UART Sensor Integration Project Documentation

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1. Study of the Existing Code

The uart_tx_sense project from the VSDSquadron_FM repository integrates a UART transmitter with a sensor interface module on the FPGA. The Verilog code is structured with the following key modules:

Key Components:

1. top.v (Top-Level Module):

- **UART Transmission:**

    o This module triggers UART transmission when sensor input data is available.

- **Clock Division:**

    o Generates a lower-frequency clock from the 12 MHz main oscillator, typically 9600 Hz, using a counter.

- **Sensor Interfacing:**

    o Receives digital signal inputs (intended from a sensor) and passes the value for UART transmission.

- **LED Indicator:**

    o Uses RGB LED logic or single LED pin as output indicator upon data capture or transmission events.

2. uart_tx_8n1.v (UART Transmitter):

- **Transmission Protocol:**

    o Implements 8N1 protocol (8-bit data, no parity, 1 stop bit).

- **State Machine Control:**

    o Controls the transitions between idle, start bit, data transmission, and stop bit states.

- **Trigger-Based Sending:**

    o Waits for a senddata signal before initiating UART transmission.

3. Pin Constraint File (.pcf):

- **Defines pin locations for:**

    o UART TX: Pin 14

    o Clock: Pin 20

    o Sensor Input: Assigned appropriately (based on design, e.g., Pin 18)

    o LED Output: Pin 39 (or equivalent)

4. Makefile:

- **Automation of Flow:**
    - Handles synthesis, place and route, and bitstream generation.
    - Uses yosys, nextpnr-ice40, icepack, and iceprog tools.
    - Supports terminal setup using picocom.

Implementation Steps

Hardware Setup:

1. FPGA and Sensor Connection:

- Connect the ultrasonic sensor's output to the FPGA input pin defined in the constraint file.
- Connect FPGA to PC using a USB cable (for power and UART).

2. UART Connection:

- Ensure the uart_tx pin is connected to a USB-to-Serial converter (if not inbuilt).

3.Serial Terminal Setup:

- Use picocom or similar to observe the UART data:

sudo picocom -b 9600 /dev/ttyUSB0

Synthesis & Upload

1. Compile and Generate Bitstream:
Run the following command in the terminal:

make

2. Upload to FPGA:
Flash the FPGA with:

sudo make flash

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4. Testing & Verification

Test Procedure:

1. **Open Serial Terminal:**
    - Launch terminal using picocom.

2. **Sensor Stimulation:**
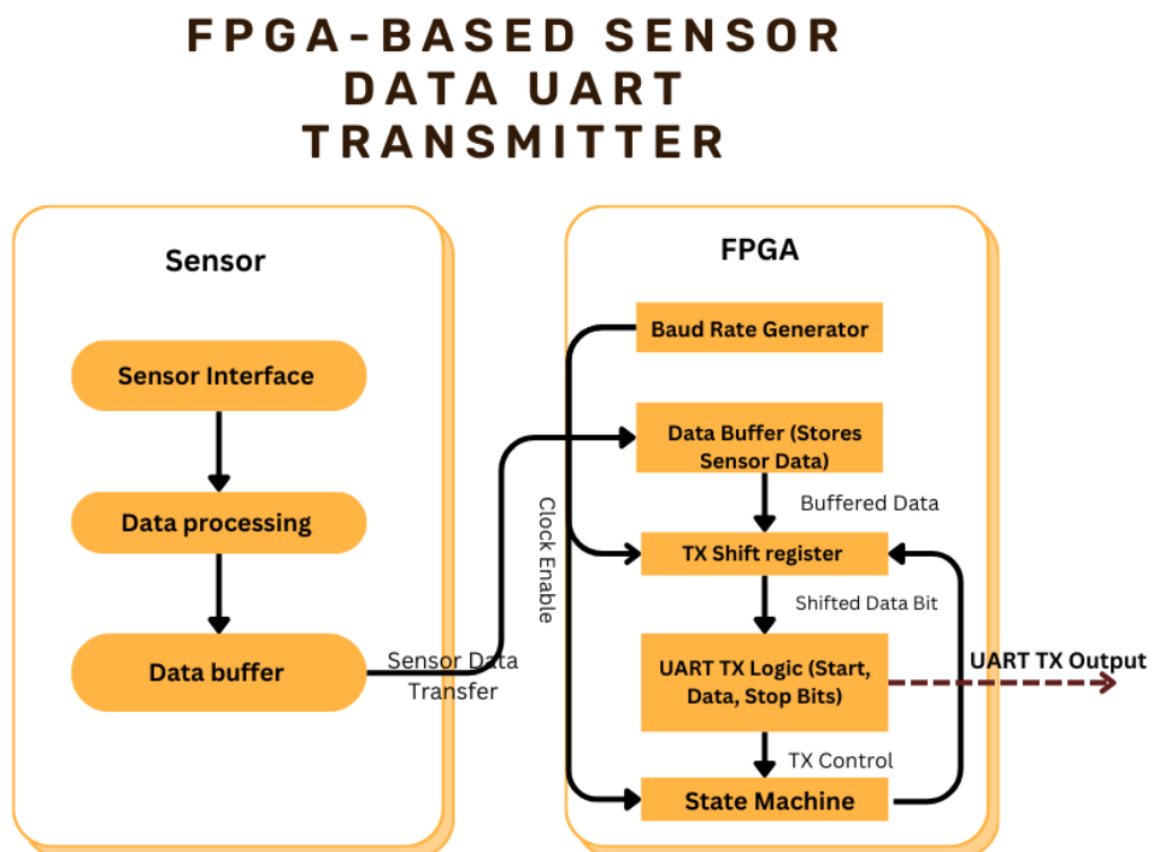   - Activate the ultrasonic sensor or simulate its digital signal.

3. **Observe UART Data:**

   o   Check if sensor-triggered values are transmitted to the serial terminal.

Expected Outcome:

- Sensor-triggered values are seen as characters/bytes on the serial monitor.

5.Block diagram:

6)Circuit diagram: