DIGITAL DICE & DATABASE

CREATED AND PRESENTED BY

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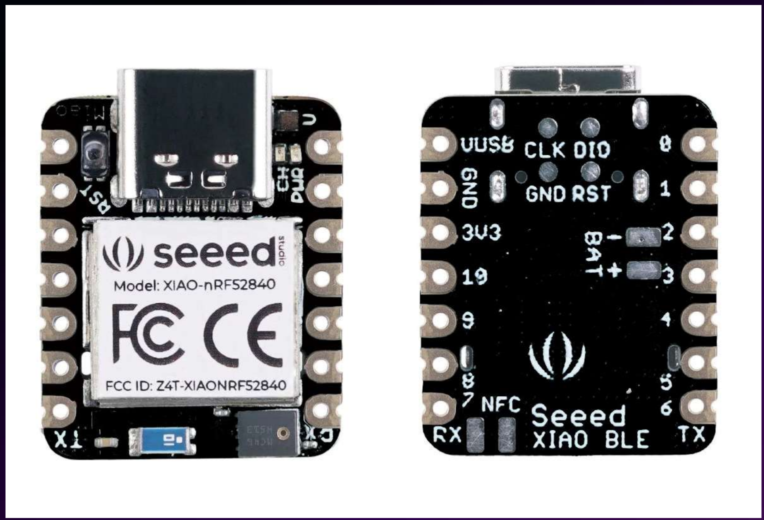
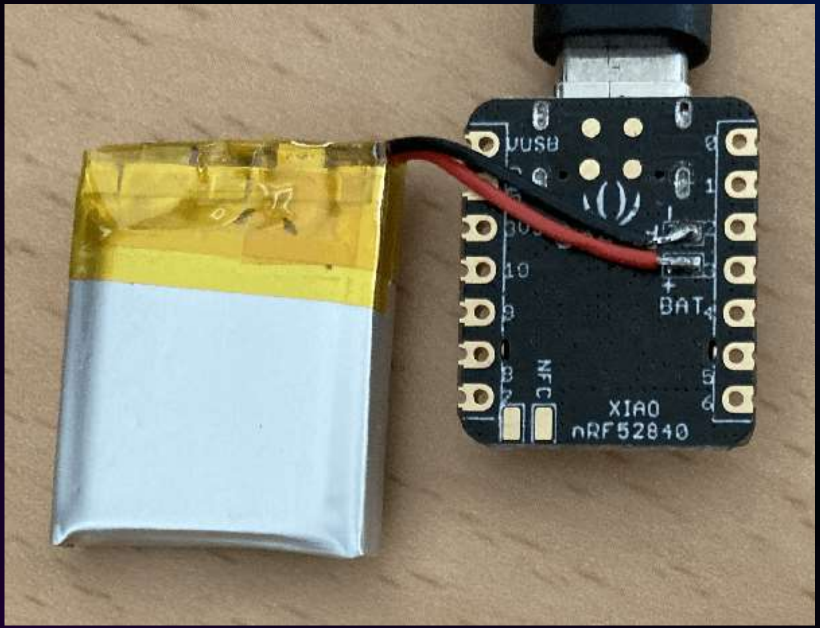
INTRODUCTION AND OBJECTIVE OF DIGITAL DICE

- We began this project with the goal of using our microprocessor and microcontroller to roll a dice and receive the output.
- The idea was to use a microprocessor with an IMU. An IMU is an inertial measurement unit, and typically consists of a gyroscope as well. This would allow us to roll the dice, and if the microprocessor was contained stably inside, receive the output it landed on.
- We also wanted the microprocessor to be small so that we could create a relatively realistic dice, and we would need a battery as well so it could actually be rolled. We decided on the Seeed XIAO BLE Sense nRF52840



SEEED XIAO BLE SENSE NRF52840

- The Seeed XIAO BLE Sense nRF52840 was the perfect candidate for our dice.
- At 21 x 17.5 mm or 13/16 x 11/16 inches, we could theoretically make a dice only 2 mm larger than a real dice, if we found a battery around the same size.
- Considering the goal of our project, our project began with soldering a battery, and designing a 3D printable dice.

