

CSE121: IoT

Introduction

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Baskin School of Engineering
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- Instructor
 - Jose Renau
 - <http://www.soe.ucsc.edu/~renau>
- Research area
 - Computer architecture
 - Improve productivity in hardware design
- Teaching
 - CSE12
 - CSE120
 - CSE220
 - CSE125
- And for the first time, CSE121

- TAs:
 - John Yu <jyu229@ucsc.edu>
 - Aravind Ramamoorthy <aramamoo@ucsc.edu>
- Meeting during section time @BE-301A
 - Sections start next week
 - Each TA should have 2 different time section
- Bels
 - Russel Evans


- Instructor: Prof. Jose Renau
 - Lecture: TuTh 9:50-11:40
 - NOT virtual
 - Office hours: Thursday 3:00-4:30pm
 - BE-301A

Course Requirements

- Prerequisites
 - CSE100
 - CSE120

- If you have a DRC and want special accommodation, send me the form by email
 - UC Santa Cruz is committed to creating an academic environment that supports its diverse student body. If you are a student with a disability who requires accommodations to achieve equal access in this course, please submit your Accommodation Authorization Letter from the Disability Resource Center (DRC) to me by email, preferably within the first two weeks of the quarter. I would also like us to discuss ways we can ensure your full participation in the course. I encourage all students who may benefit from learning more about DRC services to email the DRC office at drc@ucsc.edu.
- If you do not know what is a DRC
 - Ignore this slide

- No B00K
- Well, the ESP32 technical manual



ESP32-C3

Technical Reference Manual

VIM Material (optional book)

- <https://www.cs.cmu.edu/~15131/f17/topics/vim/vim-cheatsheet.pdf>

- Practical Vim book

- Basic VIM commands

- edit vs navigation

- esc

- I i A

- r overwrite one character

- R overwrite many

- Basic navigation

- b back one word

- w forward one word

- :300

- gg

- G



- Repleat n times

- cut&paste

- yy

- dd

- open files

- :e :w :r

- Splits

- ctrl-w v vertical split

- ctrl-w h horizontal split

- ctrl-w w go next split

- search/replace/file search

- / nN

- :%

- :Ack

- quickfix

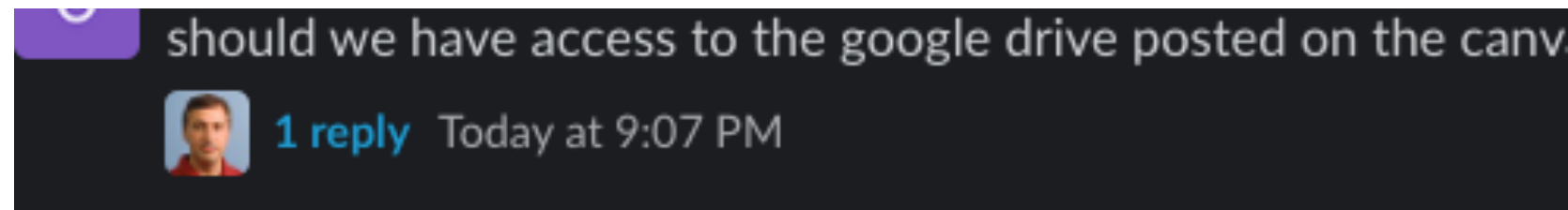
- ,q

- ,n next in quick fix

Everything is in Canvas+Google Drive+Slack

- Canvas
 - <https://canvas.ucsc.edu/courses/62510>
 - Announcements, quizzes
- Google Drive: slides, labs, materials....
 - <https://drive.google.com/drive/folders/1IbZboIAzz-zVuJlfWimlRmLv516y8TnH?usp=sharing>
 - Use @ucsc.edu email to access
- Slack channel
 - https://join.slack.com/t/cse121-s23/shared_invite/zt-1ruyyo2th-wkyLnoSEDEpwTZ8HI5izSw

- Use slack, avoid email for this class
- Use threads in replies
 - <https://slack.com/resources/using-slack/tips-on-how-best-to-use-threaded-messages>



- Use the correct channel
- Be polite/profesional

- This is going to be DIFFERENT from what you are used
- This class:
 - You can **NOT** share code with other students (same as usual)
 - You can **NOT** share google/GPT/AI search method (new?)
 - You can use google/GPT/AI results **AS LONG AS:**
 - Include the queries/searches used in the report.pdf
 - Include the answer from the query in the report.pdf
 - The code/idea IS NOT from a UC student
 - The code license is EXPLICITLY BSD/MIT or apache
 - If there is no EXPLICIT license.txt, you can not use it
 - If reddit/stack overflow, cut&paste URL and code snippet
 - ChatGPT/AI, you can use it without license.txt

What? chatGPT and LLMs are allowed?

