Embedded systems as distributed systems

Presented by: Maiada Osama Roshdy

Supervisor: Dr. Khaled Elayat
What are embedded systems?

- Any automated system using a computer for the process can be called embedded system.

- Smart systems are embedded systems.

- Embedded systems are everywhere around us.

- In phones, receivers, trains, planes, robots ..etc
Smart Cameras as embedded systems

• **What is a smart Camera?**

• While today’s digital cameras capture images, smart cameras capture high-level descriptions of the scene and analyze what they see.

• The Embedded systems group in Princeton university has developed a first generation smart Camera system that can detect people and analyze their movement in real time.
Achieved work

• There are many approaches to real-time video analysis, they chose to focus on human gesture recognition.

• Identify whether a subject is walking, standing, waving his arms, and so on.

• **Human detection and activity recognition:**

• Their algorithms use both low-level and high-level processing as shown in fig1.

• Low-level component: Identifies different body parts and categorizes their movement in simple terms.

• High-level component: Uses information from low-level component to recognize each body part’s action and the person’s overall activity based on scenario parameters.
Figure 1. Human detection and activity recognition algorithms. (a) Low-level processing algorithms identify body parts and categorize their movements. (b) High-level processing algorithms use hidden Markov models (HMMs) and a gesture classifier to evaluate overall activity.
Figure 2. Initial steps in gesture recognition: (a) original image, (b) region extraction, (c) contour following, and (d) ellipse fitting.
Related work & applications

• There are a lot of research efforts focusing on human motion detection and gesture-recognition systems.
  - Mark Lucente and Andrew D. George have implemented a system that also relies on one camera to let subjects manipulate virtual objects using gestures and voice commands.
  - MIT Media Lab is developing technology that can track people’s actions, interpret gestures, and recognize facial expressions in environments ranging from the home and workplace to car interiors.
• Smart rooms, smart desks, and wearable computers use context-sensing and communication devices to help people carry out everyday functions.
Turning a single camera to a distributes smart cameras

- Instead of a single camera, there are some efforts in developing new techniques for distributed, real-time analysis of multimedia signals.
- Smart cameras use embedded processors to analyze imagery.
- Applications: security, medicine, entertainment, smart rooms, etc.
- In many applications, networks also needed to fuse data across these modalities to make the most accurate analysis of the activity in a scene.
Example: Peer-to-peer distributed cameras

Figure 1: Camera setup, target (model car), and occluding object (box).
• That such systems must be organized as distributed real-time computing systems.
• If they are to scale to the size required for most real-world applications. The design of these systems require cross-disciplinary efforts in
  • - image/signal processing.
  • - distributed computing.
  • - real-time embedded computing.
challenges

• These systems must process most of the data inside the network. Pushing all the data to a central server, as is done in many sensor networks, would eat up too much B.W and energy. Furthermore in large networks, no server will be large enough to handle all the real-time data.

• These systems must be architected to handle large numbers of nodes. A single building may require hundreds or thousands of cameras.

• The Computational requirements are very dynamic and data-dependency.
• Thesis Goal
Questions

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