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https://github.com/anushamhegde/EE522_Assignments

Assignment 2

Objective

The objective of this assignment is to understand the theoretical capabilities of the raspberry pi board that includes understanding of the software and hardware features, its options, performance and limitations of the board. In this assignment the goal is to characterize the board, learn more about the capabilities and build the next steps of the exploration of the raspberry pi.

Installing library

I installed the BCM2835 pin library using link provided in the assignment

<http://www.airspayce.com/mikem/bcm2835/bcm2835-1.50.tar.gz>. It was working fine until the sudo make check, I got the error

```
pi@ANUSHA:~/Documents/Assignment_2/bcm2835-1.50$ make
make[2]: Leaving directory '/home/pi/Documents/Assignment_2/bcm2835-1.50/src'
Making all in doc
make[2]: Entering directory '/home/pi/Documents/Assignment_2/bcm2835-1.50/doc'
make[2]: Nothing to be done for 'all'.
make[2]: Leaving directory '/home/pi/Documents/Assignment_2/bcm2835-1.50/doc'
make[2]: Entering directory '/home/pi/Documents/Assignment_2/bcm2835-1.50'
make[2]: Leaving directory '/home/pi/Documents/Assignment_2/bcm2835-1.50'
make[1]: Leaving directory '/home/pi/Documents/Assignment_2/bcm2835-1.50'
pi@ANUSHA:~/Documents/Assignment_2/bcm2835-1.50$ sudo make check
Making check in src
make[1]: Entering directory '/home/pi/Documents/Assignment_2/bcm2835-1.50/src'
make test
make[2]: Entering directory '/home/pi/Documents/Assignment_2/bcm2835-1.50/src'
gcc -DHAVE_CONFIG_H -I. -I. -g -O2 -MT test.o -MD -MP -MF .deps/test.Tpo -c -o test.o test.c
test.c: In function 'main':
test.c:16:9: warning: implicit declaration of function 'geteuid' [-Wimplicit-function-declaration]
  16 |     if (geteuid() == 0 && !getenv("FAKEROOTKEY"))
     |             ^
mv -f .deps/test.Tpo .deps/test.Po
gcc -g -O2 -o test test.o ./libbcm2835.a -lrt
make[2]: Leaving directory '/home/pi/Documents/Assignment_2/bcm2835-1.50/src'
make check-TESTS
make[1]: Entering directory '/home/pi/Documents/Assignment_2/bcm2835-1.50/src'
make[3]: Entering directory '/home/pi/Documents/Assignment_2/bcm2835-1.50/src'
FAIL: test
make[4]: Entering directory '/home/pi/Documents/Assignment_2/bcm2835-1.50/src'
make[4]: Nothing to be done for 'all'.
make[4]: Leaving directory '/home/pi/Documents/Assignment_2/bcm2835-1.50/src'
=====
Testsuite summary for bcm2835 1.50
=====
# TOTAL: 1
# PASS: 0
# SKIP: 0
# XFAIL: 0
# FAIL: 1
# XPASS: 0
# ERROR: 0
=====
See src/test-suite.log
Please report to mikem@airspayce.com
=====
make[3]: *** [Makefile:651: test-suite.log] Error 1
make[3]: Leaving directory '/home/pi/Documents/Assignment_2/bcm2835-1.50/src'
make[2]: *** [Makefile:759: check-TESTS] Error 2
make[2]: Leaving directory '/home/pi/Documents/Assignment_2/bcm2835-1.50/src'
make[1]: *** [Makefile:830: check-am] Error 2
make[1]: Leaving directory '/home/pi/Documents/Assignment_2/bcm2835-1.50/src'
make: *** [Makefile:362: check-recursive] Error 1
pi@ANUSHA:~/Documents/Assignment_2/bcm2835-1.50$
```

```
anushahegde — pi@ANUSHA0: ~/Documents/Assignment_2/bcm2835-1....  
bcm2835.h  Makefile      test          test.o  
bcm2835.o  Makefile.am   test.c        test-suite.log  
[pi@ANUSHA0:~/Documents/Assignment_2/bcm2835-1.50/src $ cat test-suite.log | more]  
=====  
bcm2835 1.50: src/test-suite.log  
=====  
  
# TOTAL: 1  
# PASS: 0  
# SKIP: 0  
# XFAIL: 0  
# FAIL: 1  
# XPASS: 0  
# ERROR: 0  
  
. contents:: :depth: 2  
  
FAIL: test  
=====  
  
bcm2835_init: gpio mmap failed: Cannot allocate memory  
pi@ANUSHA0:~/Documents/Assignment_2/bcm2835-1.50/src $
```

