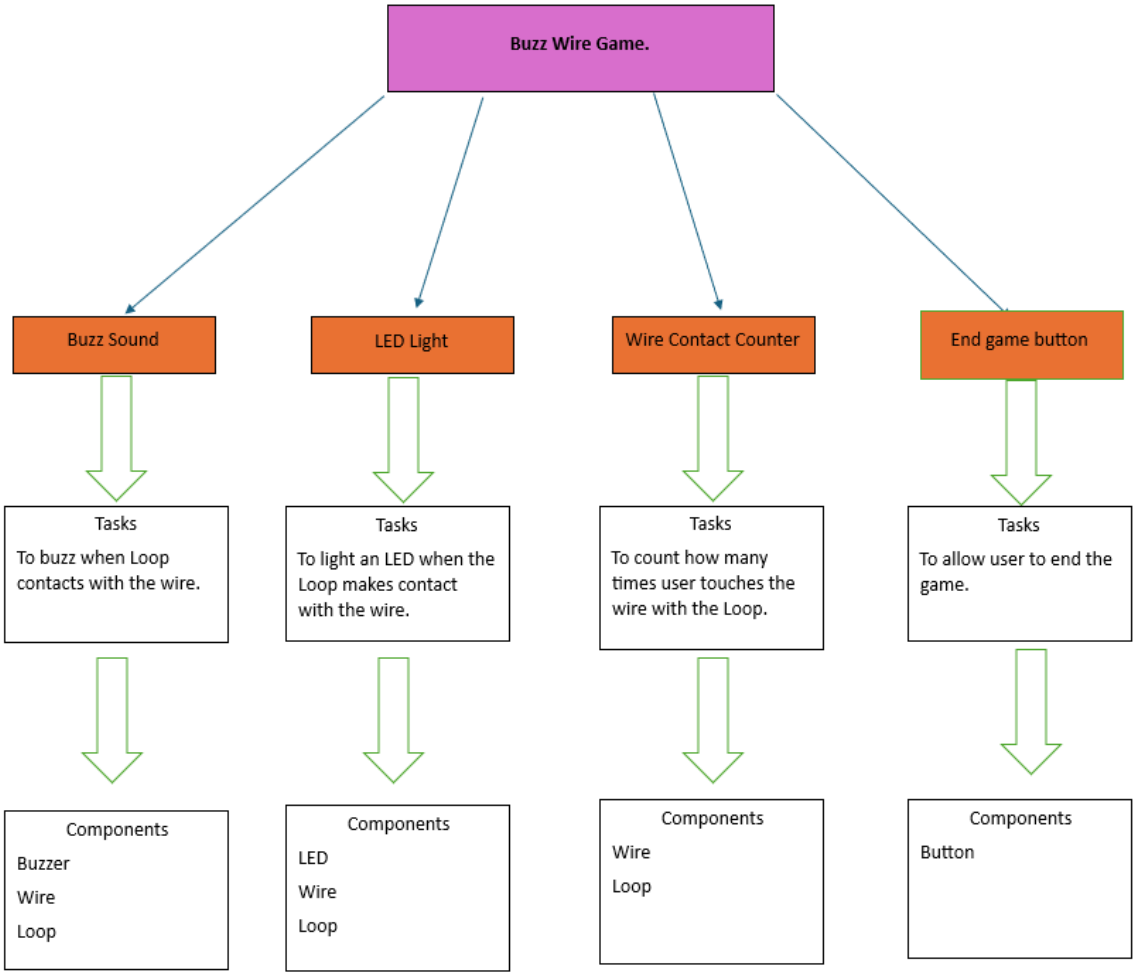
Expected outcome:

- Wire/Loop made contact twice.

Actual outcome:

