Embedded Systems Design, August 2024

Kurian Polachan
Assistant Professor, IIIT-Bangalore
email: kurian.polachan@iiitb.ac.in
Connected Devices and Wearables Lab

Course Introduction

Generic vs. Embedded

Ref: Pictures from Creative Commons

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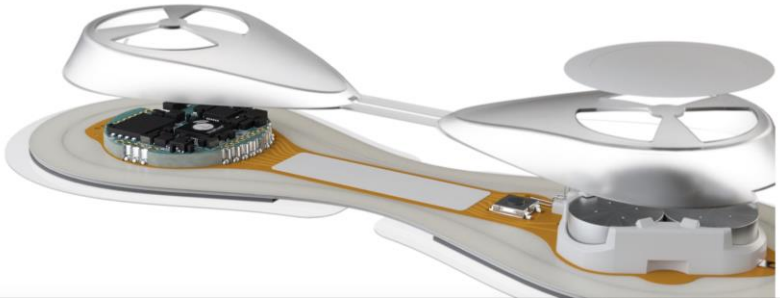
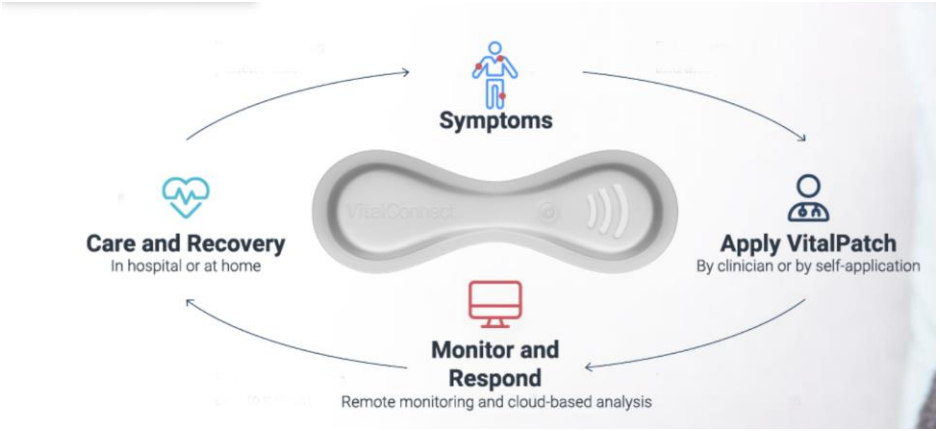
ES → Performs a Specific Function

E.g., Cardiac Monitor

Sense and Stream Electrocardiogram



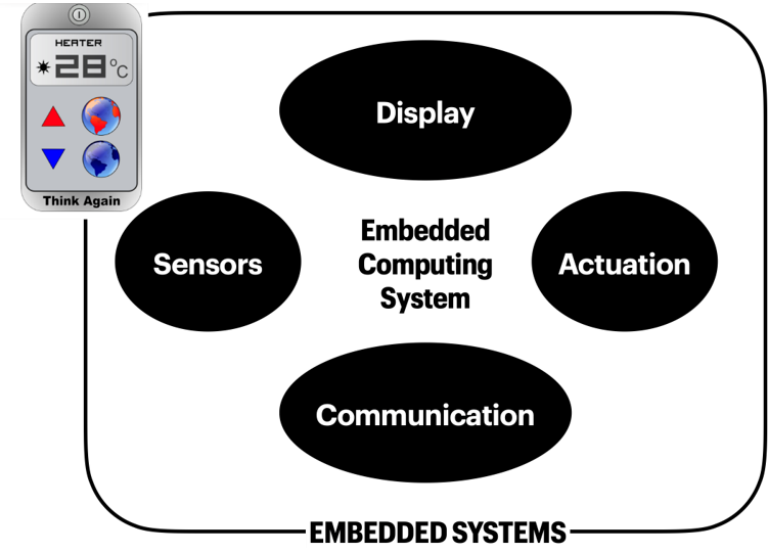


https://vitalconnect.com/cardiac-monitoring/

System Components

Thermostat → Regulates Room Temperature

Actuates Furnace when $T_{Room} < T_{Set}$



Ref: Nest Thermostat

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

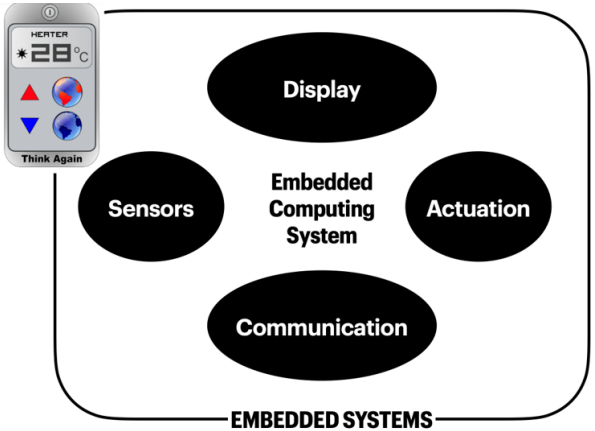
Communication → BLE, WIFI, USB, I2C, SPI, UART

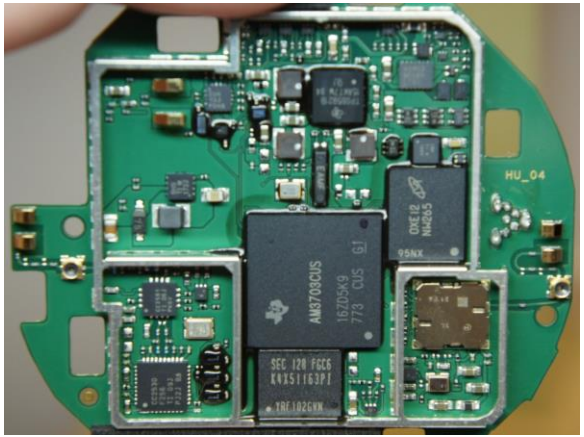
Power Management → Regulators, Sequencing, Harvesting, Battery, Low-Power Designs

Compliance → EMIEMC, ESD

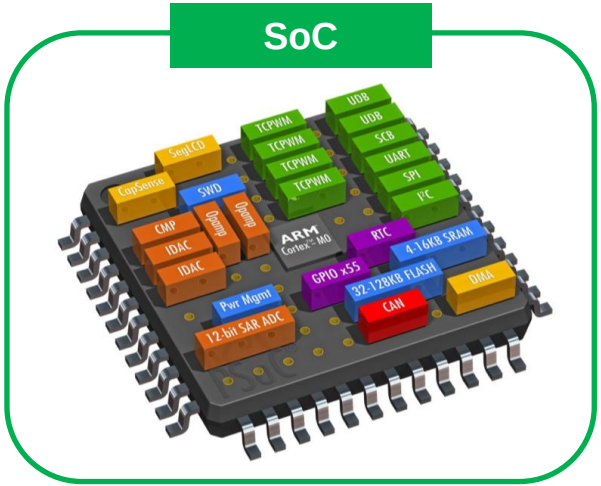
System On a Chip

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

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.

Course Outcome

E.g., Wearable Startups

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

E.g., Systems/Applications/Test Engineers