To resolved that I referred to reference 7 and could not fix it. Then after installing the latest version of the library problem was solved.

```
bcm2835-1.50/examples/spin/  
bcm2835-1.50/examples/spin/spin.c  
bcm2835-1.50/examples/event/  
bcm2835-1.50/examples/event/event.c  
bcm2835-1.50/examples/spi/  
bcm2835-1.50/examples/spi/spi.c  
bcm2835-1.50/examples/pwm/  
bcm2835-1.50/examples/pwm/pwm.c  
bcm2835-1.50/test-driver  
pi@ANUSHA0:~/Documents/Assignment_2 $ ls  
bcm2835-1.50 bcm2835-1.50.tar.gz  
pi@ANUSHA0:~/Documents/Assignment_2 $ cd bcm2835-1.50/  
pi@ANUSHA0:~/Documents/Assignment_2/bcm2835-1.50 $ ls  
aclocal.m4 config.h.in COPYING INSTALL Makefile.in src  
AUTHORS config.sub depcomp install-sh missing test-driver  
[ChangeLog configure doc ltmain.sh NEWS  
config.guess configure.ac examples Makefile.am README  
[pi@ANUSHA0:~/Documents/Assignment_2/bcm2835-1.50 $ ./configure  
[checking for a BSD-compatible install... /usr/bin/install -c  
checking whether build environment is sane... yes  
/home/pi/Documents/Assignment_2/bcm2835-1.50/missing: Unknown `--is-lightweight' option  
Try `/home/pi/Documents/Assignment_2/bcm2835-1.50/missing --help' for more information  
configure: WARNING: 'missing' script is too old or missing  
[checking for a thread-safe mkdir -p... /usr/bin/mkdir -p  
checking for gawk... no  
checking for mawk... mawk  
checking whether make sets $(MAKE)... yes  
checking whether make supports nested variables... yes  
checking for style of include used by make... GNU  
checking for gcc... gcc  
checking whether the C compiler works... yes  
checking for C compiler default output file name... a.out  
checking for suffix of executables...  
checking whether we are cross compiling... no  
checking for suffix of object files... o  
checking whether we are using the GNU C compiler... yes  
checking whether gcc accepts -g... yes  
checking for gcc option to accept ISO C89... none needed  
checking dependency style of gcc... gcc3  
checking for clock_gettime in -lrt... yes  
checking for doxygen... no  
configure: WARNING: Doxygen not found - continuing without Doxygen support  
checking for ranlib... ranlib  
checking for gcc... (cached) gcc  
checking whether we are using the GNU C compiler... (cached) yes  
checking whether gcc accepts -g... (cached) yes  
checking for gcc option to accept ISO C89... (cached) none needed  
checking dependency style of gcc... (cached) gcc3  
checking that generated files are newer than configure... done  
configure: creating ./config.status  
config.status: creating Makefile  
config.status: creating src/Makefile  
config.status: creating doc/Makefile  
config.status: creating config.h  
config.status: executing depfiles commands  
pi@ANUSHA0:~/Documents/Assignment_2/bcm2835-1.50 $ ]
```

```
anushahegde — pi@ANUSHA0: ~/Documents/Assignment_2/bcm2835-1....  
config.status: creating config.h  
config.status: executing depfiles commands  
[pi@ANUSHA0:~/Documents/Assignment_2/bcm2835-1.50 $ make  
make all-recursive  
make[1]: Entering directory '/home/pi/Documents/Assignment_2/bcm2835-1.50'  
Making all in src  
make[2]: Entering directory '/home/pi/Documents/Assignment_2/bcm2835-1.50/src'  
gcc -DHAVE_CONFIG_H -I. -I.. -g -O2 -MT bcm2835.o -MD -MP -MF .deps/bcm2835.Tpo -c -o bcm2835.o bcm2835.c  
mv -f .deps/bcm2835.Tpo .deps/bcm2835.Po  
rm -f libbcm2835.a  
ar cru libbcm2835.a bcm2835.o  
ar: `u' modifier ignored since `D' is the default (see `U')  
ranlib libbcm2835.a  
make[2]: Leaving directory '/home/pi/Documents/Assignment_2/bcm2835-1.50/src'  
Making all in doc  
make[2]: Entering directory '/home/pi/Documents/Assignment_2/bcm2835-1.50/doc'  
make[2]: Nothing to be done for 'all'.  
make[2]: Leaving directory '/home/pi/Documents/Assignment_2/bcm2835-1.50/doc'  
make[2]: Entering directory '/home/pi/Documents/Assignment_2/bcm2835-1.50'  
make[2]: Leaving directory '/home/pi/Documents/Assignment_2/bcm2835-1.50'  
make[1]: Leaving directory '/home/pi/Documents/Assignment_2/bcm2835-1.50'  
pi@ANUSHA0:~/Documents/Assignment_2/bcm2835-1.50 $ ]
```

