Embedded Systems

Introduction to Embedded Systems

17 January 2017

What is an embedded system?

What is an embedded system?

- ‘An embedded system is a computerised system that is purpose-built for its application’[1]
- ‘Any device that includes a programmable computer but is not itself intended to be a general-purpose computer’[2]
- ‘…consists of computer hardware with embedded software which is a dedicated system for [an application]’[3]

[1] Elecia White, *Making Embedded Systems*

[2] Marilyn Wolf, *Computers as Components*

[3] A.K. Ganguly, *Embedded Systems*

Examples


VGB Power Tech GmbH


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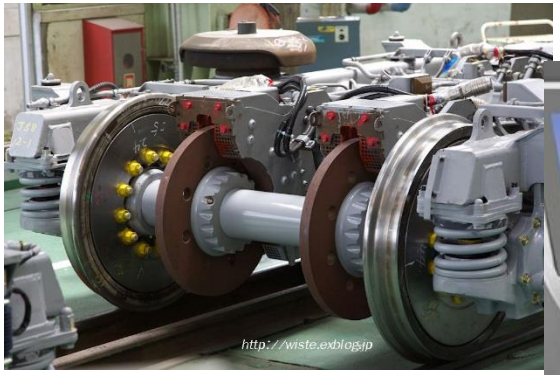
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Let’s classify types of embedded systems

ES ≠ General purpose computers

- Why would a laptop be bad in an embedded application?
- Hardware
- Software
- User interaction
- Developer interaction

Defining ES by design considerations and techniques

- Size
- Robustness
- Cost
- Weight
- Mission-criticality
- Reliability
- Availability
- Power consumption
- Real-time behaviour
- Design verification
- Inputs
- Outputs
- Programming flows
- Connectivity

What is this module about?

- Context
  - Why are embedded systems different from other computers?
  - What are the markets for embedded systems?
  - Case study: Internet-of-Things

What is this module about?

- Theory
  - How do you analyse the constrains faced by ES?
  - How do you evaluate the performance of ES platforms and programming methods?
  - How do you design hardware for ES?

What is this module about?

- Practice
  - How do you write reliable, low-level software that meets timing constraints?
  - How do you interact with the outside world?
  - What tools and platforms can you use?

Module Structure

- Part 1: The Internet of Things
  - Coursework: invent an IoT product
  - Deadline: 20 February
- Part 2: Real-time programming
  - Coursework: brushless motor controller
  - Deadline: 13 March
- Part 3: Embedded System Architecture
  - Coursework: design an embedded video platform
  - Deadline: 27 March

Module Style

- Tuesdays (11:00-12:00): Lecture(ish)
- Thursdays (09:00-11:00): Lab or Group activities

The labs

- Labs and activities are ‘bring-your-own-device’
- Coursework 1: Python
- Coursework 2: ARM Keil (windows)
- Coursework 3: gem5 (linux)
- We will work around any device problems!

The labs

- Groups of three (self-selected)
  - Or put your name in a pool for automatic allocation
- Coursework submitted in these groups
- Joint submission with individual contribution statements

The Internet of Things

L'Oreal’s Smart Hairbrush

L'Oreal's Smart Hairbrush

- '…packed with sensors to help consumers improve their brushing technique.'
- '…retail at just under $200'
- 'contains a microphone, gyroscope and accelerometer'
- ' shares the data via wi-fi or Bluetooth to an app'
- 'assess hair quality…as well as recommending products'

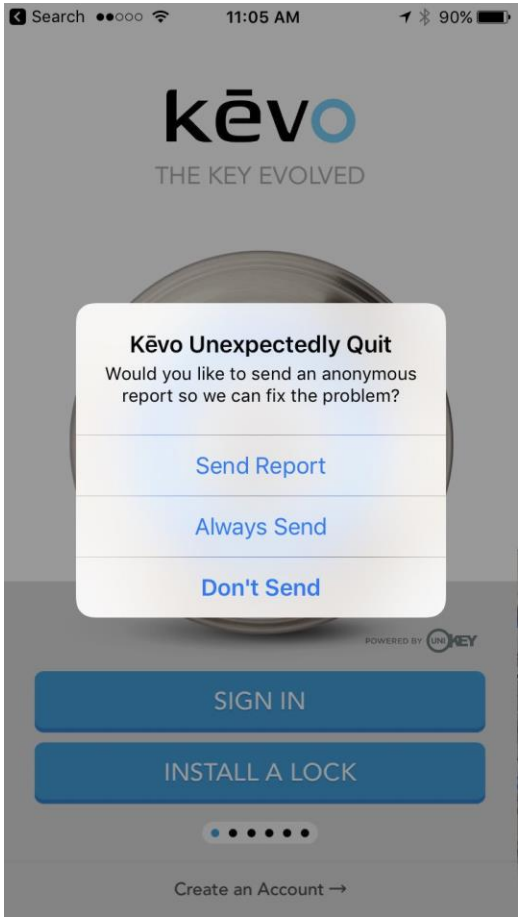
BBC News

L'Oreal's Smart Hairbrush

- 'security researchers found that a connected cooking pot could be hacked to gain access to your phone.'
- 'Listening to hair breakage requires a microphone, so can it hear more than just breaks?'
- 'This just smacks of a marketing team panicking about how to keep their product relevant in the digital age'
- 'IoT devices can be used to carry out Distributed Denial of Service attacks'

New Statesman, Ken Munro, Renate Samson

Is it worth the trouble?



Is it worth the trouble?

Is it worth the bother?

- ‘The internet of things could be key to the farming industry meeting the challenge of increasing food production by 70% by 2050’
- ‘…monitors daily activities of senior or ill people, to watch for dangerous anomalies’
- ‘the factory can now turn out 25% more bikes with 30% fewer workers’
- ‘information is transmitted immediately to smart meters, thermostats and appliances so that they can draw the power they need at off-peak times’

Beecham Research, Guardian, Report on Business

Next time…

- Evaluate some more IoT products
- What do they do?
- How do they work?

In the meantime…

- @internetofshit (https://twitter.com/internetofshit)

Next week…

- Design your own IoT product!