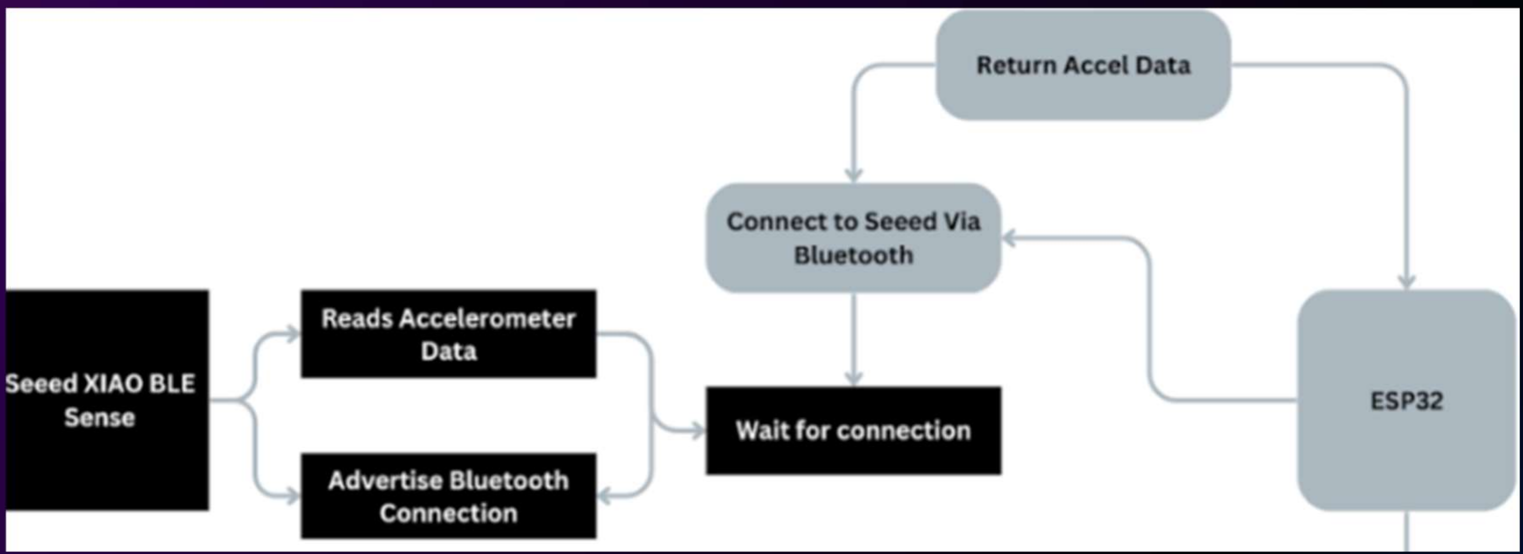


FIRST DICE MODEL

After getting our battery soldered to the micro-processor, we began designing our 3D printed dice. Due to a lack of experience in 3D printing, our first model was much bigger than expected.

- Due to the size of our dice, and the small size of our board & battery. We had to use stuffing to keep the board in place for rolling purposes.
- We decided to put off designing a smaller dice for the meantime and began to focus on establishing connection with our microcontroller, the ESP32.
- This would be done utilizing Bluetooth which the Seeed XIAO BLE is capable of while utilizing low energy.
- BLE - Bluetooth Low Energy

SEEED XIAO BLE SENSE -> ESP 32



- We were quickly able to get our IMU processing accelerometer data and returning dice side depending on position/rotation of the microprocessor.
- We began by trying to establish a connection with the ESP32 being the server, while the Seeed was the client.
- This allowed us to concatenate and transmit the accelerometer data to the ESP32 and allow it to do the heavy lifting such as calculating dice side. This also later allowed for much easier manipulation of how dice side is calculated.

