Summer Research Project: FPGA-Based Control Systems for Quantum Annealing Hardware

Faculty Supervisor: Selcuk Kose

This project focuses on developing precision timing and control infrastructure for annealing systems using FPGA technology. The student will design and implement programmable sequencing logic that manages the initialization, operation, and measurement phases of annealing experiments.

The core technical objective is to create an FPGA-based controller that coordinates multi-phase experimental sequences with microsecond-level timing precision. This includes implementing state machines for register initialization, configuring programmable timing intervals for the annealing phase, and developing synchronization protocols between the FPGA and external control systems. The student will work with high-speed digital logic operating at frequencies exceeding 100 MHz and learn to manage clock domain crossing, counter-based timing generation, and external interface protocols.

Through this project, the student will gain hands-on experience with hardware description languages (Verilog/VHDL), FPGA development tools, and embedded system interfacing. They will learn fundamental concepts in digital design including finite state machines, clock management, and hardware-software co-design. The project provides exposure to unconventional computing hardware interfaces while developing practical skills in FPGA programming and experimental automation.

Prerequisites: Basic digital logic knowledge (ECE 111 or equivalent). Familiarity with a programming language (Python, C, or similar) is helpful but not required. Interest in hardware design and experimental systems.

Learning Outcomes: FPGA design and implementation, precision timing systems, hardware-software interfaces, experimental automation, technical documentation.