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# CS107E CURIS 2025

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# CS107E: RESEARCHING COMPUTERS FROM THE GROUND UP

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## OVERVIEW

This summer we aimed to "hack" on the Mango Pi to **develop its libraries** and capabilities for students to use in the CS107E course

We **established APIs** for MangoPi serial communication protocols, allowing students to pursue more ambitious projects.



## DRIVERS

### SPI

Overhauled our SPI driver adding integration with DMA and allowing **asynchronous transfers** while establishing an easier to use API.



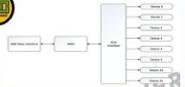
### I2C

Further developed and tested an I2C driver module. Designed a **student-friendly API**.



### DMA

Created a new driver for the DMA controller, unlocking **faster and asynchronous APIs** for other drivers.



### I2S

Further developed the Mango Pi's I2S drivers, establishing a **more robust API** for students to use when working with mono/stereo audio for both microphones and speakers.



### SHMC (SD CARD)

We successfully **ported and tested** the (SMHC) for SD cards. Exposed the block read and block write functions, effectively abstracting the underlying hardware layer.

```
mmc_bsp.c
mmc.c
mmc.h
util.c
util.h
```

## DEMOS

### POV SPHERE

The use of SPI and sensor data in sphere using



### DOOM PORT

For the final test, we decided to compare how our drivers compare across multiple devices.

With our DOOM port, SPI LCD display, an I2C speaker to run the original completely bare metal on the

### I2C HYDRA

One final test was making a giant "hydra" of our I2C devices including RTCs, OLEDs, and **accelerometers**, as I2C was the protocol that we had the **most devices working** for.

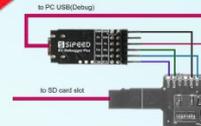
This demo also served as an **experiment** to explore the limits of our drivers and confirm that we could simultaneously communicate with multiple devices.



## COURSE REVIEW

Some of the biggest challenges for students when working on embedded systems is the lack of a debugger. Currently the course uses a software simulator to allow debugging, but it doesn't allow interacting with hardware components like screens or buttons. We researched the JTAG hardware debugging protocol in order to allow students to debug their code on device. **Future work**: the manufacturer's proprietary software only runs on Linux and Windows machines. Can we make it work on Mac?

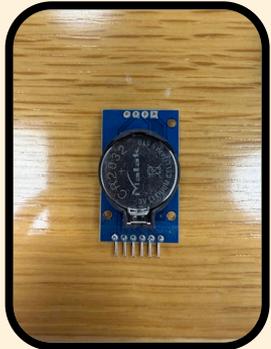
In addition to debugging, we developed other aspects of the course to allow students to do more with the Mango Pi, whether that be guides explaining how to enable **Vector instructions** or barebones SD card drivers.