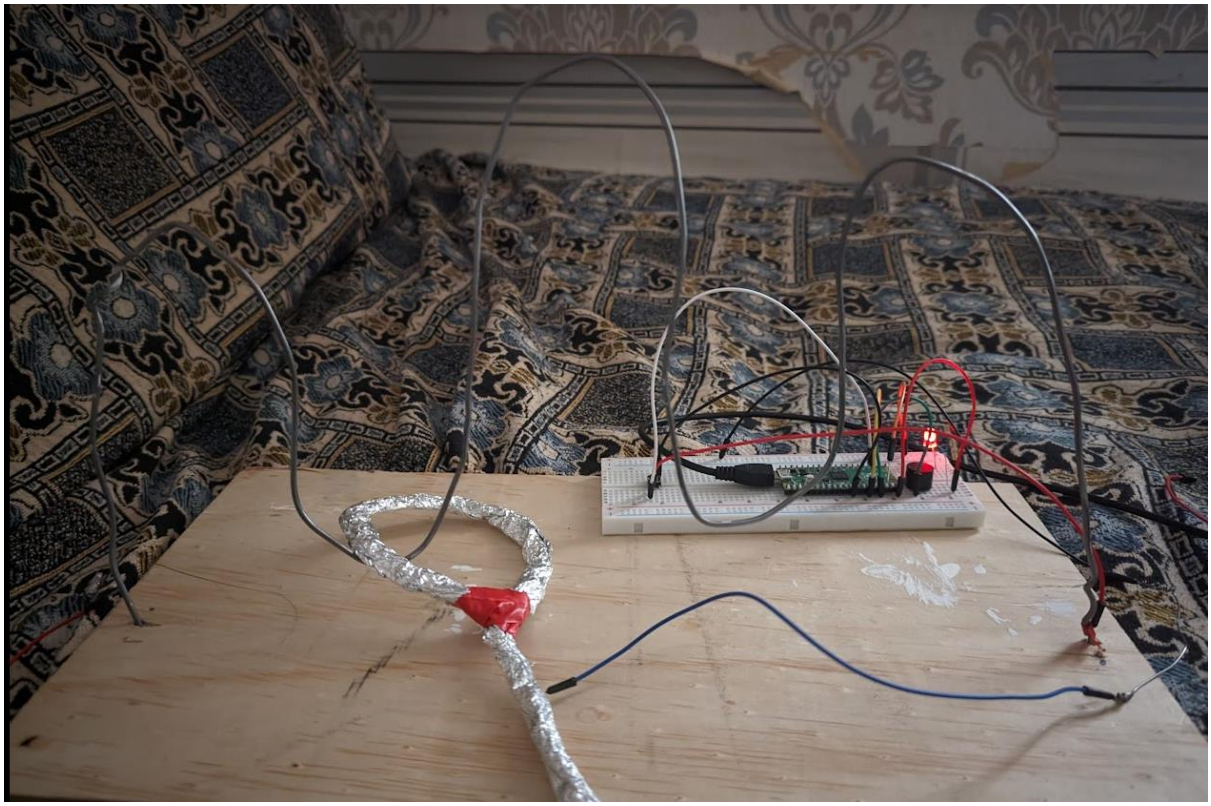
- Wire/Loop made contact twice.

## Box Diagram


Buzz Wire Game.
Buzz Sound
LED Light
Wire Contact Counter
End game button
Tasks
To buzz when Loop contacts with the wire.
Tasks
To light an LED when the Loop makes contact with the wire.
Tasks
To count how many times user touches the wire with the Loop.
Tasks
To allow user to end the game.
Components
Buzzer
Wire
Loop
Components
LED
Wire
Loop
Components
Wire
Loop
Components
Button

## Prototype Produced

Prototype of light LED



Code to make LED light

```
    # Checks for wire/loop contact
    if wire_loop.value() == 0:
        # wire/loop contact so LED and buzzer value set to 1
        led.value(1)
        buzzer.value(1)
        # Increments contact counter
        times_contact += 1
        # Starts another timer
        time_lasted()
        break
    # Turn off LED when wire is released
    led.value(0)
    # Turn off buzzer when wire is released
    buzzer.value(0)
```