ESTABLISHING AND CONNECTING TO A DATABASE

- Using the professor's suggestion, we used InfluxDB to store and receive our data. This was a process as while some teammates had experience transferring data via HTTP, others did not but we all wanted to learn.
- So, we decided to do our projects in two different steps.
- First, we had our data transmit over Wi-Fi to InfluxDB from the ESP32, and then from InfluxDB to Python by creating a read script that connects to the same bucket.
- We then altered the script so instead of printing the data it receives, it writes it to a CSV for storage so that we can access it at any time. As well as perform a wider range of statistics and analysis than InfluxDB allows us to do.

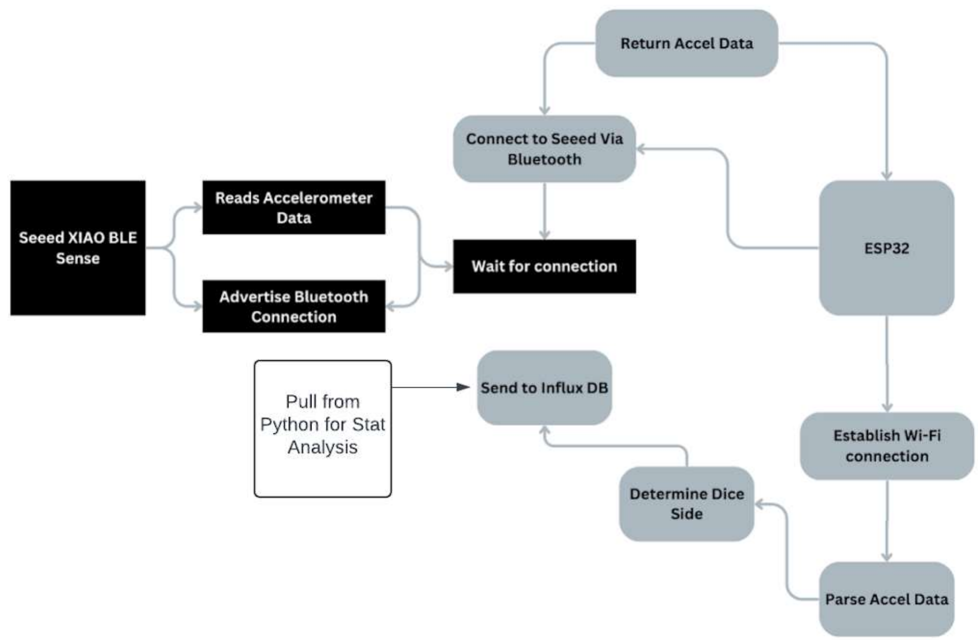
- This can be a lot to grasp so to re-iterate over our basic architecture, our Seeed XIAO BLE Sense microprocessor collects accelerometer data, concatenates the 3 axis's of data, and transmits it via Bluetooth to our ESP32. Our ESP32 determines the dice side as it receives the data and transmits this value to our bucket in InfluxDB. The Python script then reads from this bucket without allowing duplicates and writes it to a CSV with the time. We then have a script that reads this CSV for plotting and analysis.

FINAL IMPROVEMENTS

- We did make some final improvements to our project before considering it finished.
- We implemented a method to only send data WHEN a roll is done, as previously it would send that dice side repeatedly.
- We re-created our dice to a minimal size while incorporating our battery into design.
- Due to the hard nature of our dice, we created an elastic environment for rolling consisting of a t-shirt pulled tightly to allow bouncing.
- The roll detecting did cause a slight delay in the delivery of our data as we have it set to only send the data once the same side is detected n times.

