EE411 Senior Design

Electrical and Computer Engineering Department

2008

Design Capstone

- Student owned
- Professor mentored
- Course coordinator supported

Deliverables

Week of 25 Aug
- Project Assignment #1 Due (Team Selection & Preliminary Project Ideas)

Week of 8 Sep
- Project Assignment #2 Due (Simple Problem Statement)

Week of 15 Sep
- Project Assignment #3 Due (Extended Problem Statement)

Week of 22 Sep
- Project Assignment #4 Due (The Requirements Specification)

Week of 20 Oct
- Project Assignment #5 Due (System Design Architecture)

Week of 27 Oct
- Project Assignment #6 Due (The Project Plan)

Deliverables (cont)

- Peer evaluations
- Weekly progress reports – to mentors

- Prototypes (as part of the project proposal)
  - Mentor guided/defined
  - Small piece of final project
  - Can be simulation

Voigt Venture Capital Corp

- Our Goal – to help YOU succeed
  - Foster greater understanding of the importance of venture capital
  - Support entrepreneurial activity and innovation
  - Maintain high professional standards
  - Bring customers and innovators together

Federal Express, Intel, Sun Microsystems and Genentech are all examples of successful companies who were once venture-backed.

Program Plan

- Present ideas
- Form teams
- Teams choose top 3 projects
- Receive assignments
  - May be student generated – requires extra work
- Begin design process

Project List

- Fiber Optic Cellular Repeater
- Beagleboard Interface
- Solar Panel Controller
- Two-Man Quiet Reconnaissance Vehicle
- IED Red Cell
- IED Blue Cell
  - Prevent
    - Persistent Surveillance Network Design
    - Sensor Module for Persistent Surveillance System
  - Detect
    - Robot mounted metal detector
- RoboCup
- Multi-spectral Imager
- Video Surveillance/Tracking
- Microstrip Antenna Design
- Computing In Parallel
- Diesel-Hybrid Project
- Speed Control of a Large DC Motor
- Analysis of Interlace Artifacts in Public Datasets
- Class-D Amplifier

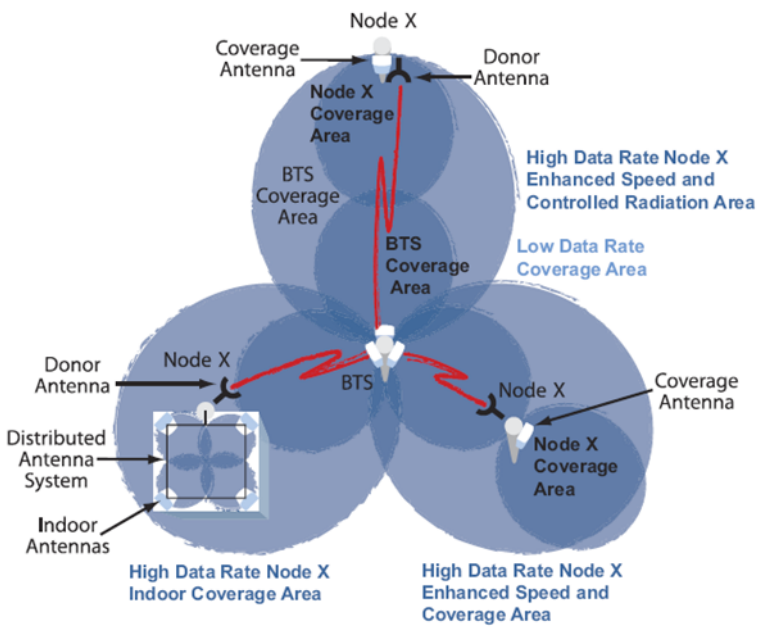
Fiber Optic Cellular Repeater Overview

Problem:

Cellular signals are weak (or nonexistent) on the lab deck of Rickover.

Goals:

Develop a repeater to receive cellular signals, amplify, filter, and rebroadcast them on the Rickover lab deck.



