An Embedded System Development for Field Workers Safety Detection

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Embedded System Final Project

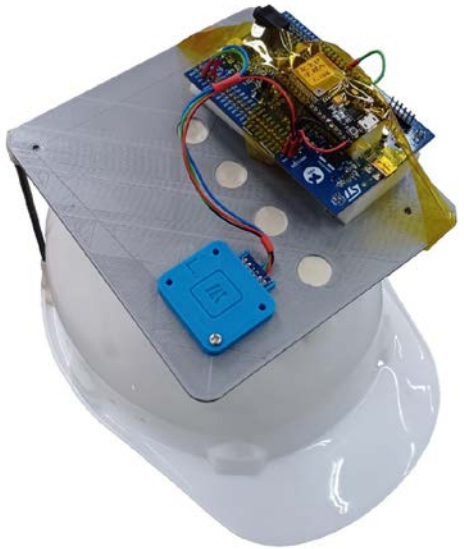
Group 7

Outline

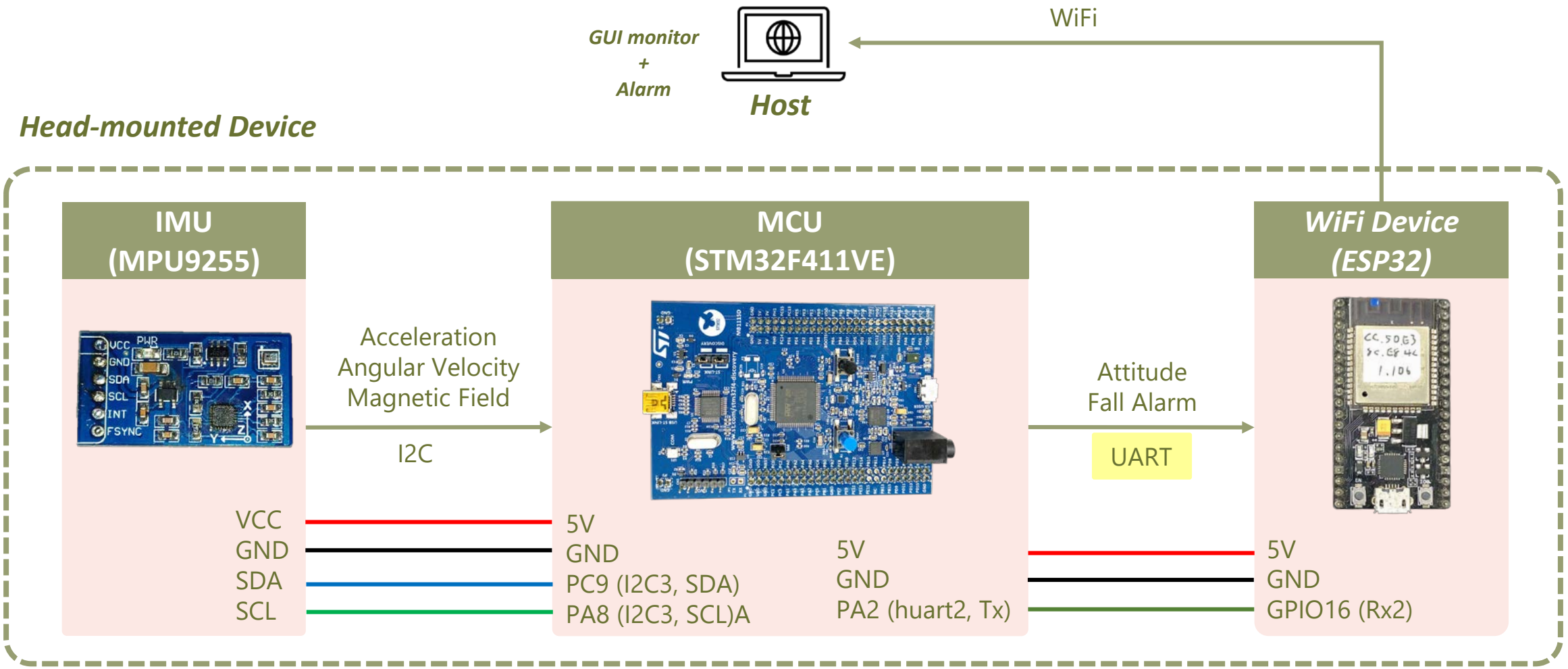
1. Motivation
2. System Structure
3. Demonstration
4. Conclusion

