Project: Implementation of Communication Protocol on FPGA

Innovation and Originality

I. Introduction

In ICT, innovation often comes from combining existing technologies in new ways. My project, *Implementation of Communication Protocols on FPGA*, brings together UART, SPI, and I²C protocols in one system and connects them with Arduino hardware and a web-based dashboard for visualization. Normally, projects focus only on one protocol at a time, but here multiple protocols work together in a single framework.

The originality of this project lies in its multi-level approach: hardware implementation on FPGA, simulation using ModelSim, and real-time visualization through a web dashboard. This makes the project useful not only for communication but also for learning, debugging, and expanding protocol-based systems.

II. Novel Approach

1. **Multi-Protocol Integration on FPGA**
    - Instead of only UART or SPI, this project integrates both in one system.
    - Data flow:
        - User sends data from PC → FPGA receives via UART → sends to Arduino through SPI.
        - Arduino increases the data by 1 → sends it back via SPI → FPGA sends it back to PC via UART.
    - This creates a complete communication loop across devices.
2. **FPGA as Master, Arduino as Slave**
    - Usually, Arduino or microcontrollers act as master, while FPGA is used as helper.
    - Here, FPGA directly controls Arduino as master in SPI communication.
    - This shows FPGA's strength in managing real hardware devices.
3. **Web Dashboard for Visualization**

- A simple web dashboard is proposed that can detect communication ports and later show real-time waveforms.
- This makes the system more user-friendly and connects hardware with ICT/web technologies.

4. **Simulation and Expansion**
    - Protocols are also tested in ModelSim for simulation.
    - Both hardware + simulation strengthen understanding.
    - Future scope: adding CAN, Ethernet, or other advanced protocols.

Comparison with Existing Solutions

- **Typical Academic Projects:**
    - Focus only on one protocol (UART-only or SPI-only).
    - Limited to basic send/receive functions.
- **This Project's Difference:**
    - Combines multiple protocols (UART + SPI) in one continuous chain.
    - Integrates FPGA, Arduino, and web dashboard for real-time use.
    - Provides a low-cost, flexible, and educational platform.

Contribution to ICT:

Impact:

- Students → better understanding through practice.
- Educators → ready-made teaching tool.
- Researchers → platform to extend with new protocols.
- Industry → scalable, low-cost protocol tester.

Conclusion

The originality of this project is not about inventing a new protocol but about creating a unique, integrated platform. By combining FPGA, Arduino, and a web dashboard, it offers a flexible and low-cost way to learn and test UART, SPI, and I²C.

Unlike single-protocol projects or costly trainer kits, this design is simple, accessible, and expandable. Its contribution to ICT is meaningful—it connects education and industry needs, supports IoT/embedded system growth, and opens doors for future development.