- Large Language Models (LLMs) like chatGPT will become de-facto tools soon
 - The idea is to get used to them, like in an industry setting
 - You can use if you keep track and do not violate license
 - E.g: most companies will NOT allow you to pick GPL code
 - You must preserve the copyright/license or you are in legal trouble
- Currently, several companies do not allow you to use chatGPT/LLMs because the current “use contract” does not forbid openAI to use your queries context to learn (this can have legal impact on future patents). In the future, I expect pay licenses... so we ignore this part in this class.

Include report.pdf
(the highest risk to fail class)

- NO EXAMS!!!
- Weekly Quizzes 250 pts (drop 25% of the quizzes)
 - 1 quiz every week
 - Grade is “average of 75% best submitted quizzes”
 - E.g: 3,1,NA,0 is $(3+1+NA)/3$ or 1.33
 - No taking them late, no excuses for absence (25% missing drop)
 - DRC students see me for arrangements, but idea is extra time
 - Quizzes done through canvas (time controlled)
- Labs: 750 points
 - You can be LATE in 1 (only 1) lab. Due week before finals.
- TOTAL: 1000 points

- Raspberry PI 4 + ESP32C3 board (rust)
- The PI4 will be used to program the ESP32C3 in several labs
- It will also be used to “communicate” with EPS32 board
- The labs are NEW
 - Lab1: setup PI4 + ESP32C3 with 2 small programs
 - Lab2: debugging
 - Lab3: soldering + displays
 - Lab4: bluetooth mouse for PI4
 - Lab5: wifi, against PI4 server to display info
 - Lab6: YOU CHOOSE (we approve) or communication speed
 - Lab7: ultrasound
 - Lab8: rust lab (optional to catch up missing labs)

Lab “you choose”??

- If you do not choose
 - Communicate with LEDs between PI4 and ESP32
 - At least 1m distance
 - Must be able to transfer info from PI4 to EPS32 and back
 - The “fastest” (2) data rate in class gets a “free lab” points
- If you choose
 - You must present a 1 page document of what you want to do
 - ->I<- must approve before end of April
 - It can not be too simple (or too complex)
 - If complex enough, it can also get points for a “free lab”

- 8 labs -> one lab per week
- Mitigations:
 - Lab8 is optional, so it is 7 labs
 - There are no exams
 - Last week has no class (maybe April week due to conference)
 - “You choose” lab can be 2 if “fast” or you choose large
- What if late in 2 labs? (Canvas submitted time)
 - 1st late lab gets full credit
 - The 2nd late lab 1/2 points, the 3rd 0 points, 4th 0 points

- As student, you have been “incorrectly” trained for industry
 - You expect a “fully specified problem”
 - In industry, I have never found this
 - They have a “we want this”, not a “this is how to build it”

- Grading is curved
 - Avg grade for this class 3.2–3.5 (based on similar institutions)
 - 25–35% of As (A+...A-)
 - 5–10% of failing (C-...F)
 - Rest Bs (and some Cs)
 - (Cheaters get an F, not in these stats as sometimes they cluster)
- Ideally, all pass, but I do not want to feel ashamed of some pass grades
 - If you get all the labs working, you get an A
 - If you get all the labs but 1, and “75%” of the quizzes, you get an A

- The lectures are to go over material related with IoT
 - ADC/DAC
 - PWM
 - Interrupt
 - Real-time OS
 - ...
- We will have last week before finals week without lecture
 - So you have more time for labs

What will you learn in this class?