Fiber Optic Cellular Repeater Design Objectives

- Receive, filter, and digitize cellular signals from an antenna mounted outside Rickover Hall.
- Optically modulate these signals and transmit them to a single rebroadcast antennas.
- Repeat the process for the uplink direction.
- Design the system for future expansion (multiple rebroadcast antennas).

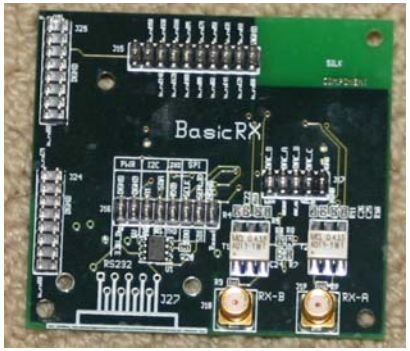
Beagleboard SDR Interface Board Overview

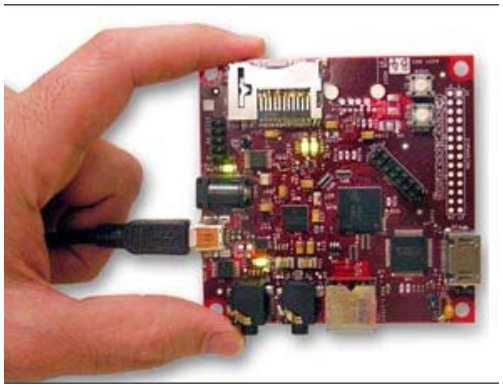
Problem:

The software radio community is in dire need of a low-cost, moderately high performance embedded development platform.

Goals:

Develop an FPGA-based interface board between the Beagleboard (a $150 high-performance embedded processing platform) and COTS Analog Front Ends (AFE's).





Beagleboard SDR Interface Board Design Objectives

- Interface between an ADC and a USRP TX/RX daughterboard.
- Interface between the ADC and Cyclone III FPGA.
- Control sampling clocks, FPGA timing, and command & control signals; deal with all the different logic voltages.
- Integrate the solution onto a small, low-cost PCB.
- Demonstrate complete system integration with a version of GNU radio running on the Beagleboard.

Solar Panel Controller

- Project Goals
  - Constant Load Voltage
  - Maximum Power Point Tracker (MPPT)
  - Battery Charger
- DC/DC Converter Design
- PIC-Based MPPT Control
- Battery State of Charge Indicator
- Battery Charging Control

Design Competition

- Two-Man Quiet Reconnaissance Vehicle
  - 2 personnel + 300 lbs of gear
  - Top Speed
    - > 30 mph
  - Total Range
    - 150 miles
  - Grade
    - up to 15%
  - Air droppable
    - 28.5ft/s on impact

More Specifications

- Ultra-Quiet: on gravel road
  - <52dBA at 30mph from 100m
  - <40dBA at 10mph
- Overcome
  - Rocks ~8”
  - 4ft narrow passageways
- Budget Constraint:
  - < $30k

IED Red Cell

- Students are challenged to design an IED (minus the explosives)
- Classified brief in fall semester
- Design parameters
  - Inexpensive
  - Readily available parts
  - Not already seen in theater

Blue Cell - Prevent

- Persistent Surveillance
  - Wireless Network Design
- Sensor Network
  - Sensor Design

