



# Smart Cattle Monitoring System Documentation



## Project Overview

The **Smart Cattle Monitoring System** is designed to monitor cattle's environmental and physical conditions in real-time. This system utilizes various sensors, displays, and communication modules to provide accurate and actionable insights. It displays data on a TFT screen, sends updates via Bluetooth, and ensures critical information is continuously monitored.

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## Hardware Components

1. **LilyGo TTGO T-Display**
    - Microcontroller with integrated TFT screen
    - ESP32-based board for Bluetooth communication
    - **SDA:** GPIO21
    - **SCL:** GPIO22
  2. **MLX90614 Infrared Temperature Sensor**
    - Measures ambient and object temperature.
    - **SDA:** GPIO21
    - **SCL:** GPIO22
  3. **MPU6050 Motion Sensor**
    - Measures acceleration and gyroscope data.
    - **SDA:** GPIO21
    - **SCL:** GPIO22
  4. **Power Management**
    - **USB\_PIN:** GPIO2
    - **Battery Voltage Pin:** GPIO34
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## Functionalities

### 1. Temperature Monitoring (MLX90614)

- **Ambient Temperature:** Surrounding environmental temperature.
- **Object Temperature:** Surface temperature of the cattle.
- **Display:** Both temperatures are shown on the TFT display in cycles.
- **Bluetooth:** Temperature data is transmitted via Bluetooth for remote monitoring.

### 2. Motion and Orientation Detection (MPU6050)

- **Acceleration:** X, Y, and Z-axis data.
- **Gyroscope:** X, Y, and Z-axis rotation data.
- **Display:** Real-time movement data is displayed on the TFT.
- **Bluetooth:** Motion data is sent to the connected Bluetooth device.

### 3. Battery and USB Charging Status

- **Battery Voltage:** Voltage reading via GPIO34.
- **USB Connection:** Charging status detected via GPIO2.
- **Display:** Battery health is displayed periodically.
- **Bluetooth:** Battery health data is transmitted.

### 4. Display Information on TFT

- Displays data cyclically:
  1. Ambient Temperature
  2. Object Temperature
  3. Accelerometer Data
  4. Gyroscope Data
  5. Battery Information

### 5. Bluetooth Communication

- All sensor data is sent over Bluetooth for external monitoring on a mobile device or computer.

### 6. PNG Image Display

- A welcome screen displays an image using the integrated TFT screen.



## Pin Configuration

Component	Pin
SCL (I2C)	GPIO22
SDA (I2C)	GPIO21
Battery Voltage	GPIO34
USB Detection	GPIO2

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## Setup Instructions

1. **Install Required Libraries in Arduino IDE:**
  - Adafruit\_MLX90614
  - MPU6050\_light

- TFT\_eSPI
  - BluetoothSerial
  - PNGdec
2. **Wire the Components:**
    - Connect MLX90614 and MPU6050 to SCL (22) and SDA (21) pins.
    - USB connection pin to GPIO2.
    - Battery voltage to GPIO34.
  3. **Upload the Code:**
    - Ensure the board is set to ESP32 Dev Module.
    - Upload the code using Arduino IDE.
  4. **Bluetooth Pairing:**
    - Search for the Bluetooth device named AKIJ\_Cattle.
    - Connect via a mobile app or serial monitor.
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## Code Breakdown

### 1. Initialization (setup()):

- Initialize **I2C, Bluetooth, TFT Display, and Sensors**.
- Display a **welcome screen** with an image.

### 2. Main Loop (loop()):

- **Every 15 seconds:** Display battery health for 2 seconds.
- **Sensor Data Display:** Cycles through temperature, accelerometer, and gyroscope readings.
- **Bluetooth Updates:** Send all sensor data periodically over Bluetooth.

### 3. PNG Image Rendering (pngDraw()):

- Decodes and displays a PNG image on the TFT screen.
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## System Behavior Workflow

1. **Startup Sequence:**
  - Displays the welcome message and image.
2. **Periodic Updates (every 15s):**
  - Show battery health for 2 seconds.
3. **Sensor Data Cycle (3s intervals):**
  - Ambient Temperature → Object Temperature → Accelerometer → Gyroscope.
4. **Bluetooth Updates:**
  - Real-time data sent continuously via Bluetooth.



## Bluetooth Commands Example

- **Ambient Temp:** Ambient Temp: 25.5 C
  - **Object Temp:** Object Temp: 27.2 C
  - **Accel:** Accel: X:0.05, Y:0.02, Z:0.98
  - **Gyro:** Gyro: X:0.2, Y:0.1, Z:0.05
  - **Battery:** Voltage: 3.7V, Charging: Yes
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## Troubleshooting

1. **No Sensor Data Displayed:**
    - Verify I2C connections (SDA, SCL).
    - Check the power supply.
  2. **Bluetooth Not Connecting:**
    - Ensure Bluetooth is enabled on the mobile device.
    - Restart the device and try again.
  3. **Battery Readings Incorrect:**
    - Verify resistor divider circuit for voltage sensing.
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## Future Improvements

- Add real-time cloud integration for remote monitoring.
- Integrate additional sensors for humidity and gas detection.
- Implement alerts for critical conditions via mobile notifications.