Motivation

- Workplace accidents are sometimes due to insufficient manpower allocation and confined space. For these conditions, it may cause more damage if the worker cannot seek rescue in time.
- Wearable devices like wristbands, watches and necklaces are not allowed in workplace.
- Hence, we're trying to propose a fall detection system, which should achieve these design features:
  - Low cost
  - Lightweight
  - Low power consumption
  - Real-time monitoring
  - Automatic alarm systems



System Structure - Block Diagram



System Structure – I. UART Communication

UART Transmitter (Tx)

char str = ‘s’;
↓
1byte: 0111 0011

0111 0011

UART Receiver (Rx)

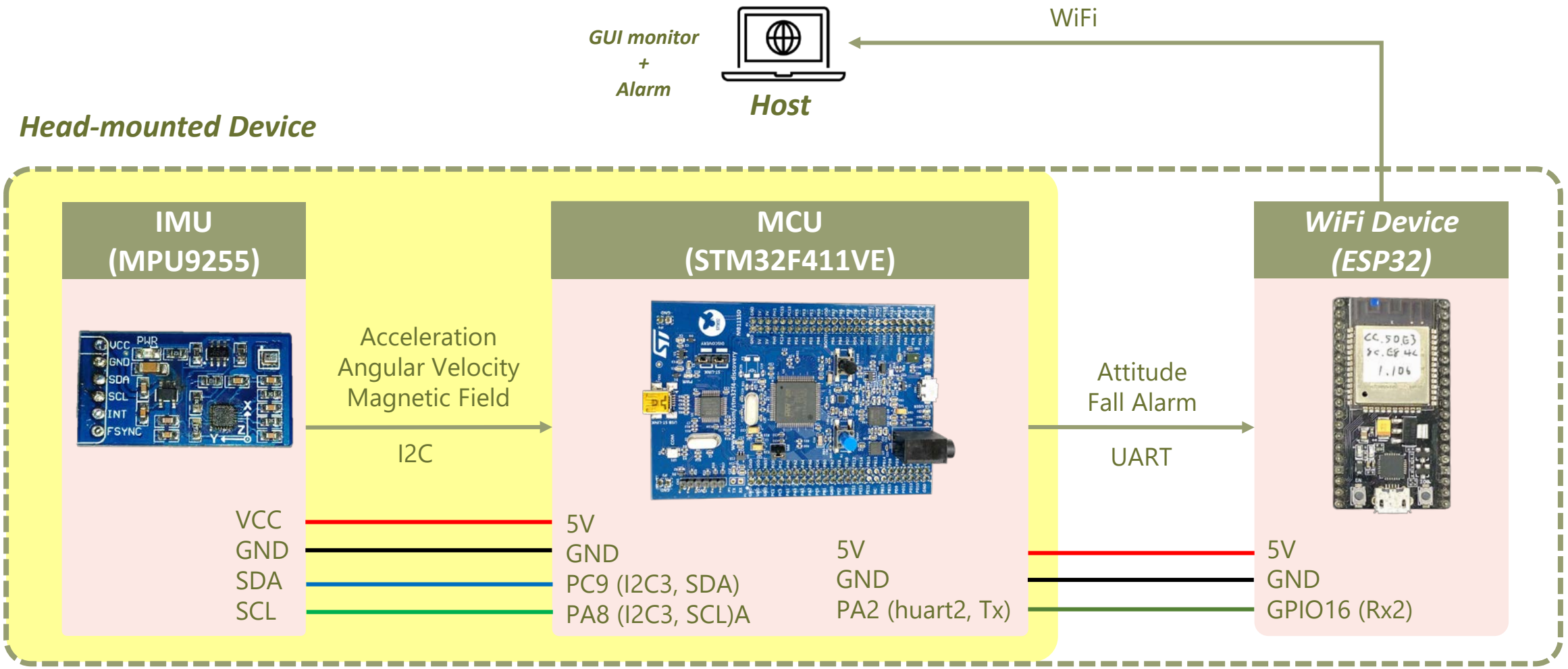
uint8_t buf = 0b01110011;
char dest = (char) buf;

