Bird Impact Detection Syste

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Birds on UBC Campus

- Many different kinds of birds live on UBC Campus
  - Migratory and nonmigratory
- UBC Campus is on a major migratory route along the West Coast
- Birds on UBC Campus have an important role in the ecosystem
  - Pollinating plants
  - Dispersing seeds
  - Pest control
- Sustainability is very important to UBC, so bird populations are key to protect

The Problem

- Birds have a difficult time seeing glass, especially if it is clear or there are significant reflections of foliage
- Approximately 10,000 birds hit windows on UBC Campus each year
- SEEDS and other programs are developing technology to reduce this number
- To effectively do this, precise numbers are needed for how many birds impact windows
- Currently, bird impacts are counted manually, which is inefficient

Goals

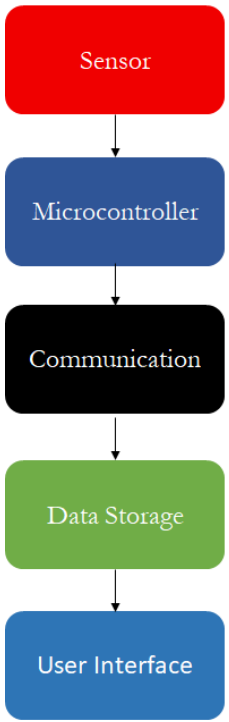
Our goal is to replace the manual data collection done by SEEDS in previous years with an automated system that can detect bird impacts more accurately and with minimal maintenance. The data collected will provide necessary data to help our client implement bird-friendly building guidelines and mitigate the issue.

- Detect bird impacts in different environments (Ideal, Rain, Loud Noise)
- At least 95% accuracy in detecting bird impacts.
- Record bird impact events and store impact data in a database accessible by the client at all times

Challenges

- Need to be able to detect bird impacts among other window disturbances
  - Many different environments can cause window vibrations
    - Rain
    - Loud noise
  - Each source of window disturbances has distinct vibrations that look different from a bird impact
  - Simulate bird impacts to isolate traits used for impact identification
- Maintaining accuracy of system while making it as simple as possible
  - Limit number of parts used to ensure window is not blocked
  - Simplicity makes the system more reliable, and more tamper-proof
  - Less components means less data, must make signal analysis robust to ensure detection is still accurate

Solution: System Architecture



Detection System: ADXL337 Accelerometer

Detection System: Arduino Uno WiFi Rev 2

Communication System (WiFi): UBC Visitor WiFi

Data Storage: MyDevices Cayenne

User Interface: Cayenne Dashboard

Bird-Window Collision Simulation Design

- **A Mock bird**
  - Similar in characteristics such as compressibility
  - Higher mass than bird, compensated by reducing speed of impacts
  - 57.3g tennis ball
  - conservation of energy calculations used to simulate different bird flight speeds

- **Pendulum Setup**
  - ensures repeatability and reliability
  - impact speed is controlled by pendulum drop angle
  - can simulate an impact anywhere on the window

The Pendulum Setup

Demonstration of the Product

Successful Bird Impact:

1. We will drop the mock bird at a 90° angle (equivalent to 9.7m/s of a 7 g bird, .0255 J)
2. The bird will strike the window, triggering the system to begin signal processing
3. The system will acknowledge the window disturbance as a bird impact and update the Cayenne UI in real time

Testing

To ensure the system will function on UBC Campus, we tested in 3 environments:

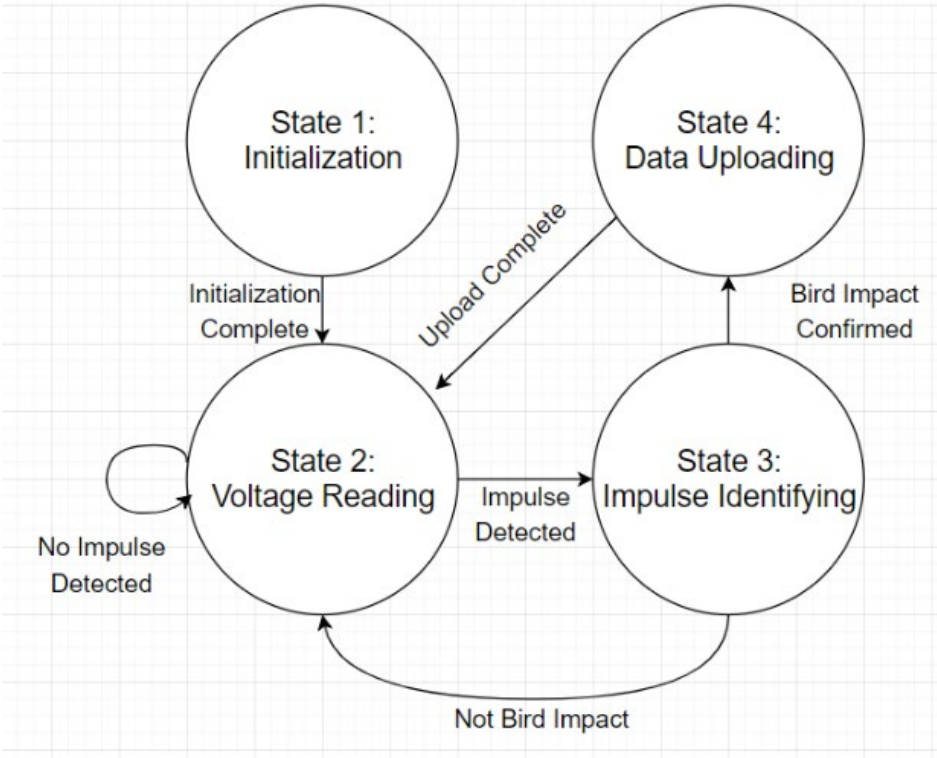
1. **Ideal:** A controlled environment with nothing disturbing the window
    a. Only vibration is due to impacts
2. **Rain:** Water is sprayed onto the window to mimic heavy rainfall
    a. Water impacting the window causes extra vibrations
    b. System must reject vibrations from the 'rain'
3. **Loud Noise:** Loud noise mimicking conversation near the window
    a. Approximates vibrations from loud noise such as heavy machinery and loud voices
    b. System must consistently reject vibrations from different noises

In all environments, the system must be able to detect bird impact vibrations among other vibrations caused by the environment