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0x00000004: v2 (13.2b)
0x00000008: v3 (14.2b)
0x0000000c: v4 (15.2b)
0x00000010: v5 (16.2b)
0x00000014: v6 (17.2b)
0x00000018: v7 (18.2b)
0x0000001c: v8 (19.2b)
0x00000020: v9 (20.2b)
0x00000024: v10 (21.2b)
0x00000028: v11 (22.2b)
0x0000002c: v12 (23.2b)
0x00000030: v13 (24.2b)
0x00000034: v14 (25.2b)
0x00000038: v15 (26.2b)
0x0000003c: v16 (27.2b)
0x00000040: v17 (28.2b)
0x00000044: v18 (29.2b)
0x00000048: v19 (30.2b)
0x0000004c: v20 (31.2b)
0x00000050: v21 (32.2b)
0x00000054: v22 (33.2b)
0x00000058: v23 (34.2b)
0x0000005c: v24 (35.2b)
0x00000060: v25 (36.2b)
0x00000064: v26 (37.2b)
0x00000068: v27 (38.2b)
0x0000006c: v28 (39.2b)
0x00000070: v29 (40.2b)
0x00000074: v30 (41.2b)
0x00000078: v31 (42.2b)
0x0000007c: v32 (43.2b)
0x00000080: v33 (44.2b)
0x00000084: v34 (45.2b)
0x00000088: v35 (46.2b)
0x0000008c: v36 (47.2b)
0x00000090: v37 (48.2b)
0x00000094: v38 (49.2b)
0x00000098: v39 (50.2b)
0x0000009c: v40 (51.2b)
