Project Proposal: Real-Time Sensor Data Acquisition and Transmission System

1. Introduction

In the era of the Internet of Things (IoT) and real-time monitoring, acquiring sensor data efficiently and transmitting it for processing or display is crucial. This project aims to develop a system that interfaces with various sensors, processes the data using an FPGA, and transmits the information to external devices via UART communication protocol.

2. Objectives

- Conduct comprehensive research on existing real-time data acquisition systems.
- Design and implement a system that collects data from sensors, processes it using FPGA, and transmits it via UART.
- Develop a detailed project plan outlining system functionality, required components, and implementation strategy.

3. Literature Review

Several studies have explored FPGA-based data acquisition systems:

- A high-performance DAS on a single Virtex5 FPGA offers flexibility and power efficiency.
- Multi-channel real-time data acquisition systems using 16-channel ADCs support up to 100 MSPS, emphasizing the importance of integrating acquisition and processing on a single FPGA chip.
- Implementations focusing on human body motion measurement systems highlight the versatility of FPGA in real-time sensor data acquisition.

4. System Requirements

Hardware Components:

- **FPGA Board**: iCE40UP5K or similar
- **Sensors**: Ultrasonic sensor (e.g., HC-SR04)
- **ADC**: If sensors provide analog output

- **UART Interface**: USB-to-Serial converter (e.g., FT232RL)
- **Power Supply**: 5V regulated power source

Software Tools:

- **HDL**: Verilog
- **Synthesis Tool**: Yosys
- **Place and Route Tool**: NextPNR
- **Programming Tool**: IceStorm
- **Serial Monitor**: PuTTY or Tera Term or picocom/

5. System Architecture

The system comprises the following modules:

1. **Sensor Module**: Captures physical data (e.g., distance)
2. **Processing Module (FPGA)**:
    - **Sensor Interface**: Handles sensor signal timing
    - **Data Processing**: Processes raw sensor data

    - **UART Transmission**: Formats and sends data via UART
3. **Communication Module**: Transmits data to external devices

6. Implementation Strategy

1. **Module Development**:
    - Design and test individual modules: sensor interface, data processing, UART transmission.
2. **Integration**:
    - Combine modules and ensure seamless data flow.
3. **Testing**:
    - Validate system functionality with real sensor data.
4. **Optimization**:
    - Enhance system performance and reliability.

7. Project Plan and Timeline

Week	Task
1	Literature review and requirement analysis
2	Design sensor interface module
3	Develop data processing module
4	Implement UART transmission module
5	Integrate modules and perform testing
6	Optimize system and prepare documentation
7	Final testing and project presentation

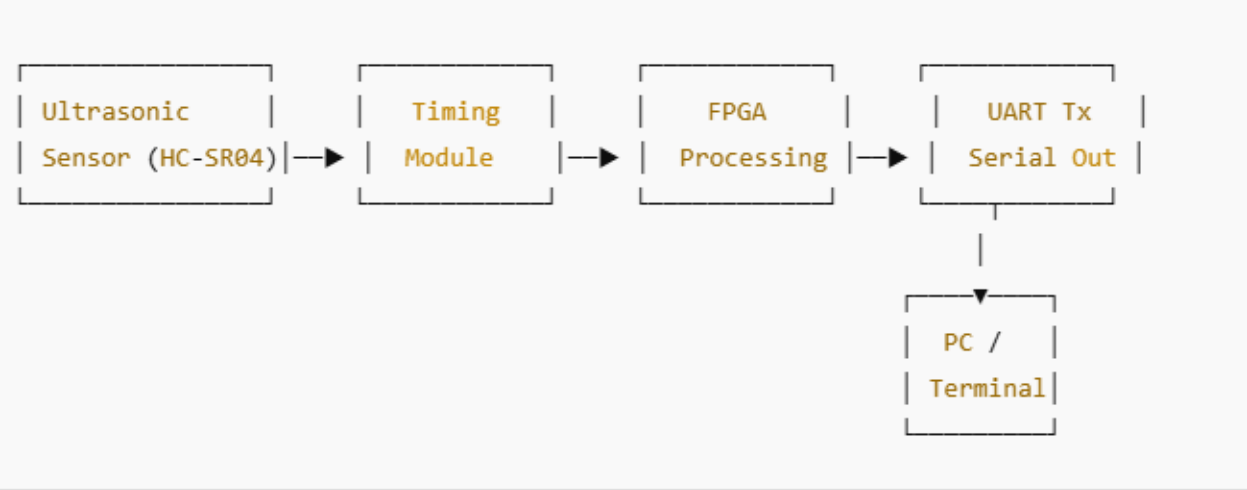
8. Deliverables

- Comprehensive project proposal document

- System architecture diagrams
- Detailed project plan with timelines
- Verilog source code for all modules
- Test reports and performance analysis

9. Block diagrams.

i)



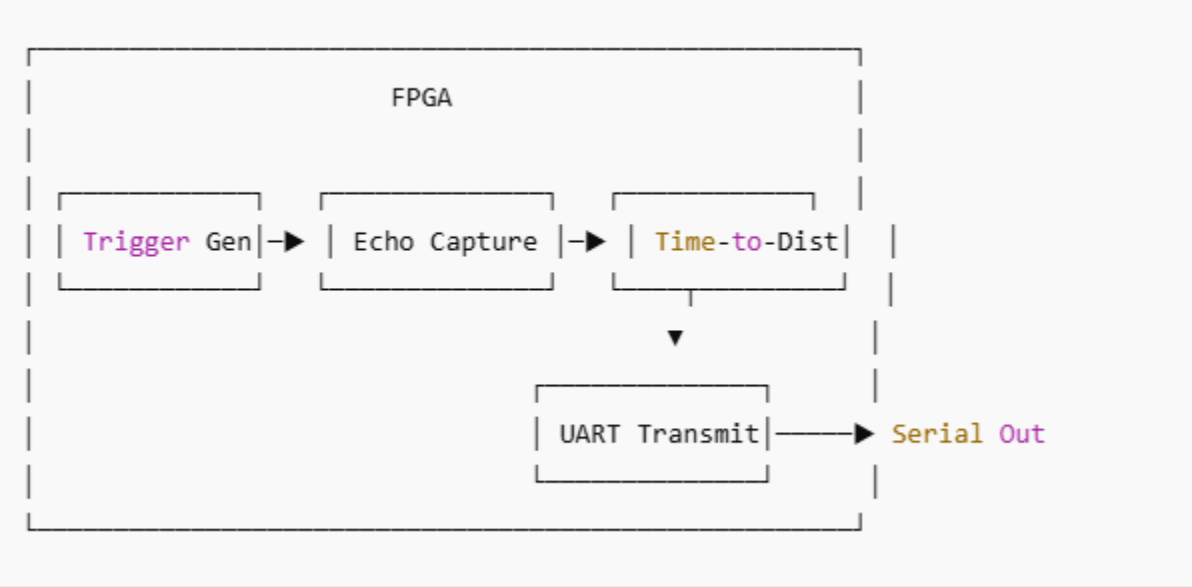
Ultrasonic Sensor: Sends a trigger and receives an echo.

Timing Module: Calculates time between trigger and echo to find distance.

FPGA Processing: Converts time to distance using formula and prepares data.

UART: Transmits result to PC for display.

ii)



- **Trigger Generator:** Sends a 10µs pulse to trigger the sensor.
- **Echo Capture:** Measures the pulse width of the echo signal.
- **Time-to-Distance Converter:** Calculates the distance using distance = (time × speed_of_sound)/2.
- **UART Transmit:** Sends the distance value over serial to a display terminal.