

**Screws Loose**

Project Deliverable G - Prototype II and Customer Feedback

**Group 9**

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**1. Simple Analysis:**

In our prototype, the two Passive Infrared (PIR) motion sensors and load cells are crucial components for accurately detecting bat activity in a bat box. Specifically, the PIR sensors detect if a bat has entered or exited the bat box based on the order in which they were triggered, while the load cell measures the overall mass of the bat box. This mass data allows us to estimate the number of bats present at any given time. A microSD card will be used to store the collected data from the sensors.

Initially, each component was connected to an Arduino Uno microcontroller to ensure that they were functional before integration with the SAMD21 microcontroller. A 5V power supply was used to ensure consistent voltage, vital for stable performance, as even slight variations could disrupt sensitive electronics.

We also continued using the Arduino IDE, which enables efficient program uploading and debugging, enhancing the likelihood of error-free code execution. Additionally, breadboards and jumper wires facilitate a modular setup for testing, but due to potential loose connections, careful attention to wiring is necessary to ensure stability and avoid short circuits during operation.

**2. Prototypes 2 & 4 Results:**

The team decided that it would be best to begin prototype 4 before prototype 3.

| **Prototypes** | | | | **Tests** | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **ID** | **Type** | **Objective** | **Priority (1-3)** | **Method** | **Expected Results** | **Duration** | **Results** |
| 2 | Core Function: Sensors | Do the individual sensors function as expected | 3 | Set up the system as intended. Model a bat to mimic movements in and out of the box | Observe if sensors detect movement accurately | ~30-50 min | Partial Success  The PIR sensors function with the Arduino Uno, and the SAMD21, but the delay before it can detect a subsequent movement is too long.  Load cell functions as expected with both microcontr-ollers. |
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| 4 | Core Function: Data Processing | Does the system log data in the correct format on the micro SD card | 3 | Use sensors from Prototype 3 to log data to SD card | Check file structure and formatting to work as listed in Fig. 2 | ~1-2 hrs | Partial Success  The microSD breakout board functions as expected with the Arduino Uno. However, it is under optimised with the SAMD21 |

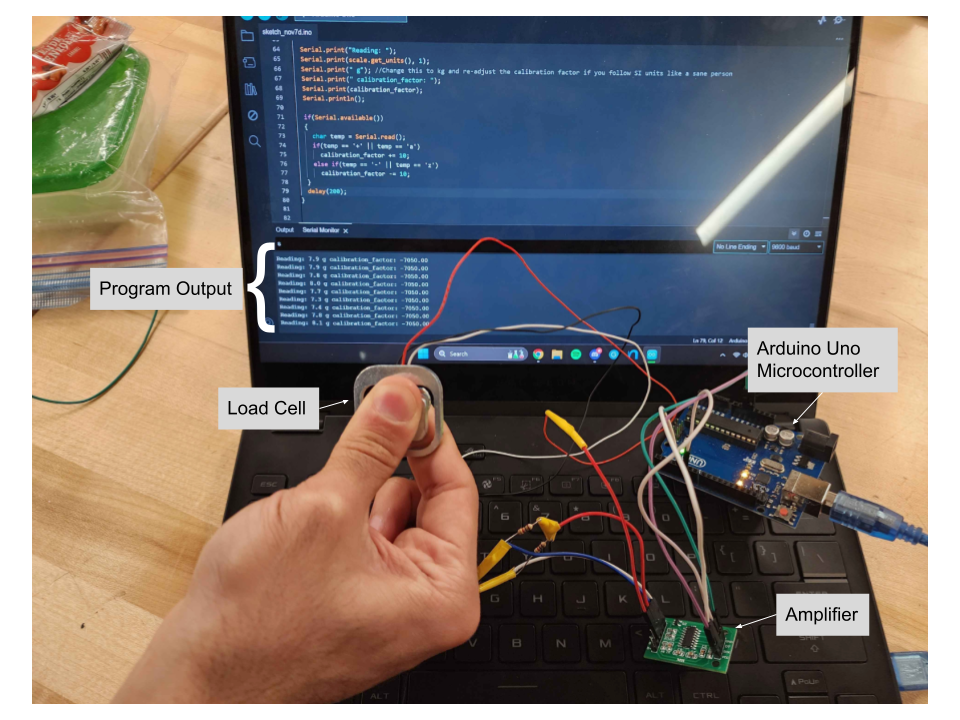
*Note: higher priority means more importance*