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0x000000a8: v43 (54.2b)
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0x000000b4: v46 (57.2b)
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0x000000c8: v51 (62.2b)
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0x000000e4: v58 (69.2b)
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0x00000100: v65 (76.2b)
0x00000104: v66 (77.2b)
0x00000108: v67 (78.2b)
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0x00000114: v70 (81.2b)
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0x00000120: v73 (84.2b)
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0x000006d8: v439 (450.2b)
0x000006dc: v440 (451.2b)
0x000006e0: v441 (452.2b)
```

# SUMMER OVERVIEW

WEEK 1



WEEK 3



WEEK 5



WEEK 7



WEEK 9



DEMO



# SUMMER OVERVIEW

WEEK 1

WEEK 3

WEEK 5

WEEK 7

WEEK 9

DEMO



I2C Drivers & API  
Supported: RTCs,  
Accelerometers,  
OLEDs, Arducam, +  
More!



# SUMMER OVERVIEW

WEEK 1

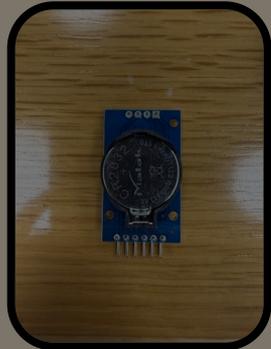
