Cover page

Project Title: ……Rubik's Cube Solver…….. Academic Year: ……2025……

Group Members: ……Momen Anani……. Department Name: ……Engineering and IT……

Mohammad Hamdan
……..

……...

……

……

Supervisor Name: ……Dr. Suleiman Abu Kharmeh……

Format:

- Single space, Times New Roman.
- 12 pt,
- Maximum 1 page.

Abstract Body:

Items must be provided in the Abstract:

- Why do you think this project is important? Please explain the significance of this Project in brief.
- In your point of view what are the important aspects that should be covered in the project?
- Objective(s): In your view, please explain the main objectives of the project.
- Methodology: Give a brief outline of the application development process.
- Had this project been done before? Are there any similar applications available today?

- **Note:** Please deliver this abstract early to ensure that your Project has been approved by the department's projects committee. **Registration will not be done without this approval.**

Project's Abstract:

This project presents the design and implementation of a Rubik's Cube solving and control system entirely developed on FPGA hardware, extended with wireless connectivity through an ESP module. The system is capable of automatically solving or shuffling the cube with adjustable difficulty levels, all controlled via a mobile application using Wi-Fi or Bluetooth communication. Unlike conventional implementations that depend on microcontrollers or software-based image processing, this project performs all visual recognition, color detection, decision logic, and motion control directly in hardware logic.

The setup integrates multiple peripherals including a camera module for cube face acquisition, servo and stepper motors for mechanical manipulation, an LCD display for showing real-time status and timer data, and key inputs for manual operation or mode switching. Communication between modules is achieved through hardware-level I²C, SPI, and PWM interfaces, requiring careful synchronization, memory management, and timing optimization. The integration of these diverse peripherals demonstrates the FPGA's capability to handle both computational and interfacing complexity.

This project is significant because it showcases how advanced robotic and vision-based tasks can be achieved purely in hardware, paving the way for future FPGA-based intelligent systems that combine deterministic performance, low latency, and real-time decision-making. Although Rubik's Cube solvers exist using software or embedded microcontrollers, a fully hardware-driven solution remains rare and challenging, particularly when expanded with wireless control and multi-mode operation.