The Intel Science and Technology Center for Embedded Computing

Investing in New Levels of Academic Collaboration

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The Intel Science and Technology (ISTC) Program

- ISTCs funded for 3+2 years and span multiple institutions
- Encourage collaboration among the best researchers in the field
- Four Intel funded researchers per center work on-campus
- Encourage collaboration between Intel and academia
- Public domain IP and open source software increase impact
Introducing...
The Intel Science and Technology Center for
Embedded Computing

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*Intel* Co-Principal Investigator
Research: Computer vision
At Intel since 2006
Carnegie Mellon alumnus
Previously at *HP Labs* and *Sarnoff Corporation*
Tech transfer to 5 HP products

Priya Narasimhan
*Carnegie Mellon* Co-Principal Investigator
Research: Embedded systems
At CMU since 2001
Intel Labs Pittsburgh director, 2010
Founder and CEO, *YinzCam*
Previously Founder and CTO of *Eternal Systems*
The Intel Science and Technology Center for Embedded Computing (ISTC-EC)

- ISTC-EC Brings together thought leaders to drive research and transform experiences in the Retail, Automotive and Home of the future.

- Popularity of real-time intelligent and personalized technology is growing providing a corresponding rise in demand for specialized embedded computing systems to support a broad range of new applications — many yet to be envisioned.

- Three unique features designed to increase the probability of successful collaboration
  - Open collaborative research model
  - Multidisciplinary approach
  - “Hands-on” involvement of Intel
Distributed Collaboration Center

Faculty + Graduate students + Intel

- Carnegie Mellon is the hub of the ISTC-EC, coordinating research among:
  - Cornell
  - Georgia Tech
  - Penn State
  - University of California, Berkeley
  - University of Illinois at Urbana Champaign
  - University of Pennsylvania
Co-evolve algorithms and hardware/software architectures to deliver innovative embedded solutions, motivated by application domains

- **Algorithms**
  - Analyze heterogeneous data, at scale
  - Understand human behavior and intent
  - Understand the environment within the context of human behavior
  - Understand the interaction between human and the environment
  - Enable interpretation, decision, predict future action

- **Systems**
  - Enable algorithms in resource-constrained environments
  - Enable seamless, large-scale computation in location/platform-agnostic way
  - Enable crowd-sourced networked operation
  - Enable real-time, high-performance, robust hardware and software
  - Enable strategic interactions with cloud-computing environments
Application-Inspired Research

APPLICATION DOMAINS

Retail
Automotive
Home

RESEARCH THEMES

Collaborative Perception
Real-time Knowledge Discovery
Robotics
Embedded Systems
Over-archching goals
- Perceive accurately and react timely by synthesizing multi-modal data, leveraging learned prior, incorporating contextual information
- Attention/intent analysis, behavior understanding
- Interaction between human and environment

Some projects of interest
- Behavior and environment understanding using first-person sensing
- Third-person human understanding
- First-object dynamic scene understanding within the automotive context
- Real-time 3D reconstruction
THEME: Real-time Knowledge Discovery

- Over-arching goals
  - Extract information from data from both online and the physical world in a timely, scalable and reliable manner
  - Pattern discovery in con-current event streams
  - Anomaly mining
  - Learning from heterogeneous, high-dimensional data

- Some projects of interest
  - Never-ending web-scale massively parallel machine learning
  - Dimensionality reduction and distance metric learning to enable embedded solutions
  - Imitation learning
THEME: Robotics

- Over-arching goals
  - Support multi-sensory exploration
  - Manipulation in human environment
  - Indoor navigation, obstacle detection/avoidance, planning

- Some projects of interest
  - Manipulation of deformable objects such as clothing
  - Reinforcement/imitation learning for manipulation
  - Automated planogram robots for retail environments
  - Embedded solution for high-precision localization
Over-arching goals
- Enable perception and knowledge discovery in a timely manner
- Respect power/memory/computational constraints
- Acquire data about human and environment (location, proximity, etc.)

Some projects of interest
- Embedded-to-cloud gateways for sensor networks
- Embedded hypervisors for location-agnostic, device-independent experience
- Multi-sensor embedded platforms for automotive telematics
- SoCs and accelerators for machine learning and perception
Application Domains

RETAIL
- Transformative experience for the shopper
- Transformative experience for the in/cross-store retail operations

AUTOMOTIVE
- Transformative experience for the driver
- Transformative experience for the occupants

HOME
- Transformative experience for the residents
- Transformative experience for in/cross-home management
Retail 2020 Vision

- Transformative experience for the **shopper**
  - Locate product in real-time (in this store or other branches)
  - Store recognizes shopper’s preference and makes relevant suggestions
    - Allergies, nutrition, clothing preferences
  - Enable the shopper to experience products
    - Digital unboxing, virtual dressing-rooms
  - Socialize the shopping experience
    - Real-time sharing to get/give feedback/recommendations
- Transformative experience for **in/cross-store retail operations**
  - Real-time inventory and planogram integrity
  - Immersive and effective training for staff, reduce injuries
  - Free staff of automat-able tasks to provide more available and attentive customer service
  - Reduce misplacement and mislabeling of products
Automotive 2020 Vision

- Transformative experience for the **driver**
  - Assist under adverse conditions (rain, snow, crowds)
  - Enhance trip efficiency/productivity
    - Customized recommendations/planning/deals for retail, dining, parking
  - Real-time cost consciousness
    - Telematics to enhance fuel efficiency
  - Real-time automated consultation of other drivers’ experiences
    - Automated analysis of crowd-sourced sensory data of road and traffic
  - Portable driving experience
    - Capture preferences to “port” them to other vehicles for personalization

- Transformative experience for the **occupants**
  - Vehicle recognizes its occupants for customization
    - In vehicle entertainment
    - Routing, services (retail, dining, entertainment) recommendation
Home 2020 Vision

- Transformative experience for the **residents**
  - Recognizing the residents to personalize/customize
    - Temperature, entertainment, work mode, family mode
  - Home automation
    - Do programmed tasks well, e.g. unload dish washer, fold laundry
    - Learn and improve on skilled tasks, e.g. cooking, ironing
  - Support for preemptive maintenance
    - Detect wear and tear, preemptive scheduling of maintenance
  - Simulated home occupancy to enhance security

- Transformative experience for **in/cross-home management**
Long-Term Impact

- Advocate and foster algorithm-system co-design
  - Co-evolve
  - Co-adapt
- Transform algorithms research
  - Innovate while understanding challenges of real world scenarios
  - Optimize while negotiating resource constraints of embedded platforms
- Transform systems research
  - Innovate to influence and support algorithms of the future
  - Understand an algorithm beyond its being just a workload
- Shift cultural mind-set
  - Algorithms and systems do not function (nor are developed) in isolation
  - Success of ISTC depends on inter-disciplinary collaboration
Thank you