**1. Power Supply**

|  |  |
| --- | --- |
| Check Item | Details |
| Input voltage range | Support 5V (USB or battery) or 12V/24V (***camera-based power***) |
| Voltage regulator selection | LDO or buck converter depending on heat and current |
| Output voltage rails | 3.3V for MCU and IMU, 5V for IR LEDs (***open***) |
| Current capacity | Total load (MCU, IR LEDs, IMU) plus margin (***at least 3A***) |
| Protection | TVS, reverse polarity. |
| Decoupling capacitors | At regulator output, near MCU and IMU |

**2. Microcontroller (STM32F4, F7, H7 or ESP32)**

|  |  |
| --- | --- |
| Check Item | Details |
| I/O voltage compatibility | Matches peripheral voltages (e.g. IMU at 3.3V) |
| Sufficient GPIOs | For IMU, IR LEDs, debug, (***optional sync)*** |
| I2C interface | For IMU communication |
| SWD debug | Exposed pins or debug header |
| Flash and RAM memory | **Enough for Kalman filter, OSC stack, buffers** (***open***) |
| Timer or PWM channels | IR LED pulsing |
| WiFi or Ethernet support | **ESP32 has WiFi, STM32 may need module or PHY** (***open***) |
| Power consumption profile | Low-power mode for battery, active mode for runtime |

**3. IMU (MPU9250, MPU9255, BNO085)**

|  |  |
| --- | --- |
| Check Item | Details |
| Sensor type | 6DoF or 9DoF depending on fusion need***(open)*** |
| Communication interface | I2C or SPI |
| Sampling rate | Range of 200 to 500 Hz |
| Mounting orientation | Known and fixed for fusion math |
| Noise and drift specs | **Needed for Kalman tuning** (***open***) |
| Power supply | 3.3V typical |
| Level shifting | If MCU is 5V logic |
| PCB placement | Away from switching noise and vibration sources |

**4. IR LEDs**

|  |  |
| --- | --- |
| Check Item | Details |
| IR wavelength | Match external camera system |
| Drive current | Consider pulse and peak ratings |
| GPIO or transistor drive | N-MOS or NPN if current exceeds GPIO limits |
| Modulation method | **Optional for time-coded visibility** |
| Power supply rail | 5V preferred, include current-limiting resistors |
| Physical placement | line of sight visibility ***(Mechanical Design)*** |

**5. Debug Interface**

|  |  |
| --- | --- |
| Check Item | Details |
| Interface type | UART (ESP32) or SWD or JTAG (STM32) |
| Connector or test pads | Easy access for flashing and logging |
| Serial output for logging | **Useful for development and testing** |
| Bootloader support | boot button or sequence for flashing |

**6. Communication (OSC or UDP)**

|  |  |
| --- | --- |
| Check Item | Details |
| Protocol | OSC over UDP, optionally serial OSC |
| Library support | Lightweight OSC parser and sender |
| Throughput and latency | Must support at least 20 to 100 Hz updates |
| Synchronization | Timestamp sensor and camera data if combined |

**7. PCB and Layout**

|  |  |
| --- | --- |
| Check Item | Details |
| Grounding strategy | Solid ground plane, avoid split planes near MCU and IMU |
| Power plane integrity | Short return paths, minimize noise |
| Decoupling capacitors | Place near power pins of MCU, IMU |
| EMI control | Keep IR LED switching noise isolated |
| Mounting and connectors | Debug header, battery connector, power input pads |
| Component spacing | Keep heat-sensitive parts isolated |
| Test points | Add for voltage rails, IMU lines, LED outputs |

**8. Extra Features**

|  |  |
| --- | --- |
| Option | Purpose |
| EEPROM or Flash | Log sensor data or store calibration |
| Real-time clock (RTC) | For timestamping fused data |
| Barometric sensor | **For altitude estimation** |
| Status LEDs | For feedback and debugging |
| External sync pin | **For camera or system-wide sync pulse** |