**3. Prototype Reflection and Future plans:**

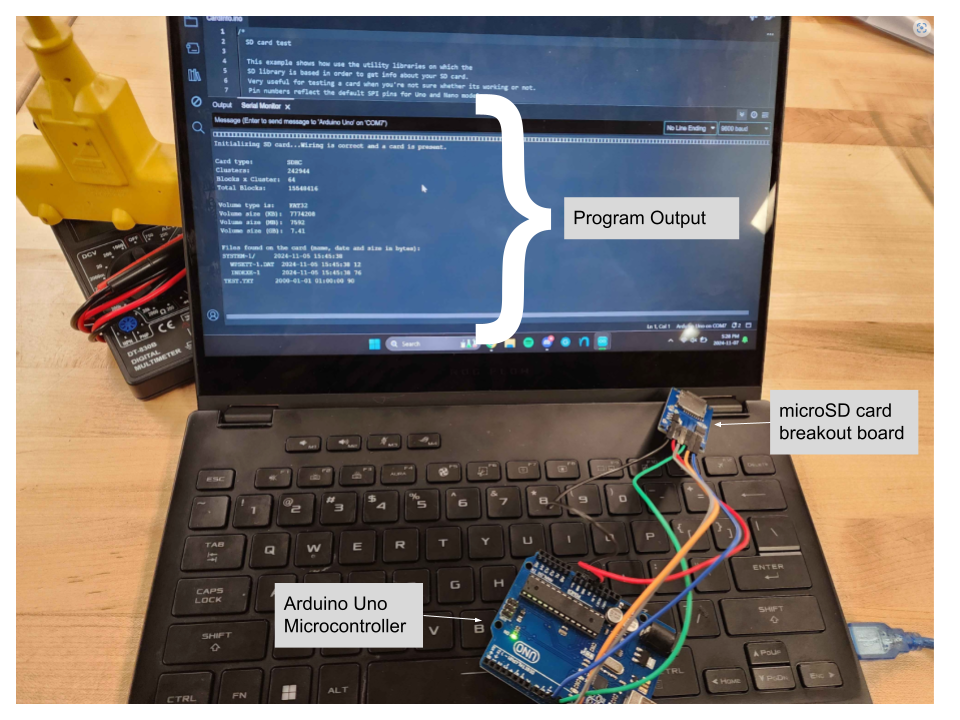
In continued testing for prototype 2, we found that the PIR sensors were able to correctly detect motion; however, there was a delay of roughly three seconds before the sensors could detect subsequent movements. This delay is not ideal, as it greatly reduces the PIR sensors' ability to accurately track the rate of incoming and outgoing bats. The load cell, however, functions as expected, correctly converting a given load into mass. For prototype 4, the microSD breakout board was functional on the Arduino Uno but not on the SAMD21. The reason for this is that the SAMD21 does not have a native SPI pin but rather one that can be configured in code. We are currently working on configuring the SAMD21 SERCOM peripheral as an SPI Master for communication with the microSD breakout board.

Moving forward, we plan to explore potential methods to reduce the delay for the PIR sensors. We will also continue to consider alternatives for the PIR sensors, specifically IR break beam sensors. For the microSD breakout board, we will explore potential alternatives that may be compatible with the SAMD21. Alternatively, we may also look into other boards similar to the SAMD21, but with support for a microSD breakout board, such as the Arduino MKR Zero. We also plan to begin designing our bat box, which will then be laser cut out of ⅛” MDF material.

**Image 1.** Load Cell + Amplifier - Correctly measuring applied load

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**Image 2.** MicroSD breakout board - Correctly creating and storing a text file

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**4. Feedback on Prototype and Testing Methods**

To enhance the design’s effectiveness, we presented our prototype and testing methods to group 10 in our lab session for input on potential improvements to be made in our prototype and testing methods. Their comments and suggestions were invaluable for refining both aspects of the project, ensuring that our design makes sense, and that our testing methods covered as much as possible.