WEEK 3

WEEK 5

WEEK 7

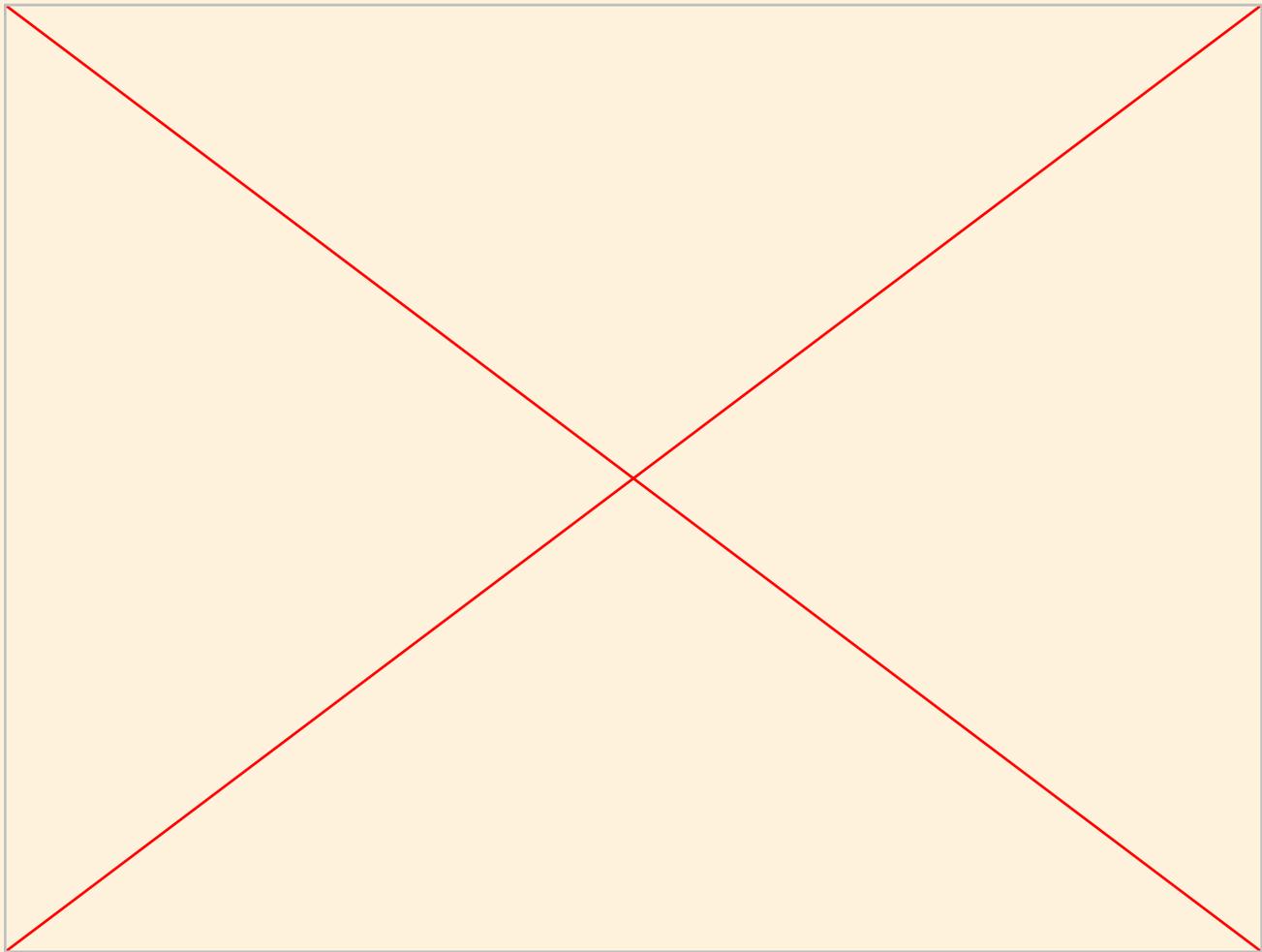
WEEK 9

DEMO



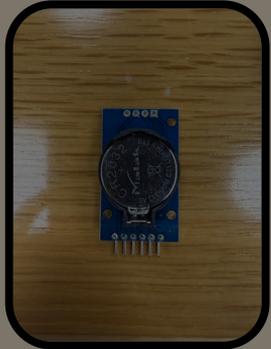
SPI+DMA Drivers & API  
Supported: LCD screens,  
Asynchronous Data  
Transfers, High Speed  
Data Transfers!



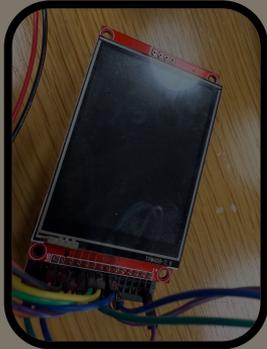


# SUMMER OVERVIEW

WEEK 1



WEEK 3



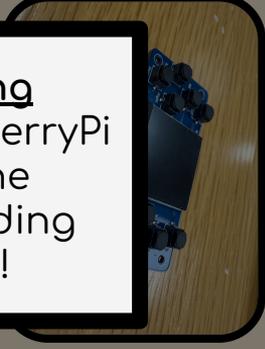
WEEK 5



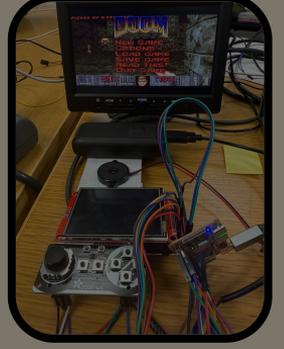
WEEK 7

Project Porting  
Ported old RaspberryPi  
projects to the  
MangoPi, including  
POV Sphere!

WEEK 9

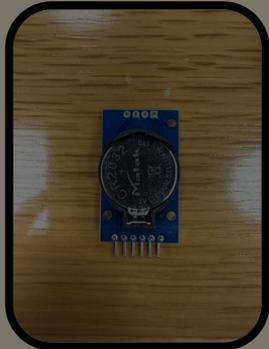


DEMO



# SUMMER OVERVIEW

WEEK 1

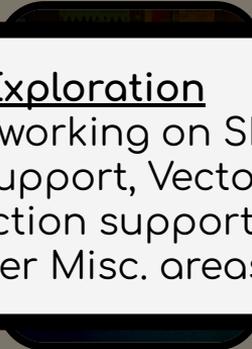


WEEK 3



Pi Exploration  
Began working on SD Card support, Vector Instruction support, and other Misc. areas...

WEEK 5



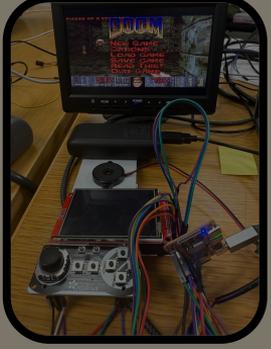
WEEK 7



WEEK 9

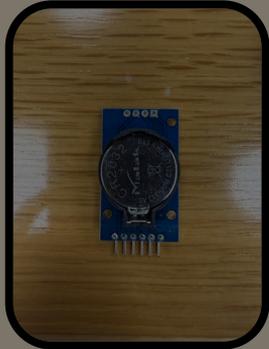


DEMO

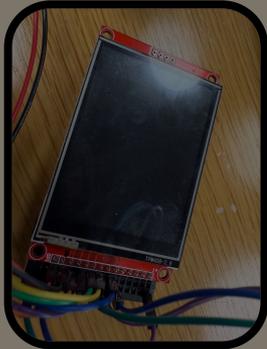


# SUMMER OVERVIEW

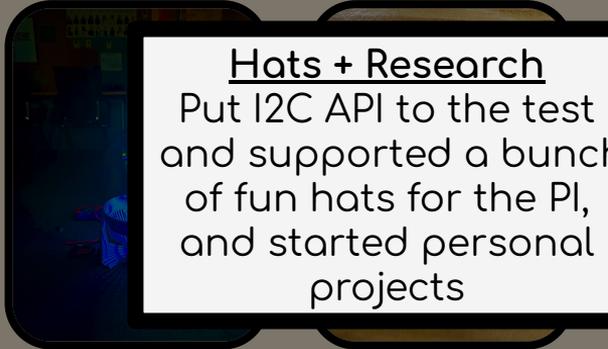
WEEK 1



WEEK 3



WEEK 5



