

Lecture 02 (Motivation)

Boeing 737 max accident was due to sensor related errors

1 Connecting Cyber and Physical Worlds

sensor \rightarrow *embedded processor* \rightarrow *actuators*

Both sensors and actuators interact with physical world

2 Automotives

1. Electronic control units: 100-200
2. Wired protocol
3. Monitors, diagnostic components and wireless components may also be present on this wired network

2.1 Functions (program size, # ECUs, bandwidth)

1. Powertrain - 2MB, 3-6 ECUs, 500Kb/s
 - i. engine control
 - ii. transmission
 - iii. gear control
2. Chassis - 4.5MB, 6-10 ECUs, 500Kb/s
 - i. antilock braking system
 - ii. electronic stability program
 - iii. automatic stability control
 - iv. adaptive cruise control
3. Body (comfort related) - 2.5MB, 14-30 ECUs, 100Kb/s
 - i. AC/climate control
 - ii. dash board
 - iii. wipers, doors, sears, windows, mirrors
 - iv. cruise control
 - v. parking distance control
4. Telematics - 100MB, 4-12 ECUs, 22Mb/s
 - i. multimedia

- ii. infotainment
 - iii. GPS
- 5. Passive safety - 1.5MB, 11-12 ECUs, 10Mb/s
 - i. rollover sensors
 - ii. airbags
 - iii. belt pretensions

arduino board \equiv 1ECU

2.2 Engine Control

1. Tasks:
 - i. calculate amount of fuel to inject
 - ii. decide time when injection should take place
2. Inputs:
 - i. pedal
 - ii. load of engine
 - iii. temperature
3. Actuators:
 - i. position of crankshaft
 - ii. valves
4. Relevance:
 - i. avoid mechanical damage
 - ii. better performance

3 Capabilities of ECUs

1. Clock frequency is usually less than 100MHz
2. Communicates less than 100 bits per packet
3. Stores less than 100MB of data

4 Experiments on Arduino Board

reference link

4.1 AES

1. Uses 9k bytes out of 32KB
2. Uses 1542k bytes out of 2KB for global variables

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1. Doesn't compile on Arduino Uno due to memory constraints
2. After commenting the testing part, it takes 95% of code memory, 52% of variable memory