The client also provided feedback during our prototype presentation. Overall, he liked what was presented, however, the client wanted to see a prototype which shows the entire system, instead of small isolated prototypes.

| **Group Number** | **Feedback on Prototype** | **Feedback on Testing** |
| --- | --- | --- |
| Group 10 | Suggested considering solar panels to prolong battery life, and replacing the NFC module with bluetooth native to the board | Positive feedback, no suggestions made. |
| Teaching Assistants | Suggested addition of a Flow Chart to the deliverables | Suggested reevaluation of time constraints and overall prototype expectations |

**5. Prototype Plan (Types: Structural: Integrity/Cable Management & EOA, Core function: Sensors/Microcontroller/System )**

| **Prototypes** | | | | **Tests** | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **ID** | **Type** | **Objective** | **Priority (1-3)** | **Method** | **Expected Results** | **Duration** | **Team member(s)** |
| 1 | Core Function: Microcontroller | Does the microcontroller program run as intended | 3 | Run the program on the microcontroller | Program runs without producing errors | ~30-50 min | Amin  Mohammed  Waleed |
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| 2 | Core Function: Sensors | Do the individual sensors function as expected | 3 | Set up the system as intended. Model a bat to mimic movements in and out of the box | Observe if sensors detect movement accurately | ~30-50 min |
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| 3 | Core Function: Sensors | Do the sensors work as expected, in tandem. | 3 | Set up the series of sensors as intended. Use the same bat model from Prototype 2 | Observe if all sensors detect movement in the expected order, under varying conditions | ~1-2 hrs | Amin  Mohammed  Waleed |
| 4 | Core Function: Data Processing | Does the system log data in the correct format on the micro SD card | 3 | Use sensors from Prototype 3 to log data to SD card | Check file structure and formatting to work as listed in Fig. 2 | ~1-2 hrs | Amin  Mohammed  Waleed |
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| 5 | Core Function: System | Verify Accuracy, Precision, and error bounds.  Read/Write data to and from NFC module | 3 | Test system's output against known standards or simulated bat data | Data output matches expected precision and accuracy | ~1 hr | Hossam  J’afar |
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| 6 | Structural:  Enclosure Integrity | Inspect for weaknesses, potential points of failure, and waterproofing | 3 | Evaluate enclosure in various simulated environmental conditions | Enclosure maintains integrity without leaks or damage | ~24-48 hrs | Hossam  J’afar |
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| 7 | Structural:  Cable Management and Ease of Access | Verify speed of replacement and check cable channel options | 2 | Test cable arrangement options and inspect ease of access during battery replacement | Cables are secure, the battery is easily replaceable, and safely routed within the time frame | ~30 min | Hossam  J’afar |

*Note: higher priority means more importance*

*Materials needed for each prototype*

| **Prototype ID** | **Equipment Needed** | |
| --- | --- | --- |
| **1** | * SAMD21 microcontroller * Breadboard * Jumper wires * Power supply * Arduino IDE |  |
| **2** | * SAMD21 microcontroller * 2 PIR sensors * Model of a bat (for movement simulation) * Breadboard * Jumper wires | * TMP36 Thermocouple * Boost Converter * Arduino IDE * Power supply * Arduino Uno |
| **3** | * SAMD21 microcontroller * 2 PIR sensors * Model of a bat (for movement simulation) * Breadboard * Jumper wires | * Load cell with HX711 amplifier * Boost converter * Arduino IDE * Power supply * Arduino Uno |
| **4** | * SAMD21 microcontroller * Micro SD card and breakout board * NFC PN532 chip * Breadboard * Jumper wires | * Arduino IDE * Boost Converter * Power supply * Arduino Uno |
| **5** | * SAMD21 microcontroller * 2 PIR sensors * Model of a bat (for movement simulation) * Breadboard * Jumper wires | * Load cell with HX711 amplifier * Boost converter * Arduino IDE * Power supply |
| **6** | * Enclosure (made of ABS material) * Sprinkler * Paper towel * Fridge | * Heater |
| **7** | * Battery * Enclosure (made of ABS material) * Cables * Bat box model | |