STM32F411VE (UART Transmitter, Tx)

```
typedef struct DataPackage
{
    double qua[4];
    double acc[3];
    int status;
} Data_t;
Data_t UART_Tx;
UART_HandleTypeDef *phuart = &huart2;
const char start_byte = 's';
const char finish_byte = 'f';
```

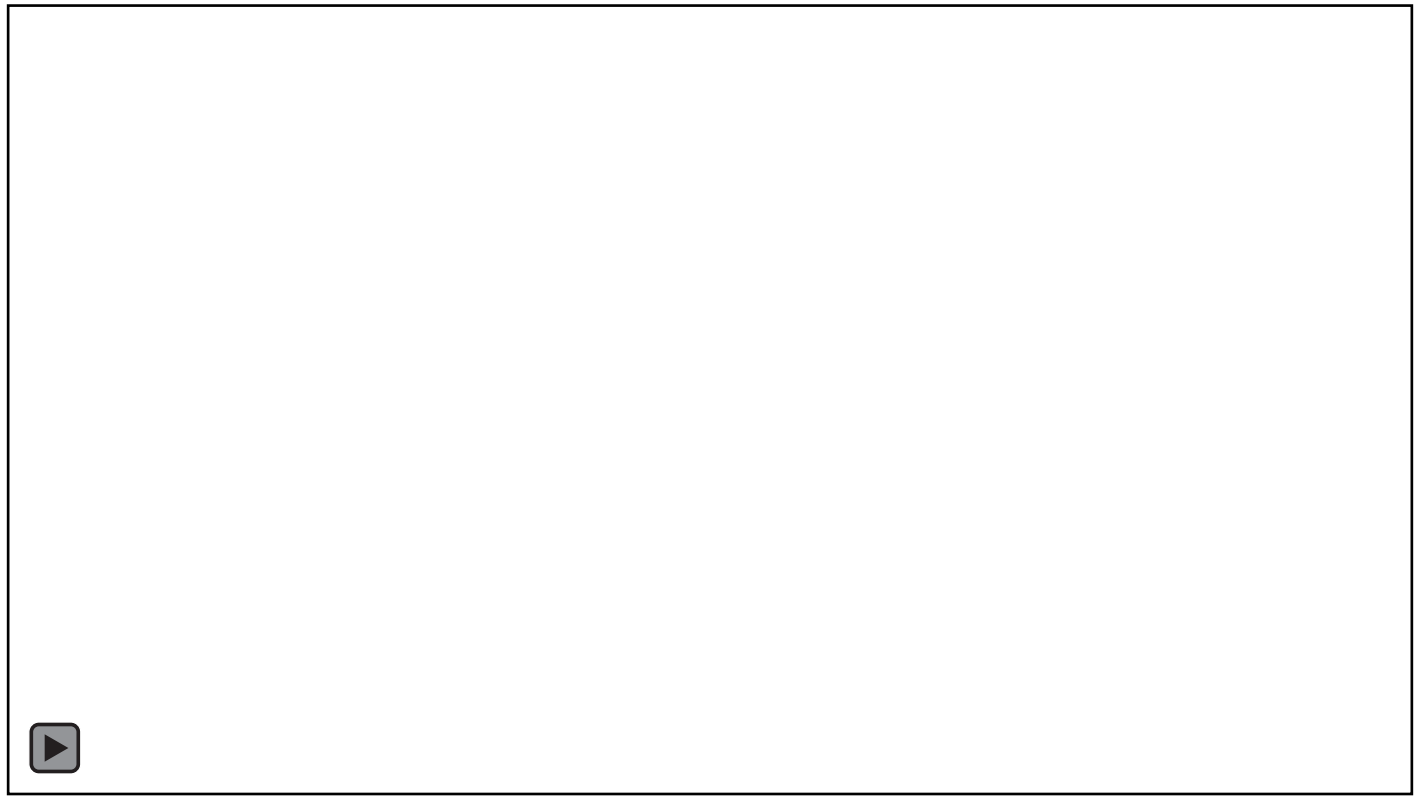

```
HAL_UART_Transmit(phuart, (uint8_t*) (&start_byte), 1, 10);
HAL_UART_Transmit(phuart, (uint8_t*) (&UART_Tx),
          sizeof(Data_t), HAL_MAX_DELAY);
HAL_UART_Transmit(phuart, (uint8_t*) (&finish_byte), 1, 10);
```