Questions

1. What size caches are present?

I started by running some linux commands to get the cache size of the raspberry pi 4. At first I used command `$getconf -a | grep CACHE` and the result was showing cache size zero. So I used `$dmesg | grep cache` to get the cache details. Using reference 1, I confirmed the cache size for this particular processor.

```

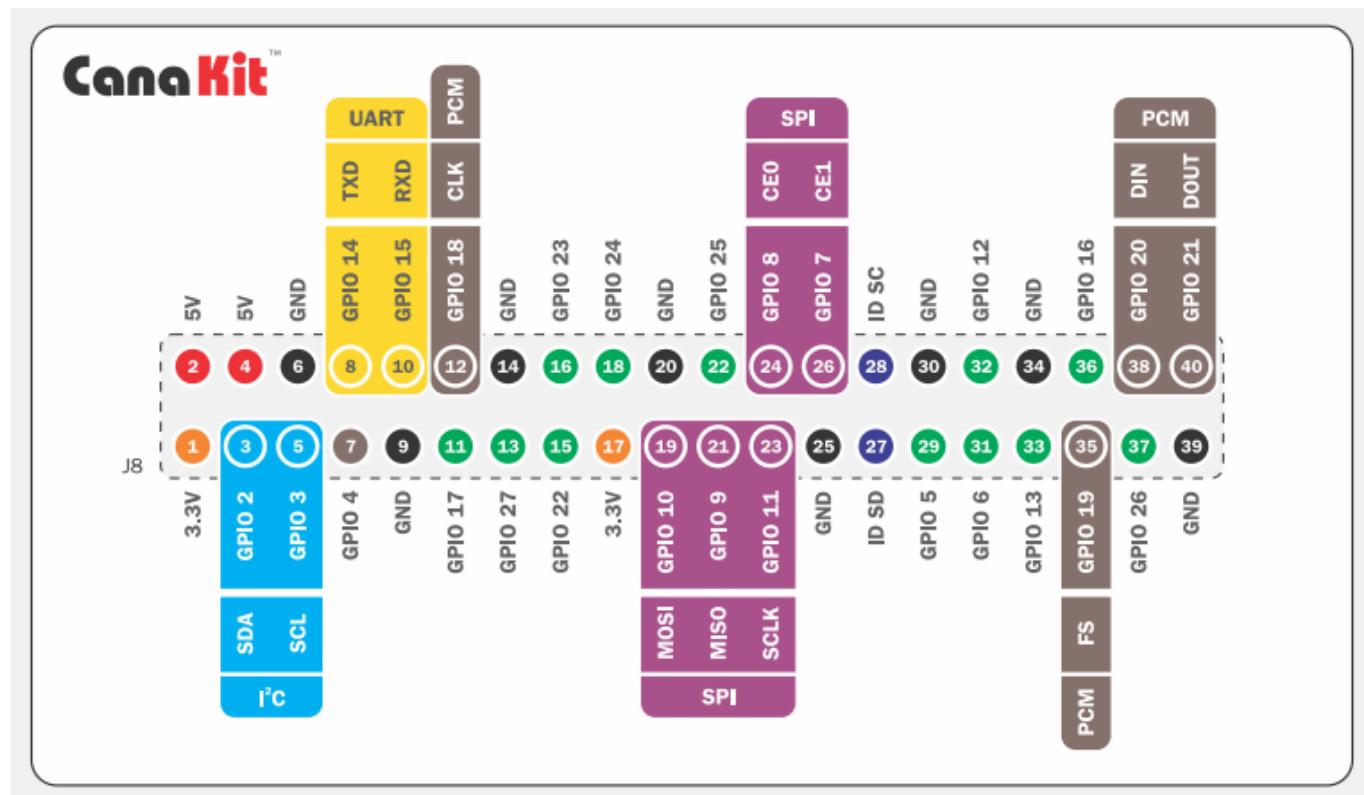
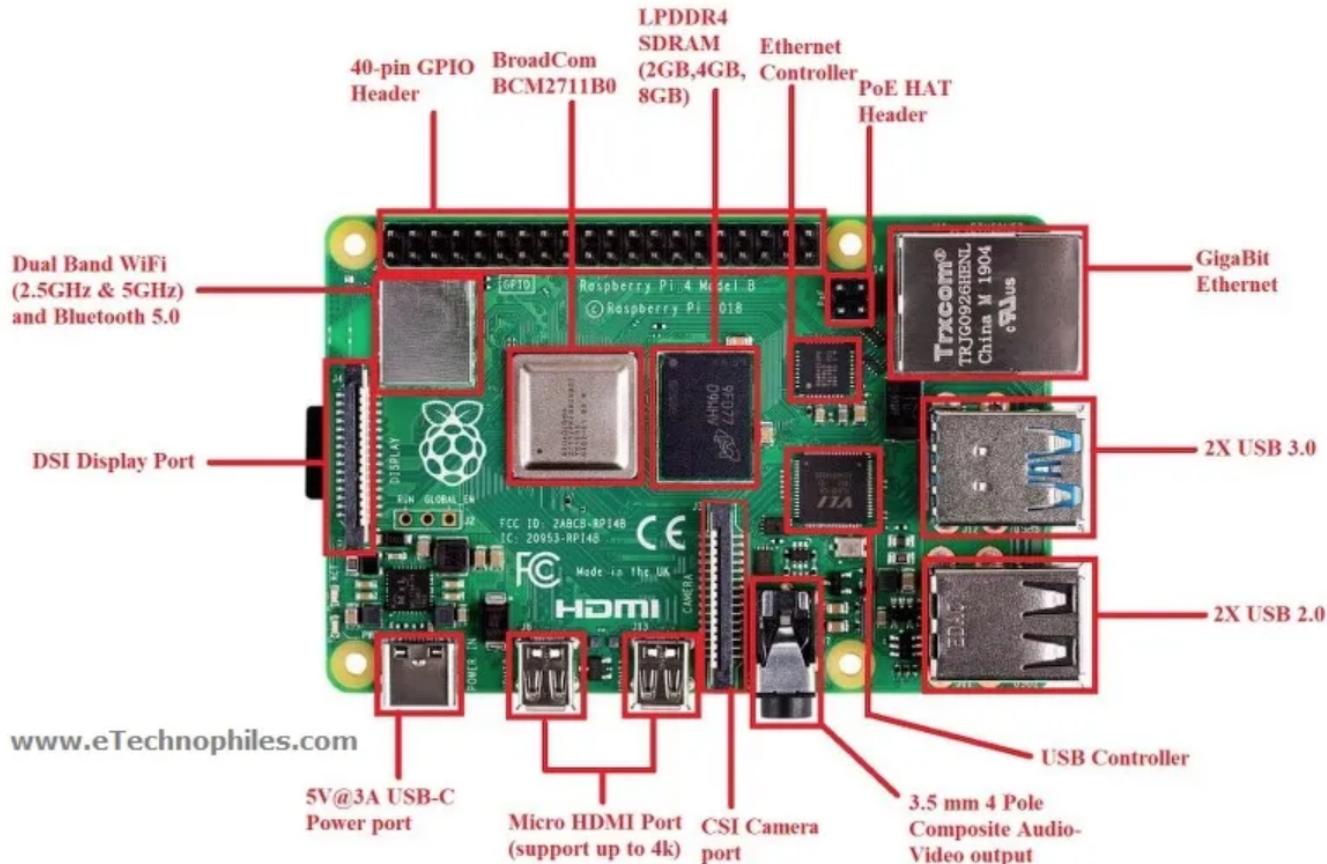
LEVEL4_CACHE_LINESIZE          0
IPV6                          200809
RAW_SOCKETS                   200809
_POSIX_IPV6                  200809
_POSIX_RAW_SOCKETS           200809
pi@ANUSHA0:~ $ getconf -a | grep CACHE
LEVEL1_ICACHE_SIZE            0
LEVEL1_ICACHE_ASSOC           0
LEVEL1_ICACHE_LINESIZE        0
LEVEL1_DCACHE_SIZE            0
LEVEL1_DCACHE_ASSOC           0
LEVEL1_DCACHE_LINESIZE        0
LEVEL2_CACHE_SIZE             0
LEVEL2_CACHE_ASSOC            0
LEVEL2_CACHE_LINESIZE         0
LEVEL3_CACHE_SIZE             0
LEVEL3_CACHE_ASSOC            0
LEVEL3_CACHE_LINESIZE         0
LEVEL4_CACHE_SIZE             0
LEVEL4_CACHE_ASSOC            0
LEVEL4_CACHE_LINESIZE         0
pi@ANUSHA0:~ $

