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Outline

➤ Purpose
➤ Functionality
➤ Device Details
  ◆ Parts
  ◆ Software Structure
  ◆ Printed Circuit Board
➤ Conclusion
➤ Demonstration
Purpose

Problem Statement
Our Solution
Problem
Solution

- Design a glove to improve intuitive interactions between humans and machines
  - Add additional functionality through haptic feedback
  - Interface new sensors into drone flying experience
  - Combine all components into small circuit design
Human-Machine Interaction – on human terms!
Functionality

Sensors and IC Usage

Device Interface
Sensors and IC Usage

- Capture motion of the hand through Inertial Measurement Units and stretch sensors
- Transmit motion data to drone to control drone flight:
  - Throttle
  - Roll
  - Pitch
  - Yaw
- Provide haptic feedback to user for use of throttle and axial movements
Device Interface
Parts

<table>
<thead>
<tr>
<th>IMU</th>
</tr>
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<tbody>
<tr>
<td>Haptic driver</td>
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<tr>
<td>Stretch sensor</td>
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<tr>
<td>nRF52</td>
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</tbody>
</table>
• IMU (inertial measurement unit)
  ○ SPI
  ○ Orientation calculations
  ○ Gyro + Accelerometer + Compass
• Haptic driver
  ○ I2C
  ○ Vibrating motor disc
  ○ User feedback
Stretch sensors

- Analog output
- Stretching changes capacitance
- Functional control of drone
- nRF52840 SoC
  - I2C & SPI
  - Bluetooth 5
  - 32-bit ARM Cortex-M4
Software

Peripherals

Android App
● IMUs
  ○ Read quaternion values
    \[
    q_0 = q_w = \cos(\alpha/2) \\
    q_1 = q_x = \sin(\alpha/2)\cos(\beta_x) \\
    q_2 = q_y = \sin(\alpha/2)\cos(\beta_y) \\
    q_2 = q_z = \sin(\alpha/2)\cos(\beta_z)
    \]
  ○ Convert quaternions to yaw, pitch, and roll
    
    \[
    \text{yaw} = \text{atan2}(2(q_0q_1 + q_2q_3), 1 - 2(q_1^2 + q_2^2)) \\
    \text{pitch} = \text{asin}(2(q_0q_2 - q_3q_1)) \\
    \text{roll} = \text{atan2}(2(q_0q_3 + q_1q_2), 1 - 2(q_2^2 + q_3^2))
    \]
• **Stretch sensors**
  ○ Measuring capacitance via RC charge timing
  ○ One charge pin in series with 50KΩ resistor and stretch sensor

• **Haptic driver**
  ○ Selecting waveform
  ○ Soft and stronger buzzes
Let's Fly

**Glove Connect**
Connect glove to smartphone through Bluetooth

**Calibration**
Capture the glove and drone's positional space

**Flight**
Select GO FLY and have fun!

**Download App**
Arveng Drone Glove application available on the Google Play Store

**Drone Connect**
Connect drone to smartphone through WiFi

**Tutorial**
Explore how the drone understands the glove
Power Requirements

- Voltage Requirements: 1.7v to 3.3v operation (LIPO Battery)

PCB Dimensions

- Width - 2.000in
- Height - 1.715in
- Board Thickness - 0.056in
Schematic: Haptic/Inertial Unit

AD0/SDO defaults to 0V. This sets the I2C address to 0b101000 (0x68) and leaves the AD0/SDO PTH disconnected. Connect to AD0/SD0 PTH to change externally. Pull high to set address to 0b1101001 (0x69).
Schematic: nrf52840 Block/Connections
PCB Layout
Simulated Physical Layout
Conclusion

Winter

Spring
Winter
Integrate Sensors
Android Application
PCB
Integrate Sensors

- Stretch Sensors
- Haptic Driver
- IMU

Android Application

- User Interface
- Control Algorithm
- Bluetooth
- WiFi
PCB

- Peripherals
- Featherboard
- SoC
Spring

Android Application

Test Drone
Android Application

- User Interface
- Control Algorithm
- Bluetooth
- Wifi

Test Drone

- Android Application
- Controls
- Additional Features
Demo

Stretch Sensors
Inertial Measurement Unit
Haptics
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Questions?