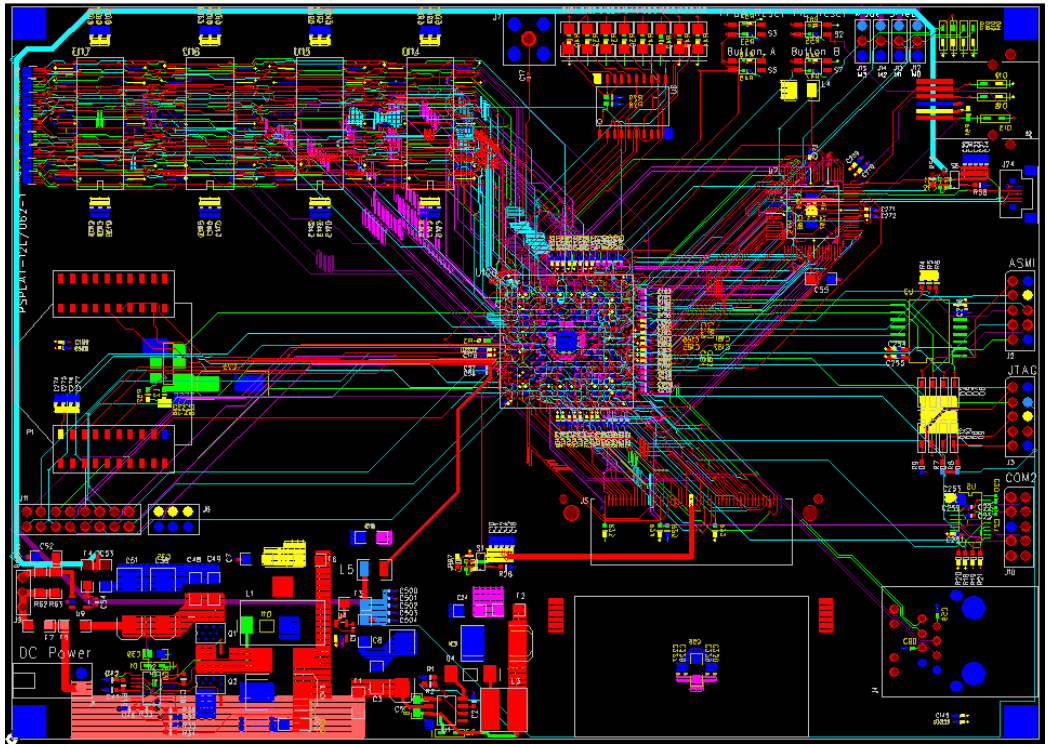
Persistent Surveillance Blue Cell Overview

Problem:

IED's continue to be a threat around the world.

Goals:

Make use of the new Persistent Surveillance platform to design a sensor network for IED detection.



Persistent Surveillance Blue Cell Design Objectives

- Develop an ad-hoc network of up to 10 PS sensor nodes.
- Interface with one or more physical sensors via I/O ports.
- Relay threat information through the network to a C2 center.
- Develop resistance to jamming and denial-of-service attacks. Incorporate LPD to hide the network operation.

Sensor Module for Persistent Surveillance System

- Goal: to create a node in a continuous surveillance system for use in force protection
- Objectives
  - Continuously monitor area in low-power mode until vibration (or other cue) sensed
  - Upon detecting vibration, power on additional sensors and relay information back through hockey puck network
  - Entire node should be battery powered, inexpensive and compact.

Blue Cell - Detect

- Buried 152mm shell detector
- Uses Garrett metal detector
- Robot mounted
- Design
  - Integrate existing metal detector
  - Wireless data network
  - Use new robots

