Location Guide Using RF and Microcontroller

-Using HT12E/HT12D, 433 MHz RF, and XIAO-ESP32-C3 Microcontroller

This wireless distance indication system is designed around the AT89S52 microcontroller, which acts as the main processing unit of the receiver. The system works by using simple wireless pulses that are transmitted from a handheld RF transmitter to a receiver circuit. The transmitter uses an HT12E encoder and a 433 MHz RF module to send out a coded radio signal each time the user presses the button. Each button press produces a single wireless pulse. To determine the distance, the user presses the button twice. These two pulses travel through the air and are picked up by the 433 MHz RF receiver, where the HT12D decoder validates the signal and outputs clean digital pulses on its D0 pin.

The AT89S52 microcontroller monitors this D0 output. When the first pulse arrives, the microcontroller records the current time. When the second pulse arrives, it again records the time and calculates the **time gap** between the two pulses. The size of this gap helps estimate the effective signal quality. A small gap means the signal is strong and steady, indicating the transmitter is **NEAR**. A medium gap indicates **MID** distance. A large gap suggests weaker signal stability, indicating the transmitter is **FAR**. Using this simple timing-based technique allows the AT89S52 to classify distance without requiring complex RF measurements.

To support low-power operation and battery running capability, the system includes a **XIAO ESP32-C3 module**, not as the main controller, but as a **power-management and supply regulation unit**. The ESP32-C3's onboard voltage regulation features allow it to deliver a clean and stable 3.3 V supply to the AT89S52, RF receiver module, and LCD. Because the ESP32-C3 includes an onboard USB Type-C power interface and can be easily connected to Li-ion/Li-Po batteries, it acts as a compact and modern **battery controller, regulator, and supply distributor**, simplifying the design and ensuring stable operation even from portable power sources.

After the timing calculation, the AT89S52 microcontroller displays all relevant results on a 16×2 I²C LCD, including the distance category (NEAR/MID/FAR), the measured time gap, the calculated pulse speed (FPS), signal strength interpretation (HIGH/MED/LOW), and an approximate distance in meters. The display shows everything on a single screen for easy reading. After displaying the result for a short period, the system automatically resets and waits for the next two pulses. This combination of a simple timing algorithm, a classic AT89S52 microcontroller, and the modern ESP32-C3 power-management module results in a beginner-friendly yet effective wireless distance estimation system.

WORKING PRINCIPLE :

The wireless distance-indication system works by sending simple radio signals from the transmitter to the receiver and measuring the **timing difference** between two button presses. This timing difference allows the system to estimate how close or far the transmitter is from the receiver. The core operation of the system is handled by the **AT89S52 microcontroller**, while a **XIAO ESP32-C3 module** is used purely for **battery handling and power regulation** to ensure stable operation.

System Implementation

1. **The transmitter unit** consists of an HT12E encoder, a 433 MHz RF transmitter module, a pushbutton, and a simple DC power source.
2. **When the user presses the transmitter button**, the HT12E encoder generates a digital encoded packet containing address and data bits.
3. This encoded packet is sent to the **433 MHz RF transmitter**, which broadcasts the packet as a wireless RF pulse.
4. **Each button press produces one RF pulse**, and the system requires two presses to perform distance estimation.
5. The **receiver unit** contains a 433 MHz RF receiver module connected to an HT12D decoder IC.
6. The RF receiver captures the wireless signal and passes the demodulated data to the **HT12D decoder**.
7. When the HT12D detects a valid packet (matching address and data), it outputs a short HIGH pulse on its **D0 pin**.

8. The **D0 output pulse is connected to the AT89S52 microcontroller**, which acts as the main controller of the system.
9. The AT89S52 records the **timestamp of the first pulse** using its internal timer.
10. When the second RF pulse arrives, the AT89S52 records the **timestamp of the second pulse**.

The microcontroller calculates the **time gap** between the two pulses using:

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GAP = Time2 − Time1
```

11. This time gap reflects the **signal stability and strength**, which naturally decrease as the transmitter moves farther away.
12. A **small gap** indicates strong reception and is classified as **NEAR**.
13. A **medium gap** indicates moderate signal reliability and is classified as **MID**.
14. A **large gap** indicates weak or delayed reception and is classified as **FAR**.
15. The AT89S52 also calculates additional values such as:
    - **FPS (pulse speed)**
    - **Signal strength level (HIGH/MED/LOW)**
    - **Approximate distance (in meters)**
16. All results are displayed on a **16×2 I²C LCD screen** for clear user feedback.
17. A **XIAO ESP32-C3 module** is included purely as a **battery and power-management unit**, providing stable regulated voltage to the AT89S52, RF receiver, and LCD.
18. After showing the distance and signal parameters, the system **automatically resets** and waits for the next pair of pulses.
19. This implementation creates a **simple, low-cost method to estimate distance** using only timing analysis and basic RF communication components.

System Architecture :