## Hats + Research

Put I2C API to the test and supported a bunch of fun hats for the Pi, and started personal projects

WEEK 7



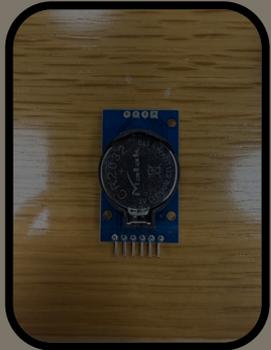
WEEK 9



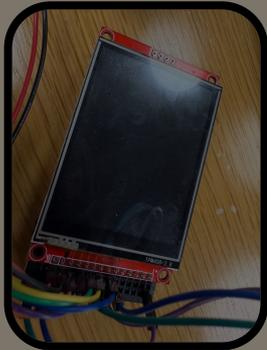
DEMO

# SUMMER OVERVIEW

WEEK 1



WEEK 3



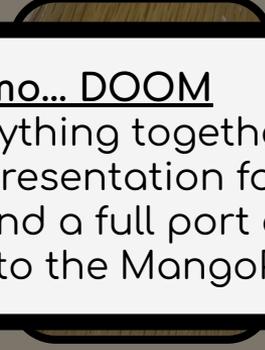
WEEK 5



WEEK 7



WEEK 9



DEMO

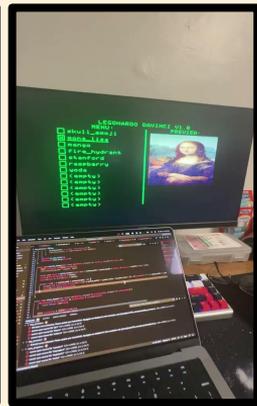
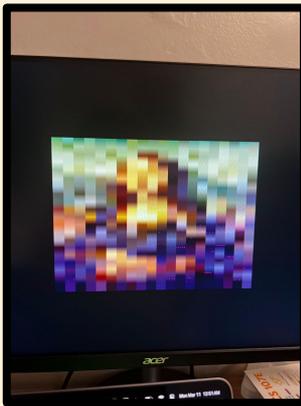
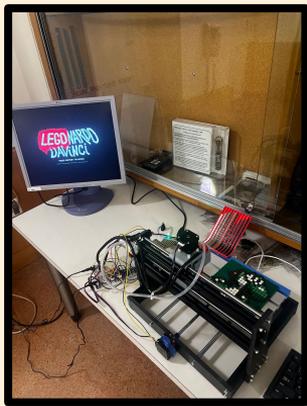


## Demo... DOOM

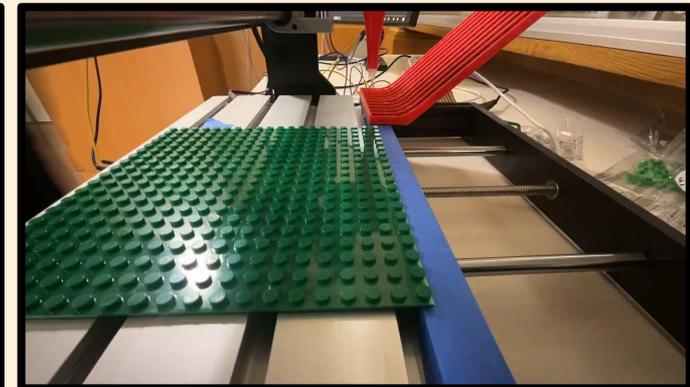
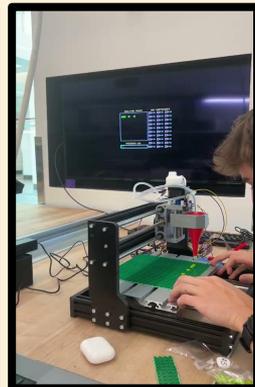
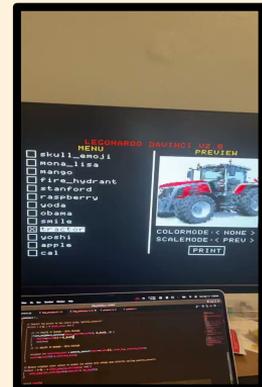
Put everything together into a presentation for CURIS and a full port of DOOM to the MangoPi

# Project Info/Demos!

# Joe's 107E Project



# Joe's 107E Project



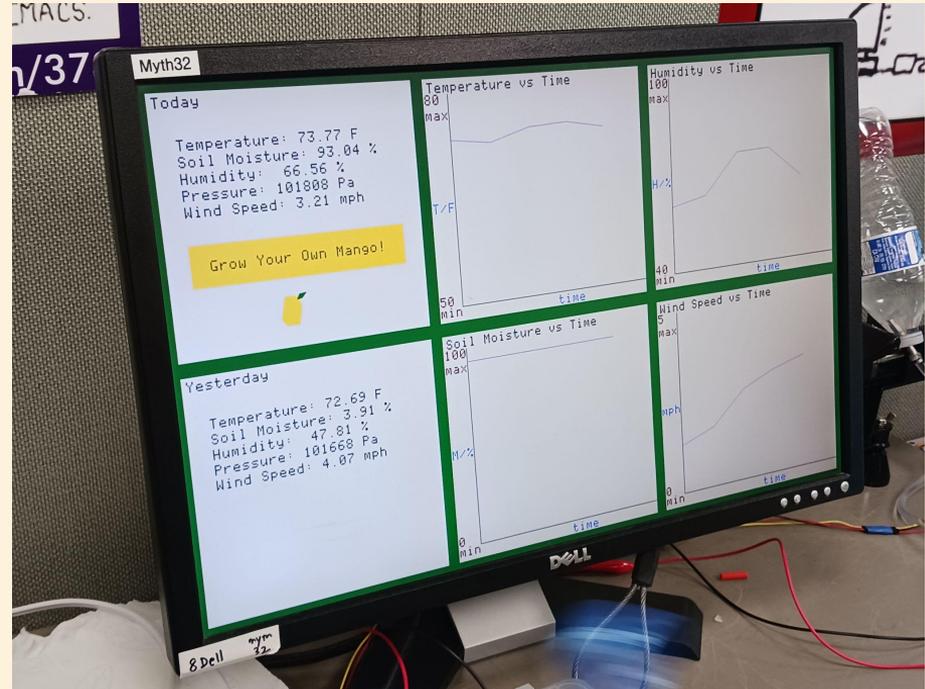
# Elias' 107E Project

# GROW YOUR OWN MANGO



## Sensors Used

- BME280 Sensor (Temperature, Humidity, Pressure)
- Hall Effect Sensor
- Soil Moisture Sensor



# Daniel's 107E Project