## MicroPython Code

```
# Import necessary modules
from machine import Pin
import time
import sys


# Function to handle game end
def game_end(pin):
'''Prints number times wire/loop contact, thank you message and then
exits programme'''
    # Access global variable
    global times_contact
    print("The loop made contact " + str(times_contact) + "
time(s)")
    print("Thanks for Playing")
# Exits programme
    sys.exit()


def time_lasted():
    '''Prints time lasted before contact'''
# Starts a timer when wire/loop contact
    end_time = time.ticks_ms()
# Time lasted is calcuated using the difference between start of
game and wire/loop contact
    time_lasted = time.ticks_diff(end_time, start_time)
# Time lasted is printed
    print("You lasted", (time_lasted / 1000), "seconds")
```

```
# Assigns a variable to components defining GPIO pin and type
led = Pin(15, Pin.OUT)
buzzer = Pin(13, Pin.OUT)
wire_loop = Pin(11, Pin.IN, Pin.PULL_UP)
button = Pin(9, Pin.IN, Pin.PULL_UP)

# Initialise variable to count number of wire/loop contacts
times_contact = 0

# Welcome message
print("Welcome to the Buzz Wire Game")

# Start
print("Start!")

# Starts timer
start_time = time.ticks_ms()

# Initialise loop
while __name__ == "__main__":
    # Checks for wire/loop contact
    if wire_loop.value() == 0:
        # wire/loop contact so LED and buzzer activate
        led.value(1)
        buzzer.value(1)
        # Increments contact counter
        times_contact += 1
       # Calls function to calculate time lasted before contact
        time_lasted()
        break
   # Doesn't turn on LED/Buzzer when wire/loop aren't making contact
    led.value(0)
    buzzer.value(0)
```

```
# Initialises loop
while __name__ == "__main__":
# Checks for wire/loop contact
    if wire_loop.value() == 0:
    # wire/loop contact so LED/Buzzer activate
        led.value(1)
        buzzer.value(1)
        times_contact += 1
    # wire/loop doesn't make contact so LED/Buzzer deactivate
    else:
        led.value(0)
        buzzer.value(0)
   # function used to simulate 1s delay to prevent multiple regis-
ters from one contact
    time.sleep_ms(1000)
    # Interrupt request triggered by button press ending game
    button.irq(trigger=Pin.IRQ_RISING, handler=game_end)
```

## Test Plan and Test Data

Table A – Test plan and Test data

| Test Case ID | Test Case Objective | Steps | Input data | Expected output | Actual Output | Status Pass/Fail |
|---|---|---|---|---|---|---|
| 001 | Ensure LED lights when wire/loop contact | Start game<br>Contact wire/loop<br>Observe LED | wire/loop contact | LED lights | LED lights | Pass |
| 002 | Ensure Buzzer activates when wire/loop contact | Start game<br>Contact wire/loop<br>Observe buzzer | Wire/loop contact | Buzzer activates | Buzzer activates | Pass |
| 003 | Ensure time lasted displays | Start Game<br>Contact wire/loop<br>Observe time lasted message | Wire/loop | "You lasted 2 seconds" | "You lasted 1.803 seconds" | Pass |
| 004 | Ensure number of times wire/loop contact display | Start game<br>Contact wire/loop<br>Separate wire/loop<br>Contact wire/loop<br>Press button | Button press<br>Wire/loop contact | "The loop made contact 2 times" | "The loop made contact 2 times" | Pass |

## Proposed Communication Technologies

The next phase of the development and planning for The University Games Club, is to consider how best to implement the prototype for multiplayer accessibility and functionality. Through employing one of the ranges of network technologies, it will be possible to elevate the gaming experience and provide the game to a larger audience (Putzke et al. 2010). This short section will introduce a variety of networking solutions which may be suitable for the protype before recommending one which will offer the Club versatility in both optimisation of the game and ease of user engagement.

Wi-Fi technology utilises frequency bands to transmit data wirelessly, either on a 2.4GHz band which is optimal for widespread coverage and is commonly used within households and 5GHz which has a smaller geographic area but transmits the data at a higher frequency with fewer incidences of interference. These bandwidths are moderated and governed by the IEEE 802.11 standard (IEEE SA, 2023). Wi-Fi technology is flexible and adaptable to a wide range of scenarios and in turn can offer a seamless communication between devices, fostering an immersive multiplayer gaming experience. As wireless networks can provide bandwidth for multiple devices it can host multiple gamers seeking to play real-time competitions within a gaming venue (Sadhasivam et al. 2017).

Wi-Fi technology has standards outlined by the IEEE which governs the performance of the network. As a consequence of this, it offers a very reliable industry standard level of performance which is pivotal for the functionality for the Buzz Wire Prototype. However, in eluding to the full picture, there is a possibility that the reliability offered by wi-fi technology could be damaged by interference from wireless devices in the locality to the game. To address this risk, careful consideration of signal strength and channel allocation is necessary. Although Wi-Fi technology is the preferred methodology, it is important for the Games Club members to consider what security protocols they may use to ensure network integrity and safeguard player information (Juhász et al. 2019). Through mitigating signal disturbances and ensuring player security for their data in-line with GDPR regulations, Wi-Fi offers the club a seamless gaming option which fosters innovation and gamer immersion (Mohammed et al. 2024).