COMPONENTS AND ARCHITECTURE

- SEEED XIAO BLE SENSE NRF85240
  - IMU Sensor
  - Gyroscope
  - Bluetooth
- ESP 32
  - Wi-Fi Connectivity
  - Central Processing
  - Bluetooth
- INFLUXDB
  - Time Series Database
  - Read and Write
  - Line Protocol via HTTP POST
  - REST API



DEMO OF DICE

CLICK HERE

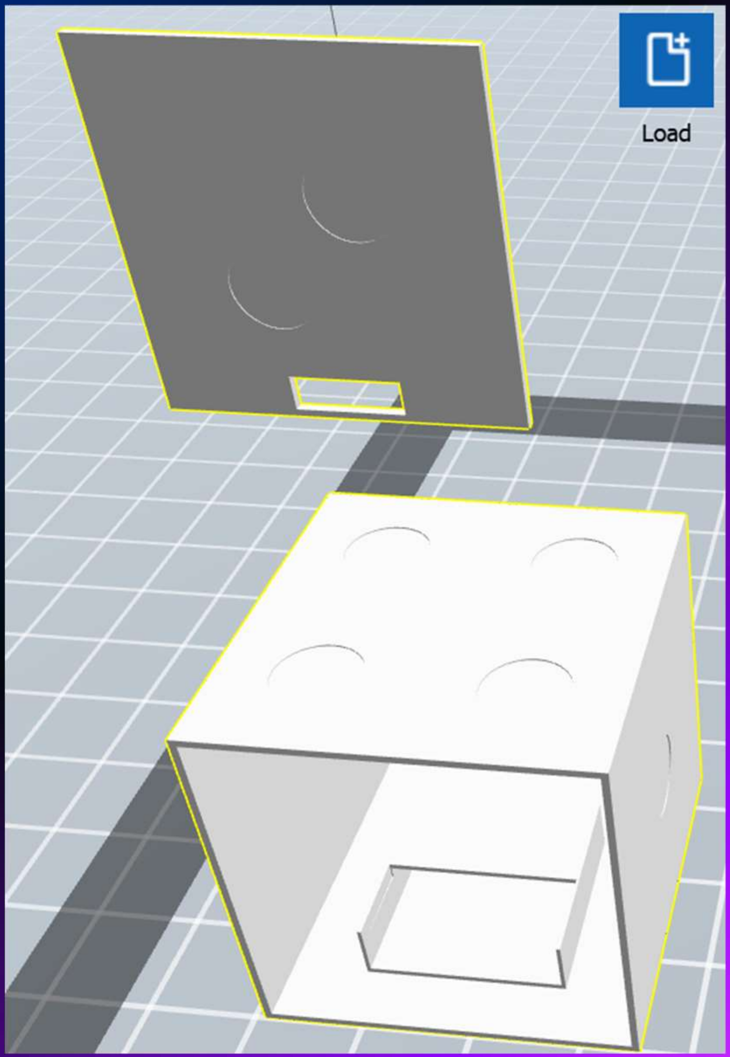
CHALLENGES

- The greatest challenges we faced was the connection between boards initially, it seems the Seeed XIAO BLE Sense can only handle a single connection at a time, while it can advertise many.
- This meant we were finding the Seeed, connecting to it, but then not getting any data.

- The second greatest challenge we faced was figuring out what method of testing we wanted to do on the dice, whether that was predicting dice side before it landed, the bias of it, among other options.
- We did have minimal trouble with the initial connection to InfluxDB, but it was less connection trouble and more not knowing how to use the database.
- The only other trouble we had was with viewing our data in InfluxDB.
- We decided to go with testing the bias of our dice due to its design.

