Embedded Systems Design

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Connected Devices and Wearables Lab

Course Introduction

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Generic vs. Embedded

ES → Performs a Specific Function

E.g., Cardiac Monitor

Sense and Stream Electrocardiogram

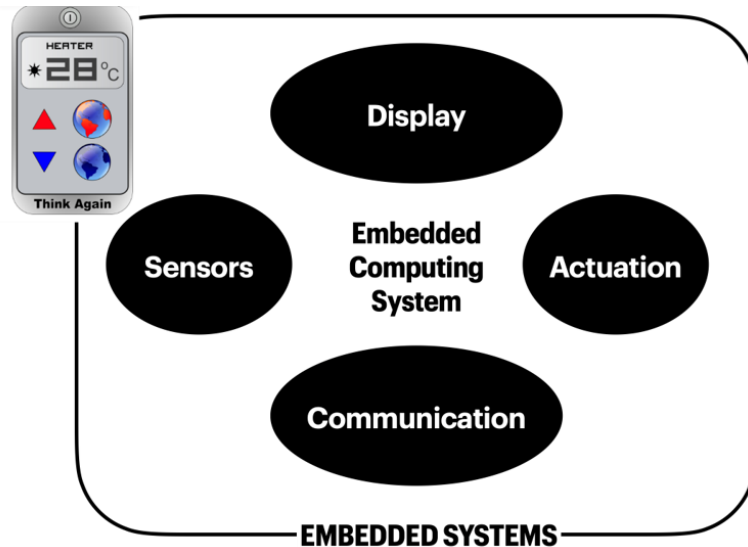*https://vitalconnect.com/cardiac-monitoring/*

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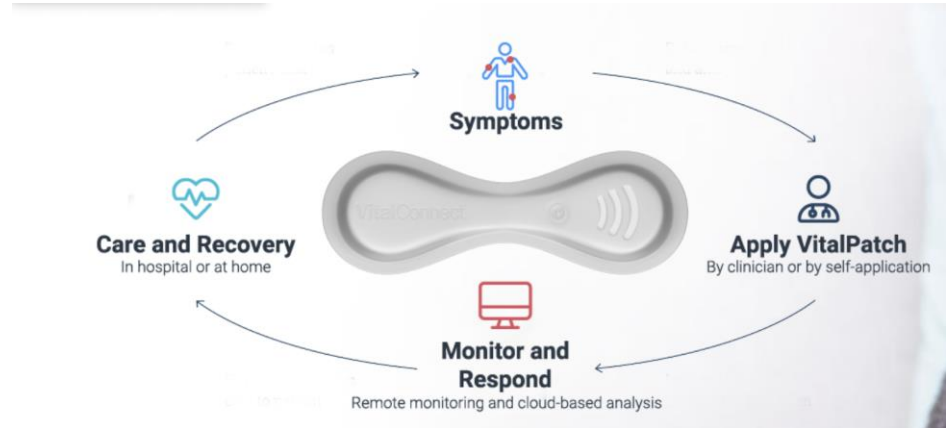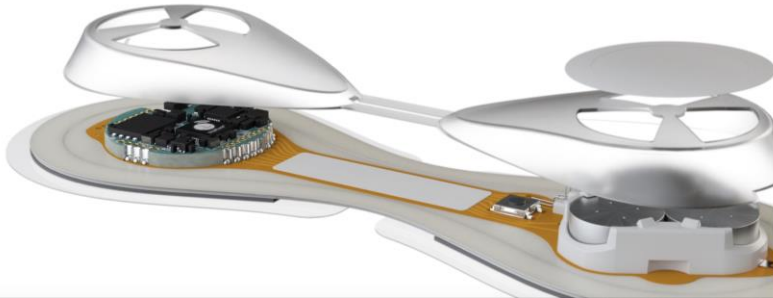
System Components

Thermostat → Regulates Room Temperature
Actuates Furnace when T_{Room} < T_{Set}

Ref: Nest Thermostat

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Topics of Interest

Embedded Computer (e.g., ARM) → Firmware, RTOS, Control Theory, Tiny ML, Bootloaders, DMA

