Arnesh Script
Project:

**Slide 1:**
Hey there Im Arnesh this is Jayti we are group 130 and our project is motion detection of bees using electrostatic sensors.

**Slides 2:**
So whats the problem?

Bees are important member of the natural environment. Being one of the main pollinators we as human rely deeply on them especially for agriculture.

However one of the main issues is that we currently have no way to monitor the health of the bees and the hive, without ripping open the hive and inspecting by eye which stresses the bees out. So nonintrusive monitor is vital.

Now monitoring the health of the hive can be an early signifier of issues in the natural ecosystem allowing preventative measure to be taken before disaster which is the main driver of this project

**Slide 3:**
Why Electrostatics?

Unlike our sister project which monitors $CO_2$ we are approaching the same problem from another perspective.

Electrostatics is key as bees healiy rely on electro reception to forage for food and communication. Using the Johnston's organ.

Bees are able to gain a charge through the triboelectric effect through flight and friction between body parts.

When positively charged forager bees around 30 to 50 pico Coulombs return to the hive they communicate information about a food source, by performing a waggle dance.

A waggle dance communicates the exact location of the food source from the hive which encodes exact information about distance and direction of the food source from the hive with respect to the sun.

The waggle dance also communicates to beekeepers about the health of the hive itself. As internal hive activity can be used to identify issues in the ecosystem early on before the negative impacts start to take effect.

**Slide 4:**
Our project objectives

- To identify the waggle dance
- To create novel sensors that can be deployed in a hive

- To tackle the beehive monitoring with another nonintrusive approach

**Slide 6:**
What has been used so far?
Here we have the BeeSpy system, the parent project. This is how testing has been done previously. Here sensors are placed inside of the hive to monitor the bees. There have been 2 versions of the electrostatic sensors:
The Electret based

- An electret is a dielectric with a quasi-permanant electric charge and was the first version of the ESF

Opamp

- The opamp design was the second iteration of sensors however there were some issues with the manufacturing thus giving questionable results, so we decided to try and make these sensors ourselves to validate the design.

Both of these versions are manufactured on a PCB with a 6 sensor array.

**Slide 7:**
The current system has many limitations such as, limited sensitivity to waggle dances further away from the sensors, the system requiring weekly battery changes thus potential loses in data, degradation of performance sensors, and false positives.

**Slide 8:**
Our Findings
Electrets

Electret base sensors have been the base line sensor which we compare our designs to, as it was previously used in the original BeeSpy project.

An electret is a material which holds a quasi-permanent electrical charge

These electrets are found in microphones, the beespy project uses the microphones with the casing removed, exposing the electret inside

When an external electric field is applied, it changes the capacitance of the capacitor

Doing some initial testing of these electret sensors, we found to be some **variability** in the signals produced due to the variability of the JFET in the sensor circuit and a sensor which didn't work

The thing about electrets are that they can be easily damaged in installation and handling

Jayti Script:

- Jfets
    - Jfets where very promising as a sensor using a very simple and low cost circuit design, thus making the development of the senor trivial
    - We explore three different versions of the jfet sensors.

    - In the first sensor design we found it would go into saturation, so the next two iterations try to keep it in the linear region of the jfet
    - Here is the results we collected from versions 2 and 3, we gave them the same signal as the electret test (8Vpp, 1kHz) and we can see a significant drop in amplitude
- PSoC
    - With the PSoC we are currently investigating two methods of sensing changes in capacitance
    - One using the PSoCs inbuilt capacitor
    - PSoC
        - The PSoC has in buit cap sensing technology which we could use to do our sensing however from our recent testing the results were inconclusive. The plan was to plug in a capacitor to one of the capsensing pins and then placing the capacitor inside of an electric field, and the field should change the capacitance which we can then use to as a metric to do some sensing.
    - Schmitt trigger design
        - The concept is that we create a symmetrical signal using two current sources. One source is constantly on and another is controlled by an external schmitt trigger, giving a symmetric triangular output on a capacitor. When an electrostatic field is applied to the capacitor we should see a change in the period of the capacitor voltage.
        - What actually happened when an external electrostatic field was applied, we saw a very minimal change in the period.
- Noise
    - Noise sucks, due to the nature of our sensing method when testing in the labs our sensed signal get desimated by noise especially the 50hz mains frequency, thus ensuring our sensor is encased in a faraday cage us vital to ensure that the sensed signal is pure and unaffected by noise.
- What are we going to do next
    - Design a testing rig to get comparable results
    - Finalising a sensor design and developing a PCB
    - CST analysis - Does increasing fringing increases the sensitivity