In considering other options for the Games Club, Bluetooth technology, renowned for its low-power consumption and short-range communication capabilities, emerges as an intriguing option. It operates within a 2.4 GHz frequency band like the Wi-Fi alternative. Bluetooth uses pairing and bonding processes to establish a secure connection between devices. Zeadally and colleagues (2019) considers Bluetooth as a favourable communication technology due to the integrity of the local device connectivity limiting the opportunities for data breaches. Bluetooth also operates at a lower power threshold making it a favourable option for many battery powered devices (Zeadally et al. 2019), however the current protype design for the buzz wire game utilises a USB charging system.

While Bluetooth does offer these distinct benefits, it is important to consider the limitations in line with the Game Club's desires for the prototype. As Bluetooth has a limited range,

players would be limited in their ability to move around during game play. Additionally, during busier periods or within more congested areas there may be disturbances to the signal and thus create difficulties with data transfer, hindering the ability for real-time gaming (Fidelis and Gbenga 2019). Ultimately, due to the limitations of Bluetooth technology, it is unlikely that it would be a suitable alternative to Wi-Fi technology.

The Game Club could also consider using ethernet technology for the protype. It offers reliability and high-speed wired connectivity which would enhance user experience. Ethernet technology is governed under the IEEE 802.3 standard (IEEE SA 2022). Ethernet facilitates the transmission of data within a local area network (LAN) which enhances the connection to being robust and reduces the levels of latency.
Much akin to the limitations of Bluetooth, ethernet connectivity would be challenging to implement within the prototype due to the hardwiring elements which are sizeable which may cause difficulties with the infrastructure of the game and the requirement for cable instalment within the gaming physical venue which would bring an element of time constraints (Aweya et al. 2008). Despite these challenges posed by the physical interface difficulties with incorporating an ethernet structure, the game would secure higher levels of reliability and low levels of latency (Aweya, et al. 2008).

As a final option, the Games Club could consider implementing a cloud networking approach which would offer centralised storing of records which would adhere to GDPR regulations, processing and networking through cloud services. However, a common complaint with cloud network for gaming is that it can have issues with latency and reliability. There may be cost implications for the Games Club for this option if they were to utilise a wide range of network solutions which may increase the cost of developing the prototype.

## Our recommendation to the Games Club

As is made evident across the prior information, it appears that deploying a Wi-Fi based communication technology would provide the Games Club with versatility and reliability without the requirement of undergoing structural changes for ethernet, location-based challenges with Bluetooth or facing latency from cloud alternatives.
As Wi-Fi technology is governed by the IEEE standards, it is mandated to provide a reliable and compatible service structure which would make it indispensable for the functionality of the buzz wire prototype. In utilising a risk adverse culture, the Games Club can mitigate for any potential difficulties posed using Wi-Fi technology through considering possible interference and GDPR conditions for user information.

To conclude, communication technology is integral in enhancing the Game Club's Buzz Wire game prototype. By considering Wi-Fi, Bluetooth, Ethernet and internet cloud services, it has been possible to identify that Wi-Fi offers the best match for the requirements of the Club. It may be possible that in future the Club may wish to consider employing a Network Cloud solution to increase scalability of the game.

## Internet of Things: Security Issues

Today, IoT integration is more and more profound, and thus, building a secure environment is the key for protecting the confidential data and resisting possible cyber offenses. Regarding the buzz wire game prototype of the University Games Club, hereinafter we concentrate on the relation between the Internet of Things and security. We intend to define IoT security, provide an insight into its importance in modern-day technology, detail the significant security challenges of the project, suggest solutions which will help to cope with the challenges, and provide instructions on the procedures which ensure IoT security.

Internet of things (IoT) is a collection of interconnected objects, services, people, and devices that can communicate, share data, and information to achieve common goals in different areas and applications. IoT can be implemented in many different domains including transportation, agriculture, healthcare, energy production and distribution, and many other areas that require things to communicate over the Internet to perform business tasks intelligently without human involvement. Devices participating in IoT typically follow an Identity Management (IM) approach to be identified. in a collection of similar and heterogeneous devices. (Mahmoud et al., 2015). This implies that you should verify and encrypt devices, apply user access control, and implement security protocols on the network to reduce the vulnerability and threats. In the case of the buzz wire game prototype, maintaining the IoT security level is vital to prevent privacy data leaks and to be sure that information is confidential. The fact that unauthorized access to player information may result in privacy infringements, identity theft, or misuse of personal information is a real threat. In addition, IoT security contributes to customer trust and confidence in this technology, making it easy for it to receive the attention it deserves and eventually be implemented. The buzz wire game prototype is advancing with the IoT-related security threats being a key issue. It is defined that a computer virus is a type of malware. Malware includes computer viruses, worms, Trojan horses, spyware, and ransomware. There is a high probability that IoT systems can get infected with a more sophisticated form of malware and high-frequency electromagnetic waves. (Aqeel et al.) Finally, insecure network protocols without encryption are liable to such attacks as interception of data and its manipulation by malicious actors. To mitigate these challenges, which are several in number, the following strategies should be employed. The newer devices of the firmware and security patches improve the devices resistance against cyber threats. Implementing strong encryption protocols helps secure data transmission between IoT devices and backend systems. End-to-end encryption ensures that data remains confidential, even if intercepted during transit (Saluja). Implementing robust access control measures, such as multi-factor authentication and role-based access control, prevents unauthorized users from gaining entry to IoT systems (Saluja). The requirement of a multi-layered strategy is obvious for IoT security to be effective. The measures should be applied which cover, among other things, both physical and electronic security controls, including such as firewalls, IDS, and network segmentation. Moreover, informed users on security practices, cooperation with producers to put in place security measures at the product lifecycle, and ongoing tracking of devices and network traffic are the critical steps.