Sensor Interfacing → GPIO, Buffer, Filter, Level-Shifting, Amplifier, ADC

Actuation → DAC, Buffer, Amplifier, Motor Control

**Display & UI → Display Drivers, Touch Technologies, Haptic Feedback**

Communication → BLE, WIFI, USB, I2C, SPI, UART

Power Management → Regulators, Sequencing, Harvesting, Battery, Low-Power Designs
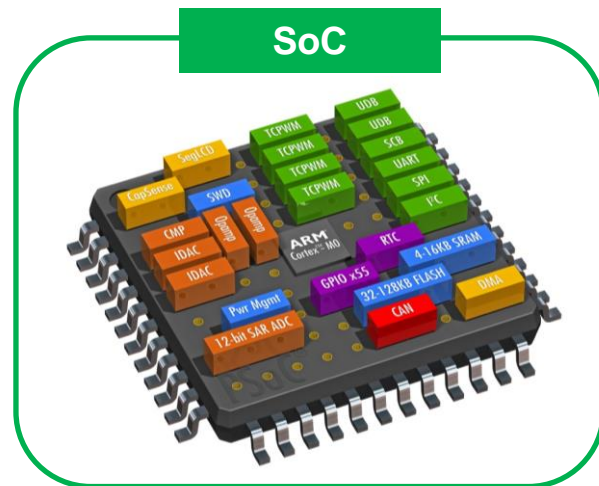
Compliance → EMIEMC, ESD

System On a Chip

SoC → Combines Circuits for Sensing, Actuation, Computation, Communication, UI and Display to a Single IC

Ref: https://learn.sparkfun.com/tutorials/nest-thermostat-teardown-/all
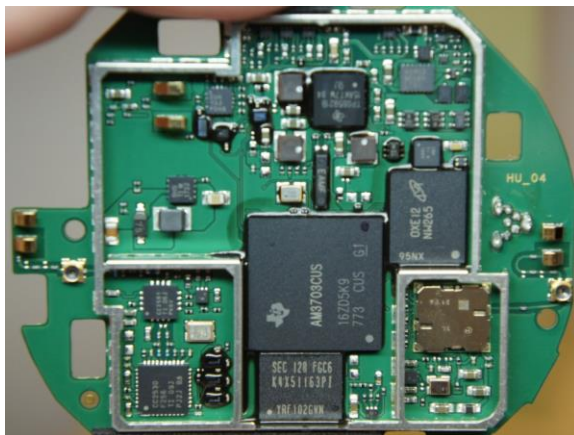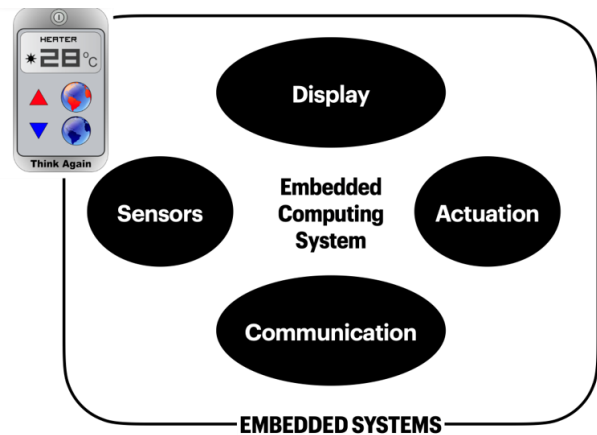
Ref: PSoC, a mixed-signal SoC from Infineon Technologies

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Course Content

Undergraduate level

Embedded systems — introduction, types etc.,

SoC — introduction, components (e.g., IO, ADC, DAC, PWM, SPI, I2C, UART etc.,), safe handling

Programming in C, interrupt handling

Post graduate level

Bootloader concepts, touch sensing, direct memory access etc.,

Ultra-low power system designs — low-power modes, power-reduction techniques

Systems packaging, component selection, PCB design and fabrication

Advanced topics

E.g., Introduction to TinyML - machine learning for embedded systems

Prerequisite for the course: Basic C programming, basic electronics.

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Course Outcome

E.g., Wearable Startups

E.g., Systems/Applications/Test Engineers

Research in Universities (e.g., Ph.D.)

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