System Structure - Block Diagram

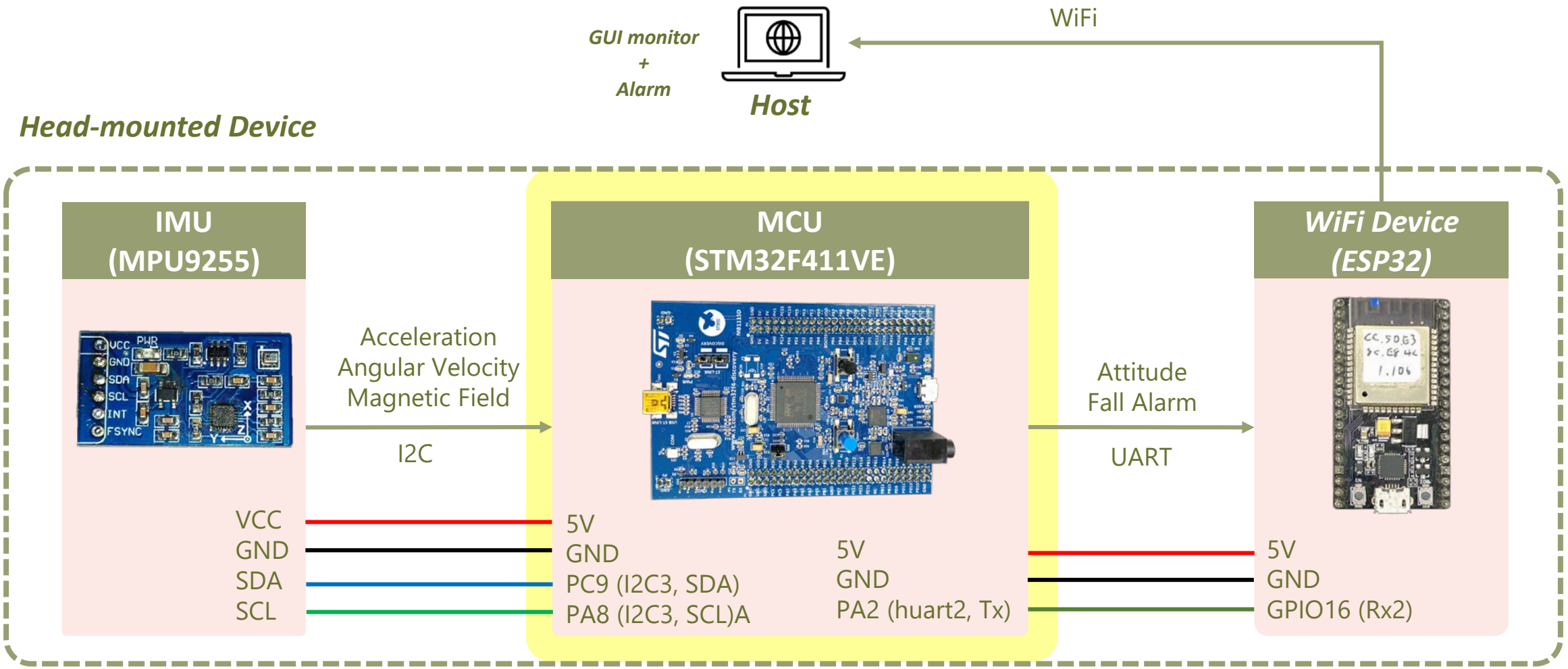


System Structure – II. AHRS

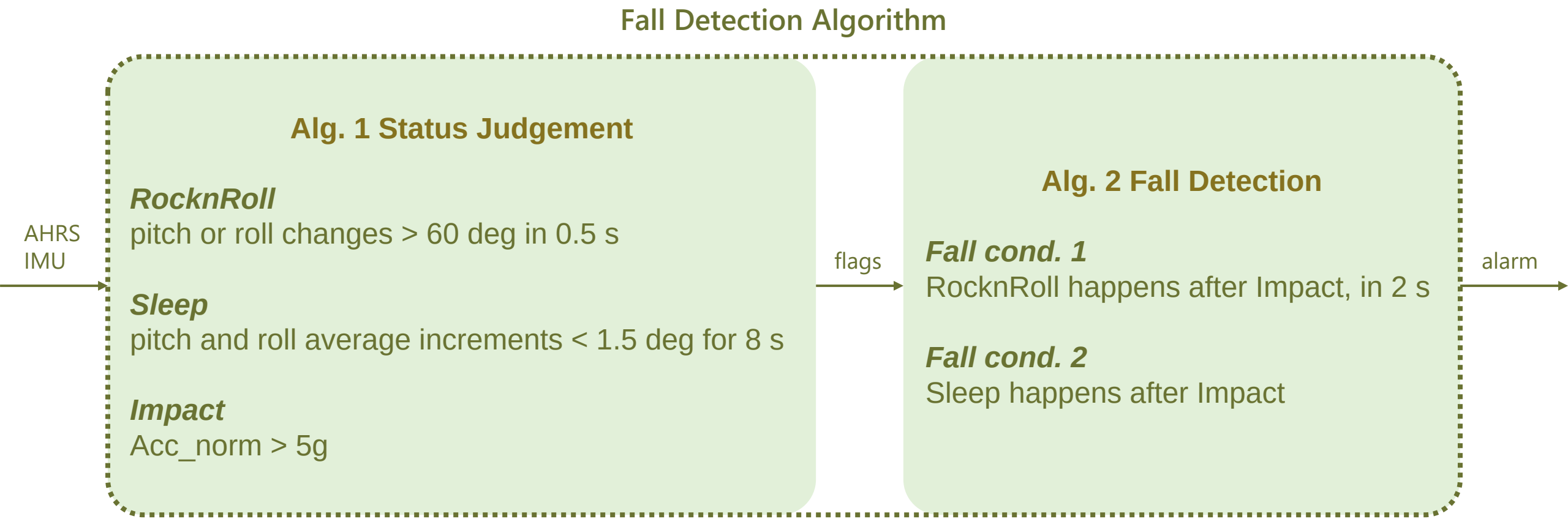
- IMU Sensor: MPU9255
  - 3-Axis Accelerometer + 3-Axis Gyroscope + 3-Axis Magnetometer
    (Acceleration) (Angular Velocity) (Magnetic Field)
- For obtaining the orientation of the body, the attitude and heading reference system (AHRS) algorithm is developed.