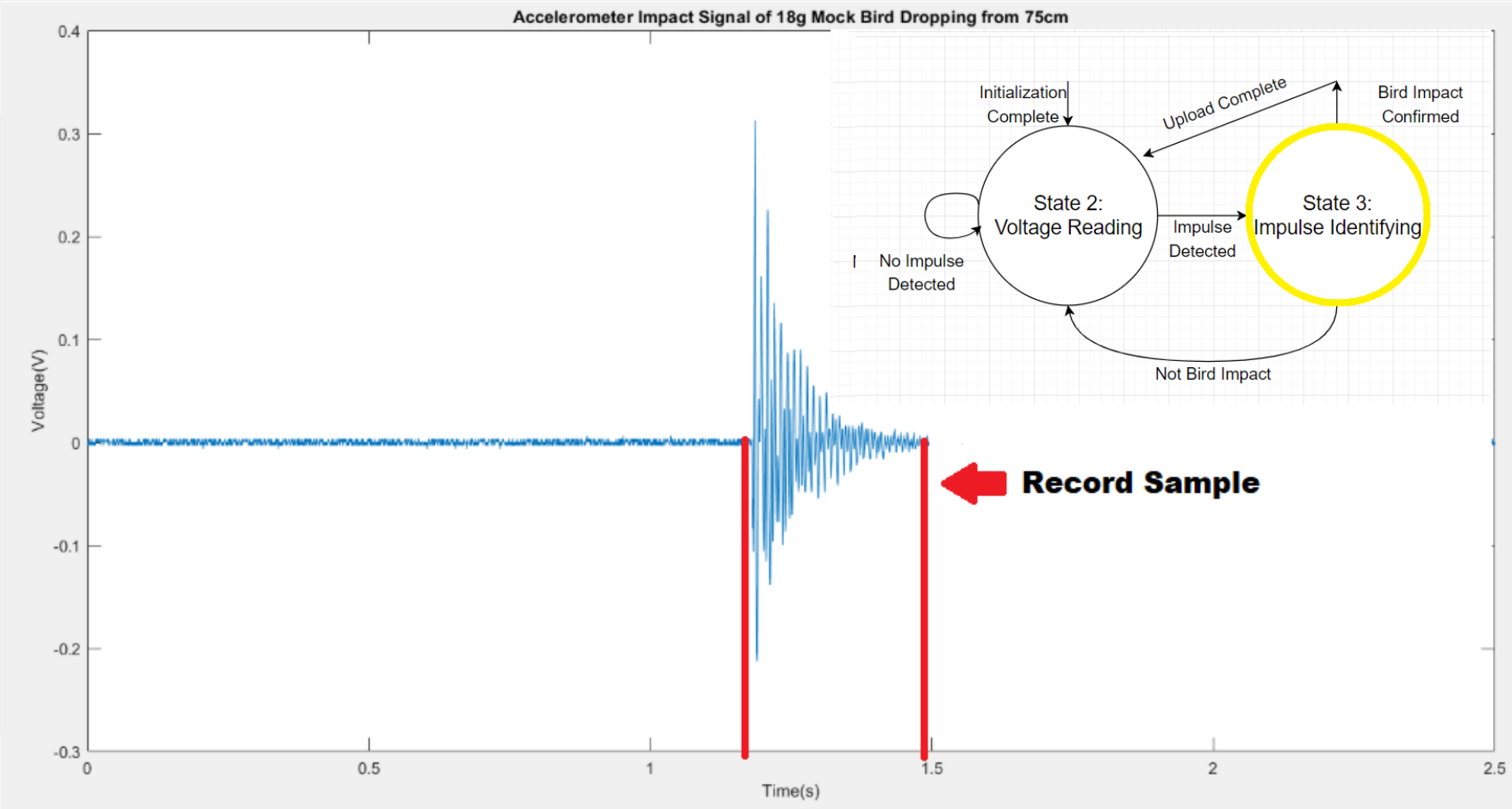
State Machine

The detection algorithm has 4 states:

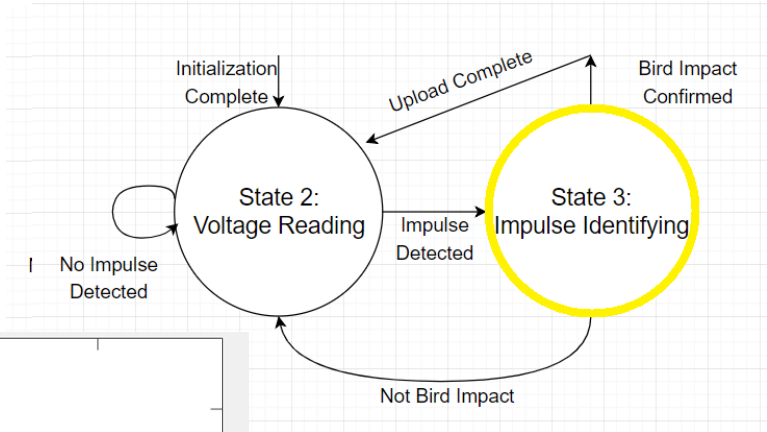
1. Initialization
2. Voltage Reading
   a. Watching sensor for signals over the voltage threshold
   b. When threshold is crossed, moves to state 3
3. Impulse Identifying
   a. Calculates dominant frequencies of signal
   b. Finds duration of signal before it goes back below threshold
   c. If these conditions match a bird impact, moves to state 4
4. Data Uploading