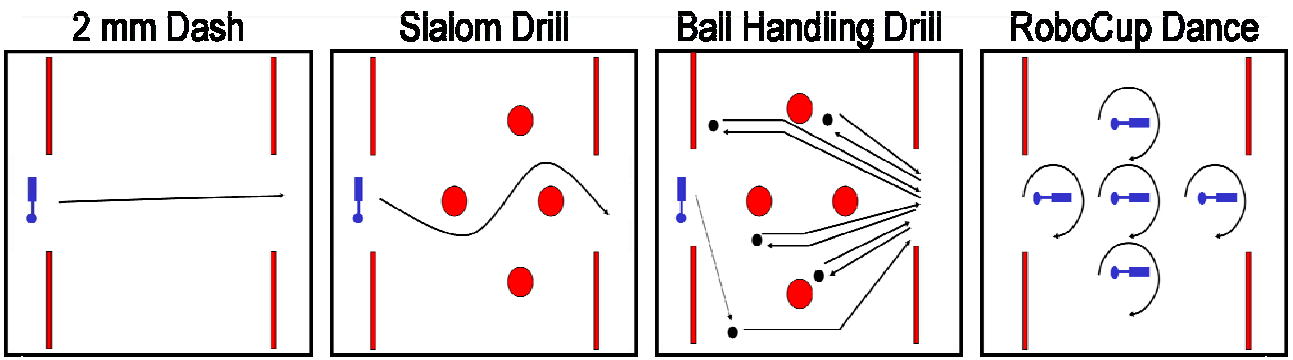
Talon Robot

Gripper Camera
(IR Illuminated)
Illumination
Package
Monocular IR
Camera
Zoom
Camera
Pan/Tilt
Elbow Camera
Microphone
Antennae
Gripper
Mast
360° Rotating
Wrist
Operator
Control Unit
Fiber Optic
Spool
Speaker
Rear
Camera
Tracks
Ballistic
Cover