BIAS EXPECTATIONS

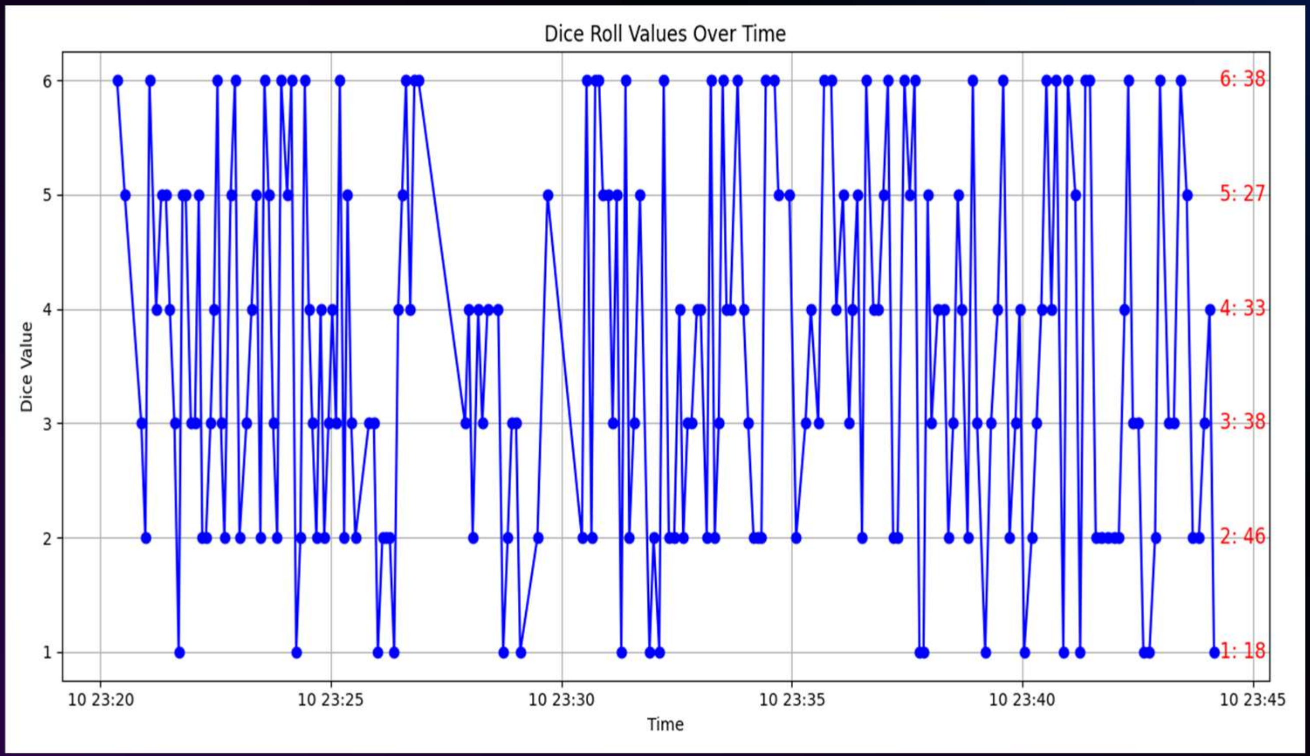
- We had expected our dice to have a clear bias towards the side with 4.
- This was due to internal design having the board on the opposite side of 4, which would cause that side to be weighed down, and the dice to land more on 4.



TESTING FOR BIAS

- Our bias expectation was incorrect or did not have enough testing.
- Our expected bias of 4 came in 4th place with 200 rolls, so the level of bias remains unclear until the dice is further developed.

6 - 38	3 - 38
5 - 27	2 - 46
4 - 33	1 - 18



FINAL THOUGHTS AND GOALS

- One of the final goals we had that we did not finish was to add multiple dice and aggregate the counts from multiple sources.
- We also wanted to purchase a smaller battery to try to minimize size as much as possible.
- We wanted to try and fill the dice completely with filament, and truly embed the board internally to allow it to have bounce weight.
- We would like to create a more sophisticated process for transmitting data, and possibly have the computer do the central processing, so as to prevent delays in transmission.
- It would have been super cool to create a custom board containing only Bluetooth and the IMU for a smaller size.

THANK YOU

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