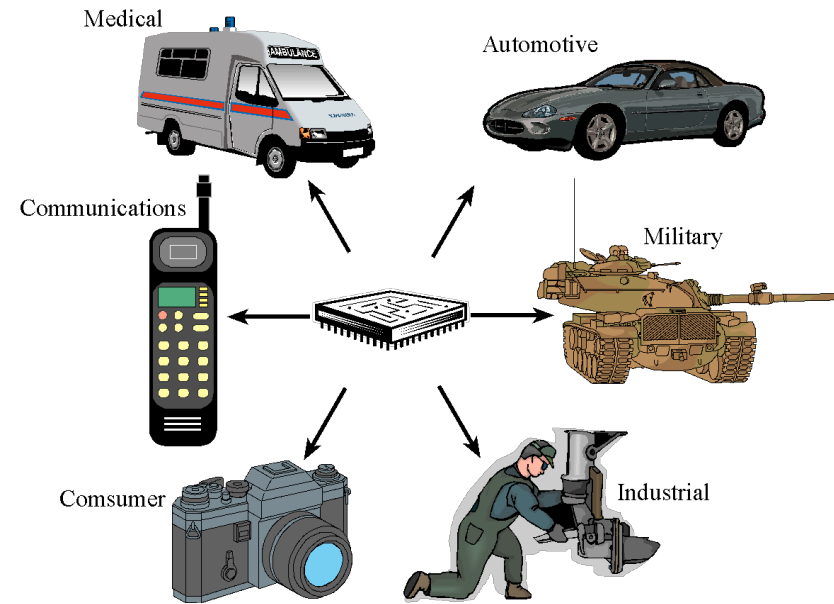
- IoT
- Debug embedded devices
- Some linux
- Some soldering
- Some chatGPT

What is different from Embedded?

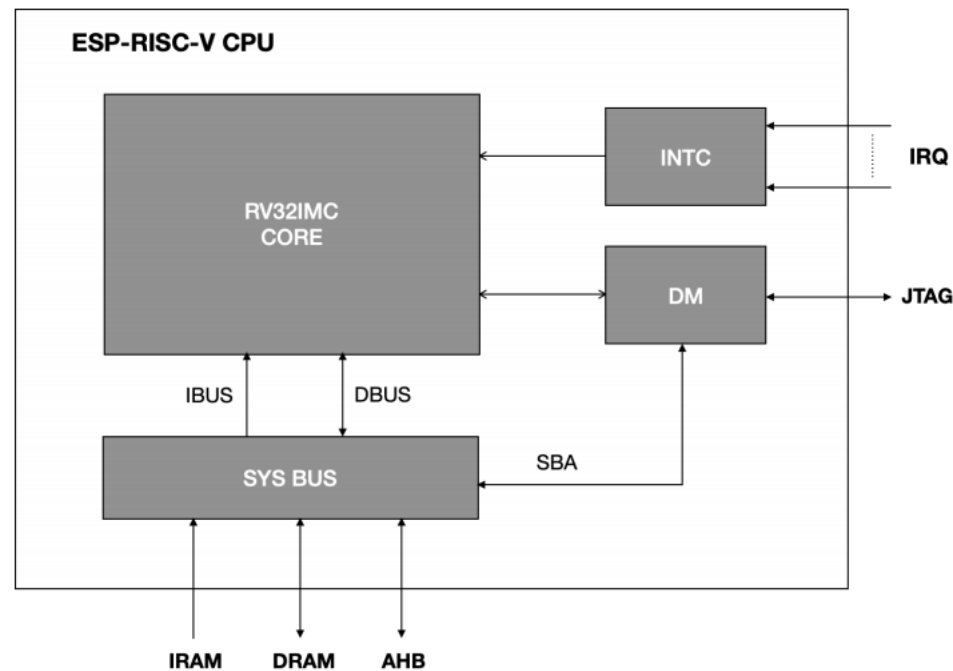
- CPU with limited resources
 - Small memory
 - Low visibility
 - Cross-compile in host (your laptop) and deploy in target (IoT)
 - Interface with hardware directly
 - No OS (baremetal) or RTOS (no windows/Linux/Android)
 - Many languages to program, but “memory usage” is important
 - If RTOS (time), typically C

Where are Embedded Systems?

- Everywhere



- EPS32 is quite popular and cheap (under \$20 for fancy boards)
 - C3 stands for RISC-V
 - C6 was just released (maybe next Year?)



- Operating clock frequency up to 160 MHz
- Interrupt controller (INTC) with up to 31 vectored interrupts with programmable priority and threshold levels
- Debug module (DM) compliant with RISC-V debug specification v0.13 with external debugger support over an industry-standard JTAG/USB port
 - Hardware trigger compliant to RISC-V debug specification v0.13 with up to 8 breakpoints/watchpoints
- Physical memory protection (PMP) for up to 16 configurable regions

- Intro and show how to use chatGPT