**6. Bill of Materials**

| BOM Level | Parts and Components | Part Number | Unit Cost | Quantity | Total Cost |
| --- | --- | --- | --- | --- | --- |
| 2 | [Passive Infrared Motion Sensor](https://www.pishop.ca/product/hc-sr501-pyroelectric-infrared-pir-motion-sensor-detector-module/) | HC-SR501 | $ 3.95 | 2 | $ 7.90 |
| 2 | [Load Cell](https://www.amazon.ca/Bridge-Digital-Amplifier-Arduino-DIYmalls/dp/B086ZHXNJH/ref=pd_sbs_d_sccl_2_2/138-3904992-8608018?pd_rd_w=hPXKX&content-id=amzn1.sym.6ad16f3c-18e0-4f22-ab86-1fc3330d8164&pf_rd_p=6ad16f3c-18e0-4f22-ab86-1fc3330d8164&pf_rd_r=63A5P5HXPR0KJP7T57CN&pd_rd_wg=nVFN2&pd_rd_r=661fe043-3687-4b71-8af3-f57dc95169b9&pd_rd_i=B086ZHXNJH&psc=1) | SEN-10245 | $ 12.98 | 4 | $ 12.98 |
| 2 | [Amplifier](https://www.amazon.ca/Bridge-Digital-Amplifier-Arduino-DIYmalls/dp/B086ZHXNJH/ref=pd_sbs_d_sccl_2_2/138-3904992-8608018?pd_rd_w=hPXKX&content-id=amzn1.sym.6ad16f3c-18e0-4f22-ab86-1fc3330d8164&pf_rd_p=6ad16f3c-18e0-4f22-ab86-1fc3330d8164&pf_rd_r=63A5P5HXPR0KJP7T57CN&pd_rd_wg=nVFN2&pd_rd_r=661fe043-3687-4b71-8af3-f57dc95169b9&pd_rd_i=B086ZHXNJH&psc=1) | HX711 | 1 |
| 1 | [SAMD21 Microcontroller](https://www.amazon.ca/gp/product/B0CBSYZKRF/ref=ewc_pr_img_1?smid=A33HV3N1GS7LPU&psc=1) | DEV13664 | $ 39.06 | 1 | $ 39.06 |
| 2 | [MicroSD Card Breakout Board](https://www.pishop.ca/product/microsd-card-breakout-board/) | ADF-101 | $ 11.95 | 1 | $ 11.95 |
| 2 | [Bi-Directional Voltage Booster](https://www.pishop.ca/product/4-channel-i2c-safe-bi-directional-logic-level-converter-bss138/) | ADF-100 | $ 5.45 | 1 | $ 5.45 |
| 2 | [TMP36 Temperature Sensor](https://www.pishop.ca/product/temperature-sensor-tmp36/) | SEN-10988 | $ 2.95 | 1 | $ 2.95 |
| 1 | [Wire Spool](https://www.pishop.ca/product/solid-core-wire-spool-25ft-22awg-yellow/) | ADF-1658 | $ 3.95 | 1 | $ 3.95 |
| 1 | [Arduino Uno](https://www.amazon.ca/Elegoo-Board-ATmega328P-ATMEGA16U2-Arduino/dp/B01EWOE0UU?crid=1QDED3773K2A3&dib=eyJ2IjoiMSJ9.mMwW9AQ5cM5IcBhuz3WQYbPvo7DtbzrKCfjhplyHspN8MGWfpVZ9GwNDOUgZk4_Vc_q-5kt3Y50pMsxO4A4mjk_eQrbHoLAnqqCwyi7Tcp3r2e8IFNaxtvMZd2B8rZXGwiidoZTVzosulkgJwx1HqYHSx3g6SSkCGhCNpNdCutI9G_dBTqt1H6spA2eAewnxBtyrN0CSNScrIAX4yKddP-TZ8kXYa5uZ-dWWqRPzlpwLY02ibc26VxzGHQijxWZSKFL8jwy6_g3NEDSxhFkEnLnv9EcBXl1latDIpw61rTM.TGP69kHqO-VqS8RDBnV5nhEheNj4F_gaXk0PiNEt9uY&dib_tag=se&keywords=arduino+uno&qid=1731282152&sprefix=arduino+uno%2Caps%2C168&sr=8-5) | DEV13664 | $ 21.99 | 1 | $ 21.99 |
| 3 | [⅛” MDF 12” x 24”](https://makerstore.ca/shop/ols/products/mdf/v/M003-1-8-12-NCH) |  | $ 3.00 | 1 | $ 3.00 |
|  |  |  | Total | 13 | $ 109.23 |

*Note. For the ABS filament, the quantity is in grams. The table excludes any taxes. Created by Mohammed on October 26th, 2024. Modified by J’afar Assaf on November 10th, 2024.*