IoT security can be described as a set of methods and tools that are used to secure devices which are connected to the Internet, networks, and data from any illegal use body snatching, modification and making unauthorized changes. This involves validation of devices and data encryption, applying user access cabinet, and using security protocols on the entire network to reduce risks and threats. It is critical to IoT security in the context of the buzz wire game prototype; it will be the secret keeper for the data of users and confidentiality of the whole system. Using private information of gamers without permission can cause various problems such as violation of privacy, identity theft or misuse of the personal data. Also, IoT security that builds consumer trust and faith makes it wider spread and easier to fail in. The physical security of Buzz wire game which interacts with the Internet of Things (IoT) has challenges that are inherent to the system designs. Vulnerabilities, including low-power processing chips, limited memory size, and obsolete firmware, can give hackers a loophole which they can use in unauthorized access and manipulation of devices. Moreover, insecure protocol failure to use encryption allow interception and malicious manipulation of the data by criminal mind. To reduce the challenges above, measures such as the ones below among others can be developed. It's important for IT professionals to recognize the role of regular patching and updates in IoT security. Like any other devices, IoT devices use software to complete their various functions, and that software needs to be regularly updated to prevent attackers from exploiting known vulnerabilities. Many of the applications that are available are built on open-source software, which means that attackers could be studying how to infiltrate your network long before they make the attempt. So, if there are any known vulnerabilities, it's a good idea to patch them as soon as possible, especially those labelled critical or high-risk (ballejos).

In summary, IoT security needs to be ensured for avoiding any potential risks and threats. For instance, the University Games Club project buzz wire game prototype must be implemented such a way to avoid any possible risks and threats. Through gaining an overall understanding of the meanings, key topics, issues, and correct practices of IoT security, all the stakeholders can skilfully mitigate the risks, preserve the sensitive data, and take security measures. Following all the best security practices and being always the ones on guard against security issues can play a big part in eliminating risks and weaknesses, and therefore help increase the level of trust, confidence and improvements in IoT technology.

## Prototype Evaluation

Critical discussion of the prototype developed and an explanation of how it can be improved/extended.

The current design of the prototype was formed into a shape which enabled ease of creation and a level which would allow players of all abilities to engage with the design. As the base shape is a rectangular piece of wood, the buzz-wire design was shaped to maximise the space which could be utilised for the gameplay. To further enhance the experience, it would be possible for the Games Club to create prototypes or games which vary in difficulty based on different shapes, for example incorporating harsh bends like that which would present in shaping similar to a 'Z'.

The use of LED's is currently incorporated into the design this visually enables players and spectators to view when a player touches the wiring with the wand while playing in real-time. Accompanying this, is a buzz sound effect which alerts when the wire has been touched with the wand. It would be possible to further add to this music in the background while the game was active which may make it more engaging.

The circuit was implemented using a combination of series and parallel wiring, whereby the components were either connected sequentially or in "branches" when needed, such as when connecting LED/resistors and buzzers to prevent the resistance from resistors on affecting buzzer volume. To increase the aesthetical value of the design, it would be possible to connect the components using fewer jumper cables which would give the appearance of a less cluttered design.

Another possible avenue for the Games Club to consider in terms of enhancements to the prototype would be to implement a timer and scoring system. By adding a timer to the game this could enhance the competitive nature of the game and this in turn could be used to form the basis of a scoring system where the duration of the session and number of times a gamer has touched the wand to the buzz wire.