```

FEATURE	ARM1176	CORTEX-A72
L1 I-cache capacity	16KB	48KB
L1 I-cache organization	4-way set associative, 32B line	3-way set associative, 64B line
L1 D-cache capacity	16KB	32KB
L1 D-cache organization	4-way set associative, 32B line	2-way set associative, 64B line
L2 cache capacity	128KB	1MB
L2 cache organization	Shared, 8-way set associative, 64B line	Shared, 16-way set associative, 64B line

2. What is the pin layout of this specific version of the target board?

Using reference 2, the pin layout of raspberry pi 4 model B is shown in below image with GPIO pins



3. How much memory is available on the board?

Using command free -h the total memory,used and available memory is found.

```
pi@ANUSHA0:~ $ free -h
total        used        free      shared  buff/cache   available
Mem:       3.7Gi      64Mi      3.5Gi      0.0Ki     164Mi      3.6Gi
Swap:      99Mi       0B      99Mi
pi@ANUSHA0:~ $
```

4. How many different types of memory are on the board?

There are 4 types of memory in raspberry pi overall. RAM(2GB/4GB/8GB),L1(32KB) and L2(512KB) cache memory, and MicroSD of variable sizes.

5. What is the name and release version of the Operating System used on the target board?

```
[pi@ANUSHA0:~ $ cat /etc/os-release
PRETTY_NAME="Raspbian GNU/Linux 11 (bullseye)"
NAME="Raspbian GNU/Linux"
VERSION_ID="11"
VERSION="11 (bullseye)"
VERSION_CODENAME=bullseye
ID=raspbian
ID_LIKE=debian
HOME_URL="http://www.raspbian.org/"
SUPPORT_URL="http://www.raspbian.org/RaspbianForums"
BUG_REPORT_URL="http://www.raspbian.org/RaspbianBugs"
pi@ANUSHA0:~ $
```

