ECE 414 Final Project Grading Report

Group: *Efe Civisoken, Jack Ewing*
Project: *Hybrid Ultrasonic–Doppler Radar System*

Category 1: Functioning Demo (Core Requirement)

- **Max Points:** 10
- **Awarded:** 10
- **Justification:**
  The system is fully functional and robust: accurate ultrasonic ranging, reliable Doppler motion detection, 360° scanning, real-time TFT radar display, non-blocking execution, and graceful error handling. All core requirements are met and demonstrated in the video and live demo.

Category 2: Technical Implementation & Separation

- **Max Points:** 4
- **Awarded:** 4
- **Justification:**
  Exceptional modular design with clear separation: servo control, ultrasonic timing, Doppler ADC/RMS processing, display rendering, FSM orchestration. Use of interrupts, hardware timers, ADC, PWM, and SPI shows deep embedded systems mastery. Analog/digital separation for noise mitigation demonstrates professional hardware-software co-design.

Category 3: Introduction & Problem Definition

- **Max Points:** 5
- **Awarded:** 5
- **Justification:**
  Clearly articulates the problem (limitations of single-sensor systems), motivation (hybrid sensing for situational awareness), and specific, measurable objectives. Well-researched and professionally framed within embedded perception systems.

Category 4: Design Description & Documentation

- **Max Points:** 7
- **Awarded:** 7
- **Justification:**
  Comprehensive documentation: high-level block diagram, detailed FSM diagram, KiCad schematic, subsystem breakdown, and mechanical integration photos. Design justifications are thorough and reflect professional engineering reasoning. Schematics are clear and support full reproducibility.

Category 5: Test Report & Results

- **Max Points:** 10
- **Awarded:** 10
- **Justification:**
  Outstanding test matrix covering functional, timing, robustness, and error handling. Each requirement is mapped to a test with clear procedure, expected result, actual result, and evidence. Quantitative data (error $\leq \pm 5$ cm, current ≤ 500 mA) and representative logs are provided. Testing is rigorous and professionally documented.

Category 6: Discussion, Analysis & Conclusion

- **Max Points:** 5
- **Awarded:** 5
- **Justification:**
  In-depth analysis of technical challenges (Doppler noise, analog-digital coupling) and solutions (physical separation, RMS/hysteresis). Discusses trade-offs (sweep speed vs. resolution, sampling window vs. responsiveness). Reflects on hardware-software co-design lessons. Conclusion summarizes achievements and provides actionable advice for future students.

Category 7: Documents & Presentation Quality

- **Max Points:** 5
- **Awarded:** 5
- **Justification:**
  Code is modular, well-commented, and available on GitHub with a detailed README. Report is professionally formatted, includes IEEE-style references, appendices with setup instructions, and clear diagrams. Writing is precise and meets publication-ready standards.

Category 8: OVERALL GRADE

- **Max Points:** 4
- **Awarded:** 4
- **Justification:**
  Report is exceptionally polished, logically structured, and visually coherent. Diagrams are professionally rendered, and the presentation reflects top-tier engineering communication.

TOTAL SCORE: 50/50 (100%)

Summary Feedback

Exemplary work. This project represents the gold standard for an ECE 414 final report. It demonstrates deep technical understanding, professional documentation, rigorous testing, and robust implementation. The hybrid sensing approach, noise-aware design, and deterministic FSM architecture reflect mature embedded systems engineering. Every rubric category is fully satisfied. This is a model submission for future students. Well done, Efe and Jack.

Best.
Prof. PK.