Mini Andros Robot

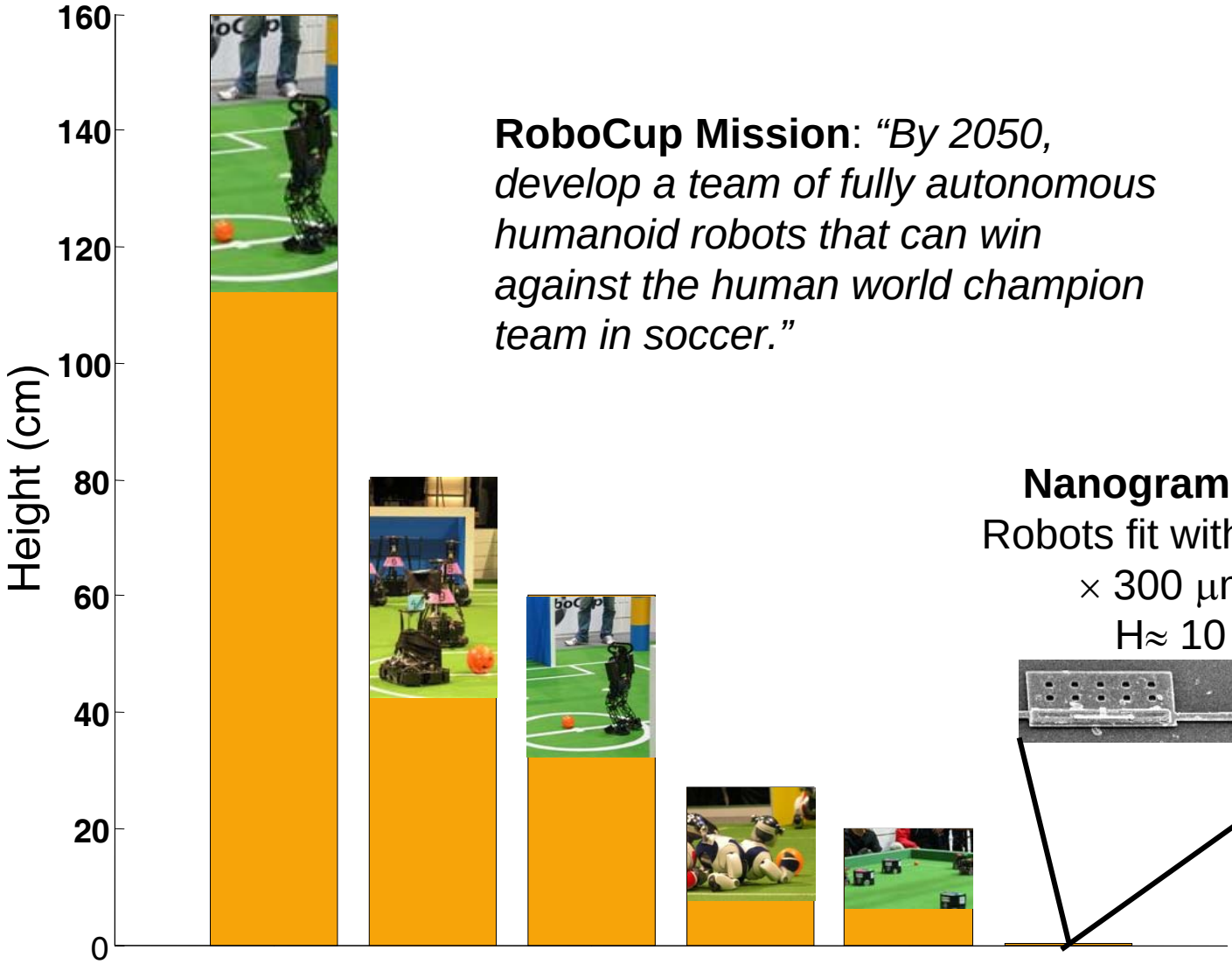
RoboCup

- Goal: to create a nanogram scale robot that can compete in soccer-related agility tasks



RoboCup 2009

Graz, Austria June 29 – July 5

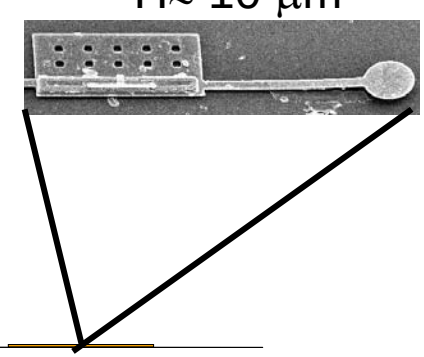


RoboCup Mission: *"By 2050, develop a team of fully autonomous humanoid robots that can win against the human world champion team in soccer."*

Nanogram League

Robots fit within 300 μm × 300 μm box

H≈ 10 μm



Multi-spectral Image Acquisition

- Need
  - Iris recognition has traditionally been done in the near infrared (NIR).
  - Understanding the effects of changing the illumination wavelength is important for cases in which NIR imaging is impractical (e.g. the milk box scenario)
  - One use: iris recognition

Multi-spectral Imager

- Approach
  - Multi-spectral illuminator composed of LEDs of various wavelengths
  - Computer controlled constant current power supply to drive LEDs
  - Camera with sufficient spectral range (e.g. Noble Peak).
  - Software to control illuminator and camera
  - Experiments conducted in low ambient
    - ambient irradiance low relative to active

Video Surveillance/Tracking

- Goal: develop a real-time video surveillance and tracking system
- Description
  - Surveillance of a room. When a person enters, they are tracked by video processing that will provide: a time stamp, an image of the person, and will steer the surveillance camera(s) to follow their movement and record the video.
- Components
  - Desktop PC
  - Frame Grabber (board for PC)
  - Steerable video camera
  - Interface/Control software (C++)
    - Use of Intel OpenCV libraries of image processing tools

- Number of students: 1

Microstrip Antenna Design Project

- Project Outline

Study microstrip antenna designs

Learn Sonnet EM Program for antennas

Design and Simulate antenna using Sonnet

Fabricate antenna

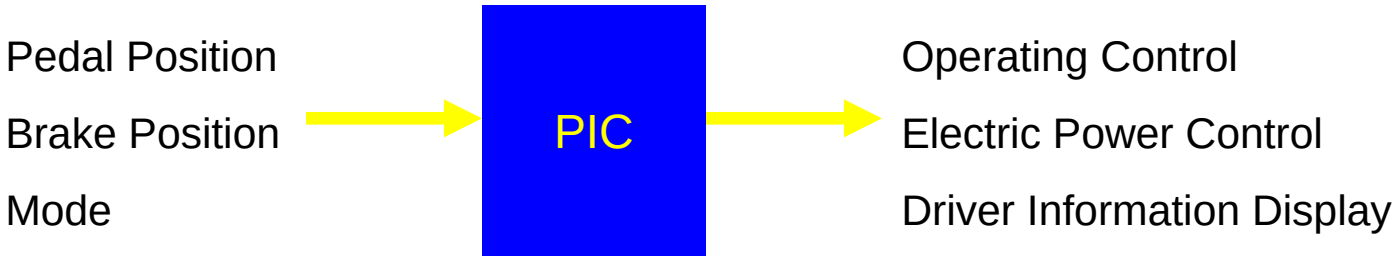
Test antenna

Computing In Parallel

- Project Goals
  - Application Parallelization
    - Edge detection (“Simple” Application)
  - “Different” modern parallel computing platforms
    - Single Core PC
      - Single threaded
      - Develop understanding of application
    - Multi-core processor (Beast)
      - Multi-threaded
    - FPGA
      - VHDL
    - Game station (PS3)
      - Cell Processor - 2 PowerPCs and 8 PEs
      - Linux based