System Structure - Block Diagram

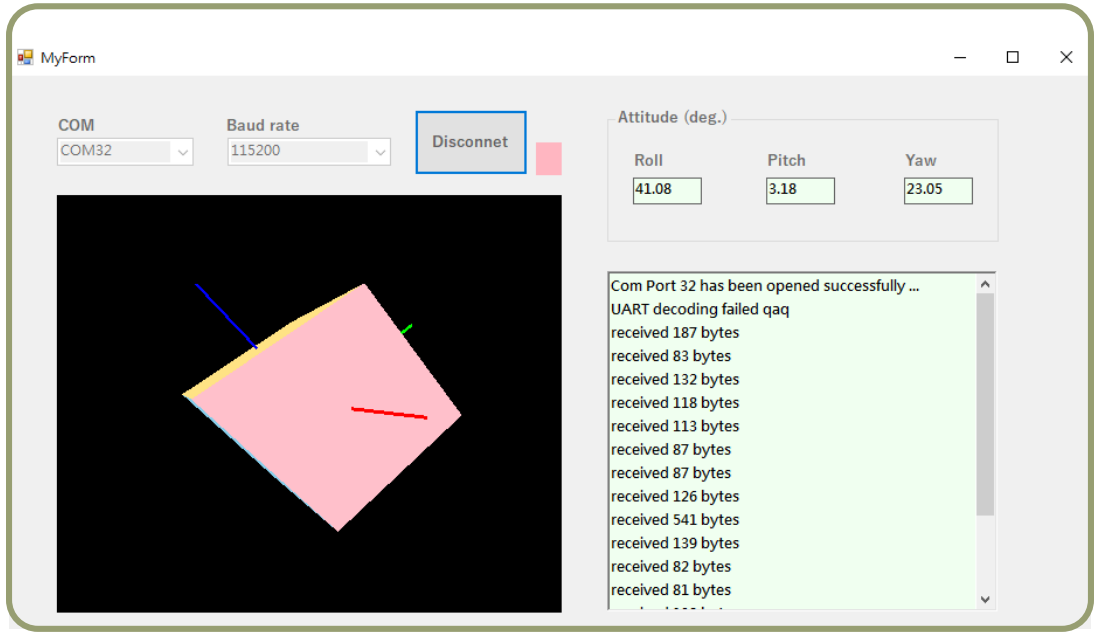


System Structure – III. Fall Detection



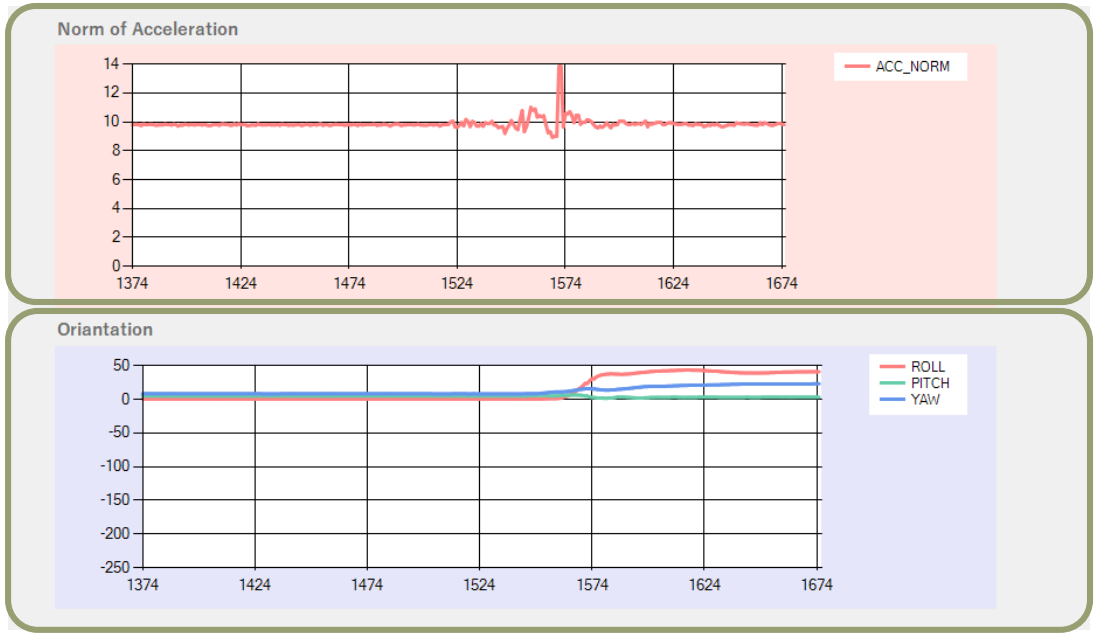
GUI – Real-Time Pose Monitor

- C++/CLI



Body Orientation Displayer

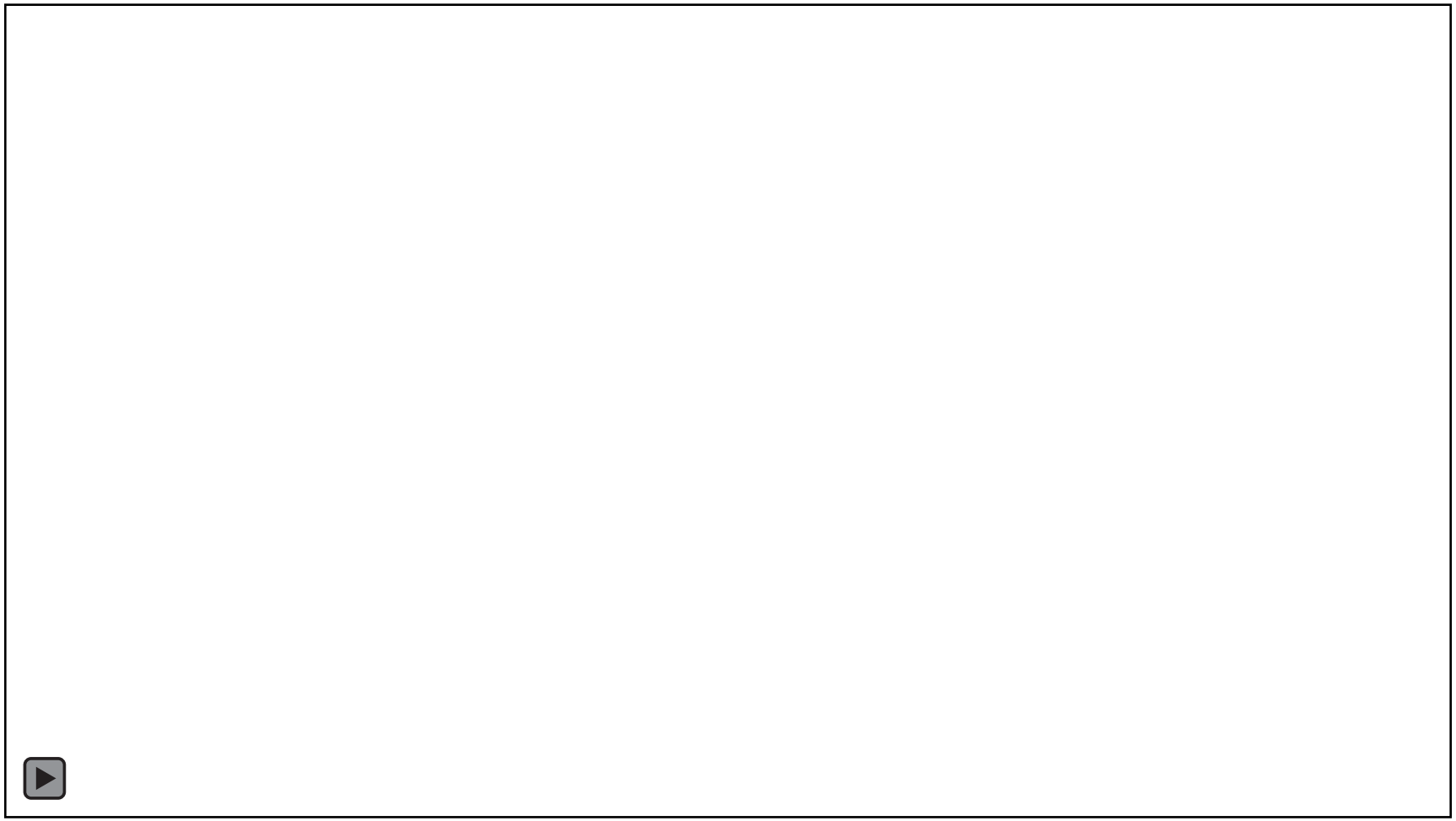
Norm of Acceleration



Orientation