6. Processors detail of the raspberry pi

```
pi@ANUSHA0:~ $ cat /proc/cpuinfo
processor      : 0
model name    : ARMv7 Processor rev 3 (v7l)
BogoMIPS      : 108.00
Features       : half thumb fastmult vfp edsp neon vfpv3 tls vfpv4 idiva idivt vfpd32 lpae evtstrm crc32
CPU implementer: 0x41
CPU architecture: 7
CPU variant   : 0x0
CPU part      : 0xd08
CPU revision  : 3

processor      : 1
model name    : ARMv7 Processor rev 3 (v7l)
BogoMIPS      : 108.00
Features       : half thumb fastmult vfp edsp neon vfpv3 tls vfpv4 idiva idivt vfpd32 lpae evtstrm crc32
CPU implementer: 0x41
CPU architecture: 7
CPU variant   : 0x0
CPU part      : 0xd08
CPU revision  : 3

processor      : 2
model name    : ARMv7 Processor rev 3 (v7l)
BogoMIPS      : 108.00
Features       : half thumb fastmult vfp edsp neon vfpv3 tls vfpv4 idiva idivt vfpd32 lpae evtstrm crc32
CPU implementer: 0x41
CPU architecture: 7
CPU variant   : 0x0
CPU part      : 0xd08
CPU revision  : 3

processor      : 3
model name    : ARMv7 Processor rev 3 (v7l)
BogoMIPS      : 108.00
Features       : half thumb fastmult vfp edsp neon vfpv3 tls vfpv4 idiva idivt vfpd32 lpae evtstrm crc32
CPU implementer: 0x41
CPU architecture: 7
CPU variant   : 0x0
CPU part      : 0xd08
CPU revision  : 3

Hardware      : BCM2711
Revision      : c03114
Serial        : 100000001dd7aaaf6
Model         : Raspberry Pi 4 Model B Rev 1.4
pi@ANUSHA0:~ $
```

7. How long does it take for a context switch?

A context switch could take anywhere from a few 100 nanoseconds to few microseconds depending upon the CPU architecture and the size of the context that is to be saved and restored.

8. How much time does it take to copy 1 KB, 1 MB, and 1GB in bytes, half words, and words in RAM?

I used the reference 3 to understand how to get the speed of copy to the RAM.

a. Checking speed for 1K of data using command `$sysbench --test=memory --memory-block-size=1K --memory-total-size=1K run`

```
[pi@ANUSHA0:~ $ sysbench --test=memory --memory-block-size=1K --memory-total-size=1K run
WARNING: the --test option is deprecated. You can pass a script name or path on the command line without any options.
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 1
Initializing random number generator from current time

Running memory speed test with the following options:
  block size: 1KiB
  total size: 0MiB
  operation: write
  scope: global

Initializing worker threads...

Threads started!

Total operations: 1 ( 58.54 per second)
0.00 MiB transferred (0.06 MiB/sec)

General statistics:
  total time:          0.0003s
  total number of events: 1

Latency (ms):
  min:                 0.00
  avg:                 0.00
  max:                 0.00
  95th percentile:    0.00
  sum:                 0.00

Threads fairness:
  events (avg/stddev):   1.0000/0.00
  execution time (avg/stddev): 0.0000/0.00

pi@ANUSHA0:~ $
```

b. Checking speed for 1MB of data using command `$sysbench --test=memory --memory-block-size=1K --memory-total-size=1G run`

```
[pi@ANUSHA0:~ $ sysbench --test=memory --memory-block-size=1K --memory-total-size=1M run
WARNING: the --test option is deprecated. You can pass a script name or path on the command line without any options.
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 1
Initializing random number generator from current time

Running memory speed test with the following options:
  block size: 1KiB
  total size: 1MiB
  operation: write
  scope: global

Initializing worker threads...

Threads started!

Total operations: 1024 (45420.07 per second)
1.00 MiB transferred (44.36 MiB/sec)

General statistics:
  total time:          0.0100s
  total number of events: 1024

Latency (ms):
  min:                 0.00
  avg:                 0.00
  max:                 0.00
  95th percentile:    0.00
  sum:                 2.06

Threads fairness:
  events (avg/stddev):   1024.0000/0.00
  execution time (avg/stddev): 0.0021/0.00

pi@ANUSHA0:~ $
```