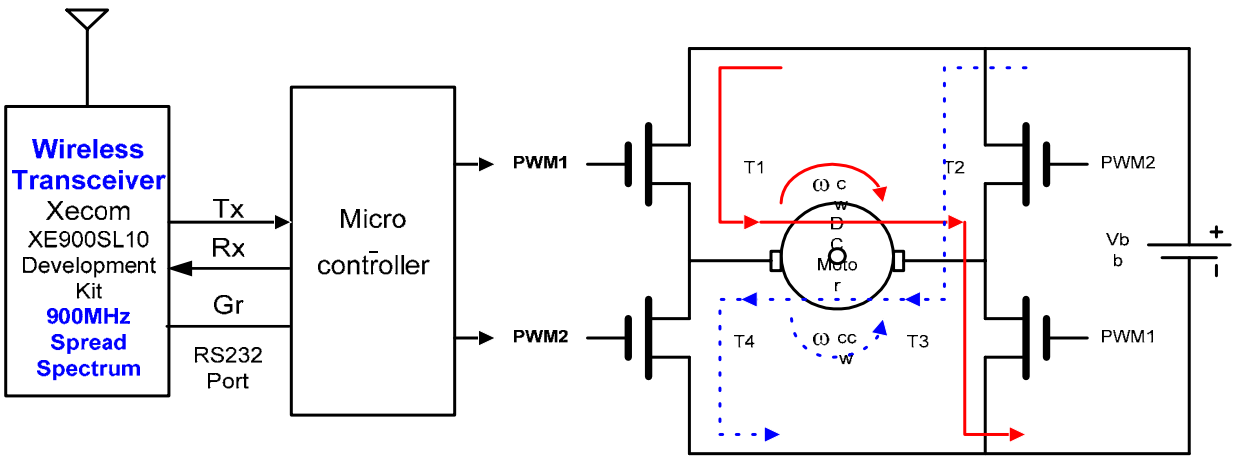
Diesel-Hybrid Project

- Previous capstone teams modified a diesel-powered ATV
  - Operation on waste vegetable oil (AY 06-07) and ethanol (AY 07-08)
- ME/EE (AY 08-09) will pursue optimization and electric hybridization
  - “hybrid” made to operate to maximize efficiency, minimize emissions
- ME design team will first measure performance
  - Over the full range of operating conditions and fuels
- EE team implements a “smart” engine control system
  - Input
    - Pedal and brake position
    - Select modes: maximum power, minimum emissions, or maximum efficiency
    - Supplied data from the ME team
  - Output
    - Engine operating control: “throttle” position, fuel heater, ethanol injection amount
    - Use electric drive system to supplement power provided by piston engine
    - Driver information display



Speed Control of a Large DC Motor

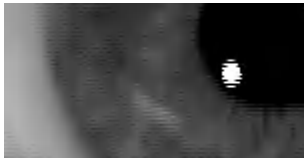
- Speed Control of a 48V, 40A DC Motor
- Use a “Smart” H-Bridge
  - Use Power MOSFETs
  - Use Optically Isolated High-Side Drivers with Totem - Pole Output