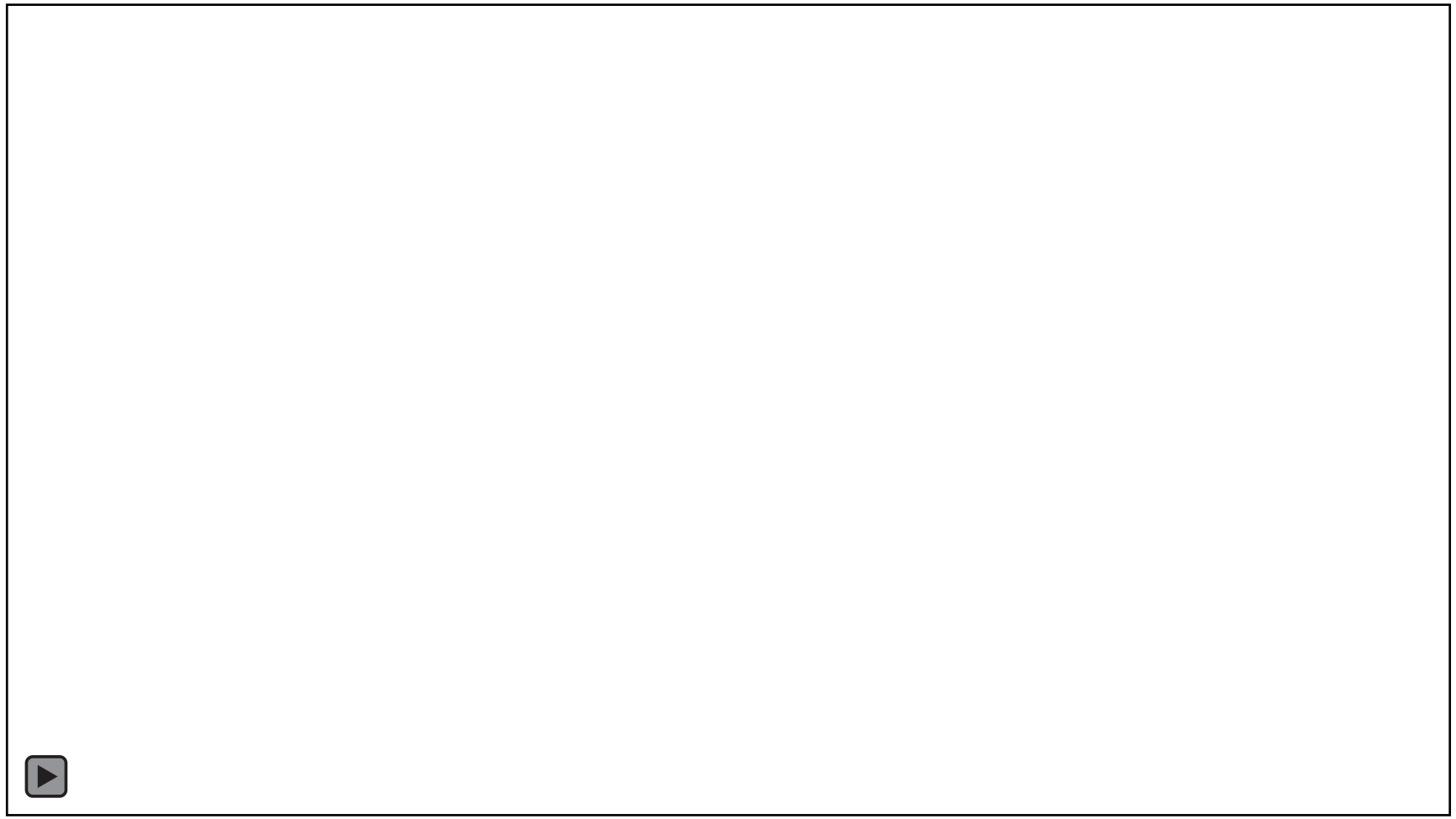
System Demonstration

- Impact + Sleep



System Demonstration

- RocknRoll + Impact



Conclusion

- The communication library based on the I2C protocol for STM32F411VE-MPU9255 is developed.
- Developed the AHRS algorithm used for motion detection and pose estimation in head-mounted devices, on the basis of IMU measurements.
- Furthermore, the safety detection algorithms for field workers are presented.
- Implemented the UART communication between STM32F411VE and the other embedded devices (ESP32) such that the system information can be passed into the PC Host by WiFi.
- On the PC side, the real-time pose monitor is established.