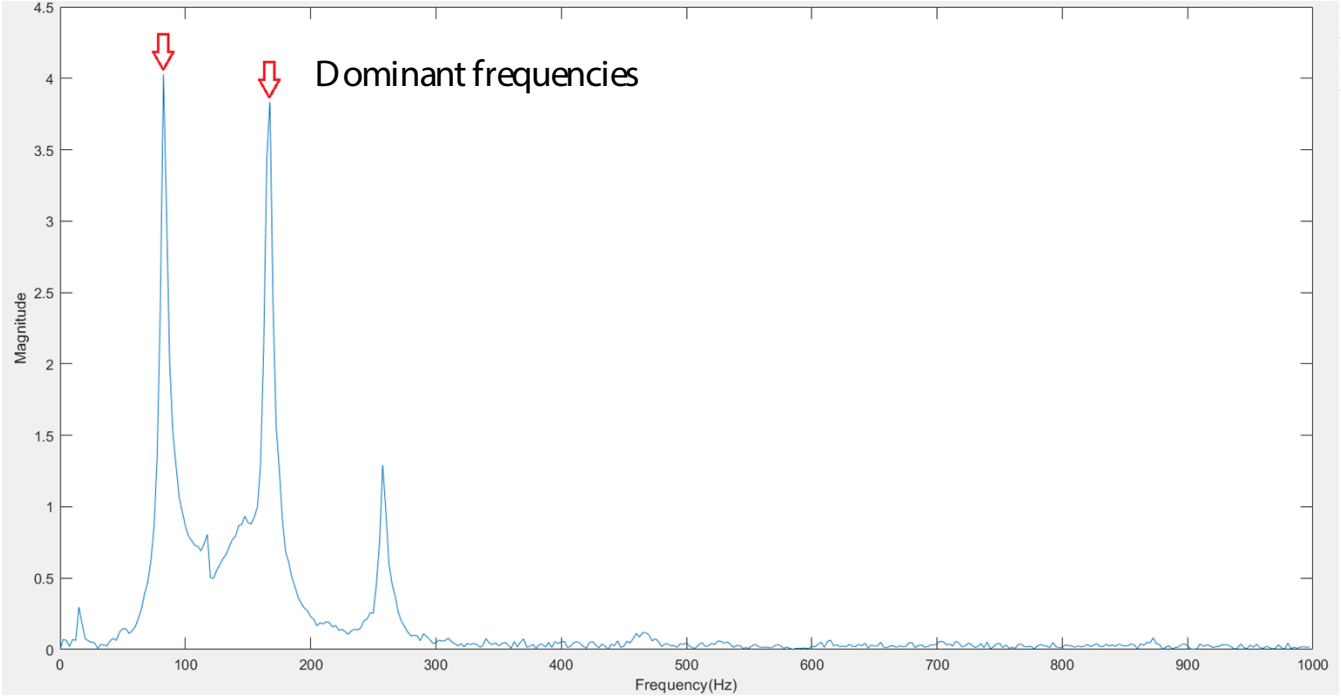
State Machine: State 2, Voltage Trigger



State Machine: State 3



- Use Fast Fourier transform algorithm to compute the discrete Fourier transform



Validation Results

To validate the performance of our device, we performed 120 impacts in each environment to meet the requirements

- Product reliability summary:

Environment	False Positive	False Negative
Ideal	0%	0.8%
Rain	0%	0%
Human	0%	1.7%

- The error rate is less than the 5% specified by the requirements.
- Our system was able to continuously operate for 7 days without maintenance.

Data Storage and Access

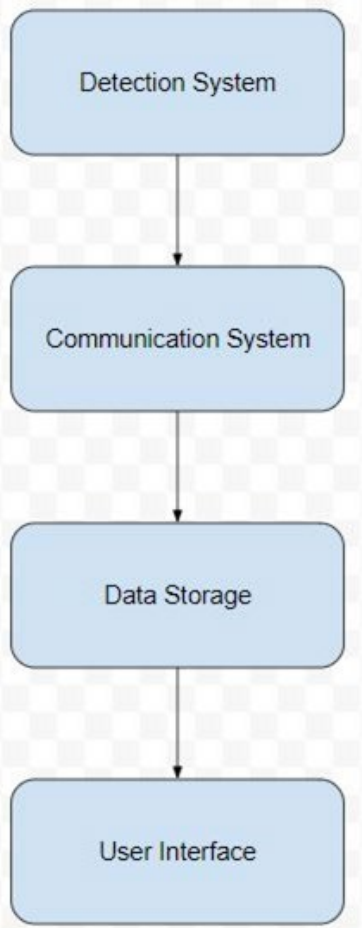
For convenient access, impacts are wirelessly stored online

- Wireless communication: UBC Visitor WiFi network
  - Wireless network available across UBC Campus
- Online storage: MyDevices Cayenne
  - Stores:
    - Number of Impacts
    - Impact Window Identifiers
    - Impact Timestamps
- User Interface: Cayenne Dashboard
  - Database, Numerical Counter, and Line Graph

Summary

Our automated system solves the existing issue with bird impact d

- Knowing exactly how many birds hit a window helps with the development of new technology to reduce bird impacts
- Through analysis of vibrations in the window glass, the system can tell bird impacts from other window disturbances
- This allows for accurate and reliable automated detection of bird impacts on a window
- The system stores data online for use by researchers



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