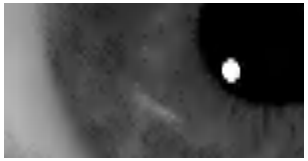


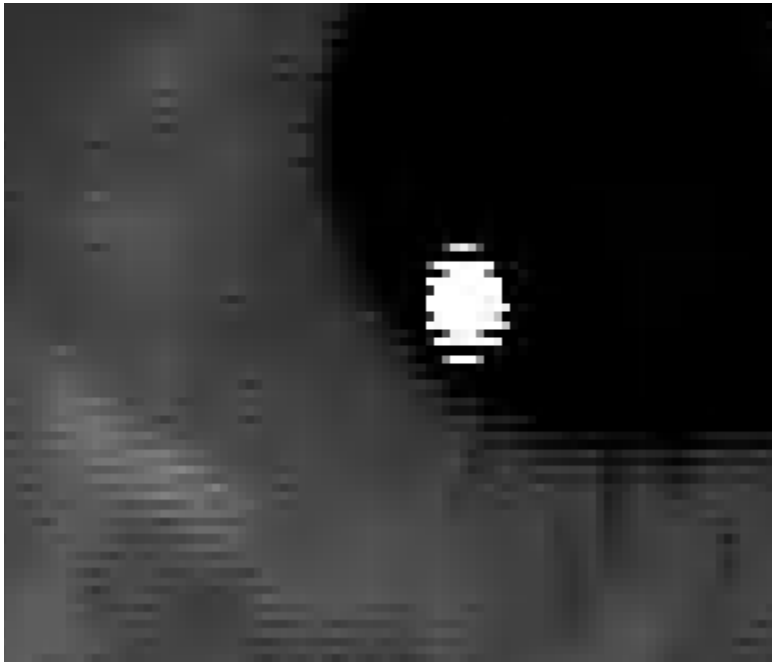
Analysis of Interlace Artifacts in Public Datasets

- Need
  - Some of the public datasets for iris recognition have interlace artifacts
  - Automated process for identifying interlace artifacts
  - Automated process for mitigating interlace artifacts
- Approach/Tasks
  - Acquire public datasets
  - Hand inspection for representative examples of interlace defects
  - Survey/select interlace algorithms from literature
  - Code/test selected algorithms
  - Write up results in a publishable paper

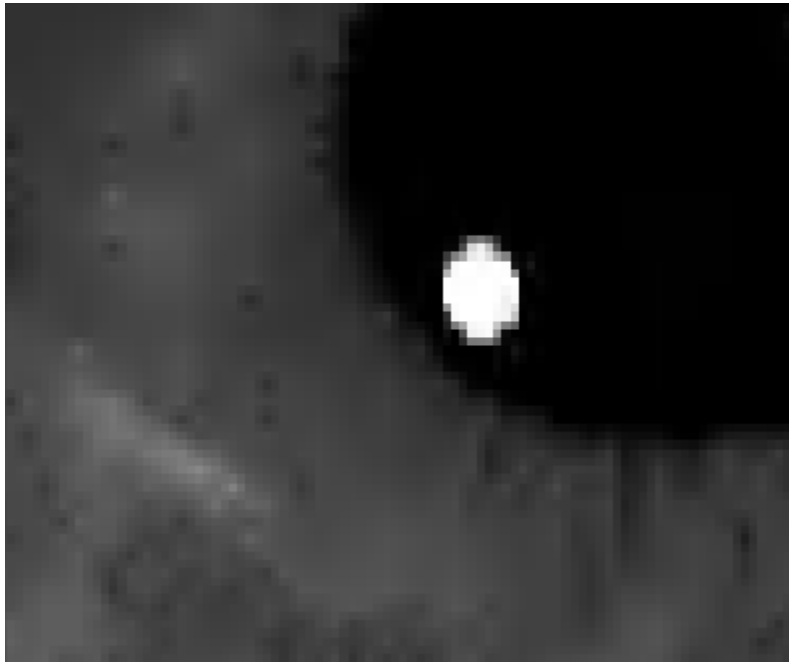
Example of Interlace Artifacts in Public Datasets







Database Image



Deinterlaced

Class-D Amplifier

- A switching amplifier or class-D amplifier
- Uses switching mode of transistor to regulate power delivery
  - Instead of active resistance in linear mode AB-class amplifiers
- Features high power efficiency (low energy losses)
- 500 Watts
- Low THD