As the game is being developed by a university games club, it may be an option to consider whether the game could be used by the computing department as an educational tool. In this instance, the Club may need to add more educational elements, like questions embedded into the media system where the music may stop and players need to answer a question relating to coding or gaming before being able to progress to a next level.

By considering the current design and functionality and possible enhancements to the Raspberry Pi buzz wire protype it is possible to enhance the options which are available to gamers who engage with the game of all levels and abilities.

References:


Aweya, J., Montuno, D., and Ouellette, M. (2008). Limitations of current Ethernet switch architectures for enhanced flow and service differentiation. International Journal of Network Management, 19(3). Available: https://doi.org/10.1002/nem.690 [Accessed 12/4/2024].

Fidelis, O., and Gbenga, A. (2019). Bluetooth Technology: Overview and Applications. *South Eastern Journal of Research and Sustainable Development, 1.* Availaible: https://sejrsd.org.ng/index.php/SEJRSD/article/view/2/2 [Accessed 12/4/2024].

IEEE SA. (2023). The Evolution of Wi-Fi Technology and Standards. *Beyond Standards*. Available: https://standards.ieee.org/beyond-standards/the-evolution-of-wi-fi-technology-and-standards/ [Accessed 10/4/2023].

IEEE SA. (2022). IEEE Standard for Ethernet. *IEEE SA: Active Standards.* Available: https://standards.ieee.org/ieee/802.3/10422/ [Accessed: 12/4/2024].

Juhász, K., Póser, V., Kozlovszky, M., and Bánáti, A. (2019) WIFI vulnerability caused by SSID forgery in the IEEE 802.11 protocol. *IEEE 17th World Symposium on Applied Machine Intelligence and Informatics (SAMI).* Available: https://doi.org/10.1109/SAMI.2019.8782775. [Accessed: 11/4/2024].

Mohammed, S. Y., Aljanabi, M., Gadekallu, T. R. (2024). Navigating the Nexus: A Systematic review of the symbiotic relationship between the metaverse and gaming. *International Journal of Cognitive Computing in Engineering, 5.* Available: https://doi.org/10.1016/j.ijcce.2024.02.001 [Accessed: 11/4/2024].

Putzke, J., Fischbach, K., Schoder, D., and Gloor, P. A. (2010). The Evolution of Interaction Networks in Massively Multiplayer Online Games. *Journal of the Association for Information Services, 11(2).* Available: https://doi.org/10.17705/1jais.00221 [Accessed: 10/4/2024].

Sadhasivam, J., Kubendiran, M., Tomy, P., Jeyakumar, B., Kumar, S., and Anusha, R. (2017). Reviewing of Gaming and Its Evolution Over Networks. International Journal of Civil Engineering and Technology, 8(11). Available: https://iaeme.com/MasterAdmin/Journal_uploads/IJCIET/VOLUME_8_ISSUE_11/IJCIET_08_11_007.pdf [Accessed: 11/4/2024].

Zeadally, S., Siddiqui, F., and Baig, Z. (2019). 25 Years of Bluetooth Technology. *Future Internet 11(9).* Available: https://doi.org/10.3390/fi11090194 [Accessed: 11/4/2024].

Mahmoud, R., Yousuf, T., Aloul, F. and Zualkernan, I. (2015). *Internet of things (IoT) security: Current status, challenges and prospective measures*. [online] IEEE Xplore. doi:https://doi.org/10.1109/ICITST.2015.7412116.

Aqeel, Muhammad, et al. “A Review of Security and Privacy Concerns in the Internet of Things (IoT).” *Journal of Sensors*, vol. 2022, 29 Sept. 2022, pp. 1–20, https://doi.org/10.1155/2022/5724168. Accessed 8 Dec. 2022.

Saluja, Nayan. “Safeguarding the Internet of Things: Addressing Security Challenges and Solutions.” *Www.linkedin.com*, 21 Mar. 2024, www.linkedin.com/pulse/safeguarding-internet-things-addressing-security-solutions-saluja-raqec#:~:text=Understanding%20and%20addressing%20IoT%20security. Accessed 19 Apr. 2024.

ballejos, Lauren. “How to Secure IoT Devices: 5 Best Practices | NinjaOne.” *Www.ninjaone.com*, 18 Mar. 2024, www.ninjaone.com/blog/how-to-secure-iot-devices-5-best-practices/#:~:text=Implementing%20IoT%20device%20security%20best%20practices&text=Implement%20data%20protection%20strategies%2C%20including. Accessed 19 Apr. 2024.