c. Checking speed for 1GB of data using command `$sysbench --test=memory --memory-block-size=1K --memory-total-size=1G run`

```
[pi@ANUSHA0:~ $ sysbench --test=memory --memory-block-size=1K --memory-total-size=1G run
WARNING: the --test option is deprecated. You can pass a script name or path on the command line without any options.
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 1
Initializing random number generator from current time

Running memory speed test with the following options:
block size: 1KiB
total size: 1024MiB
operation: write
scope: global

Initializing worker threads...

Threads started!

Total operations: 1048576 (580535.84 per second)
1024.00 MiB transferred (566.93 MiB/sec)

General statistics:
    total time:          1.8001s
    total number of events: 1048576

Latency (ms):
    min:                  0.00
    avg:                  0.00
    max:                  0.02
    95th percentile:      0.00
    sum:                 718.22

Threads fairness:
    events (avg/stddev): 1048576.0000/0.00
    execution time (avg/stddev): 0.7182/0.00

pi@ANUSHA0:~ $
```

d. Checking speed for 10GB of data using command `$sysbench --test=memory --memory-block-size=1M --memory-total-size=10G run`

```
[pi@ANUSHA0:~ $ sysbench --test=memory --memory-block-size=1M --memory-total-size=10G run
WARNING: the --test option is deprecated. You can pass a script name or path on the command line without any options.
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 1
Initializing random number generator from current time

Running memory speed test with the following options:
  block size: 1024KiB
  total size: 10240MiB
  operation: write
  scope: global

Initializing worker threads...

Threads started!

Total operations: 10240 ( 3822.05 per second)
10240.00 MiB transferred (3822.05 MiB/sec)

General statistics:
  total time: 2.6730s
  total number of events: 10240

Latency (ms):
  min: 0.24
  avg: 0.26
  max: 0.85
  95th percentile: 0.30
  sum: 2658.01

Threads fairness:
  events (avg/stddev): 10240.0000/0.00
  execution time (avg/stddev): 2.6580/0.00

pi@ANUSHA0:~ $
```

9. How long does raspberry pi takes to boot from fresh?

Boot time depends on many factors including speed of the SD card using,clock speed of raspberry pi, power provided to pi and interfaces etc. In general it takes around 10-15 seconds to boot. For me when connecting through ssh it takes only 2 seconds to connect.

10. Understanding sudo halt and sudo shutdown

Its always a good practice to shutdown the board properly. Board can be shutdown using **\$sudo shutdown -h now** or **\$sudo halt**. These commands will send SIGTERM to all running processes, notifying them to save their data and exit. It then sends SIGKILL to all remaining processes to halt the system, followed by finally unmounting all filesystems. The screen will then show System Halted and you can pull the plug. I have found in few articles that the sudo halt and sudo shutdown are almost the same since sudo halt will stop the power running in the device.

11. What are the operating temperature ranges of raspberry pi 4 model b?

Operating temperature range is from -40 degree Celsius to 85 degree Celsius.

12. Find and run some benchmarks?

a. Using sysbench tool ran the command `$sysbench --test=cpu --cpu-max-prime=10000 run`

```
[pi@ANUSHAO:~ $ sysbench --test=cpu --cpu-max-prime=10000 run
WARNING: the --test option is deprecated. You can pass a script name or path on the command line without any options.
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 1
Initializing random number generator from current time

Prime numbers limit: 10000

Initializing worker threads...

Threads started!

CPU speed:
events per second: 119.02

General statistics:
total time: 10.00005s
total number of events: 1191

Latency (ms):
min: 8.33
avg: 8.39
max: 18.85
95th percentile: 8.43
sum: 9997.05

Threads fairness:
events (avg/stddev): 1191.0000/0.00
execution time (avg/stddev): 9.9971/0.00
```

b. Using sysbench with different command `$sysbench cpu --threads=2 run`

```
[pi@ANUSHA0:~ $ sysbench cpu --threads=2 run
sysbench 1.0.20 (using system LuaJIT 2.1.0-beta3)
```

Running the test with following options:

Number of threads: 2

Initializing random number generator from current time

Prime numbers limit: 10000

Initializing worker threads...

Threads started!

CPU speed:

events per second: 238.27

General statistics:

total time: 10.0038s

total number of events: 2385

Latency (ms):

min: 8.33

avg: 8.39

max: 25.93

95th percentile: 8.43

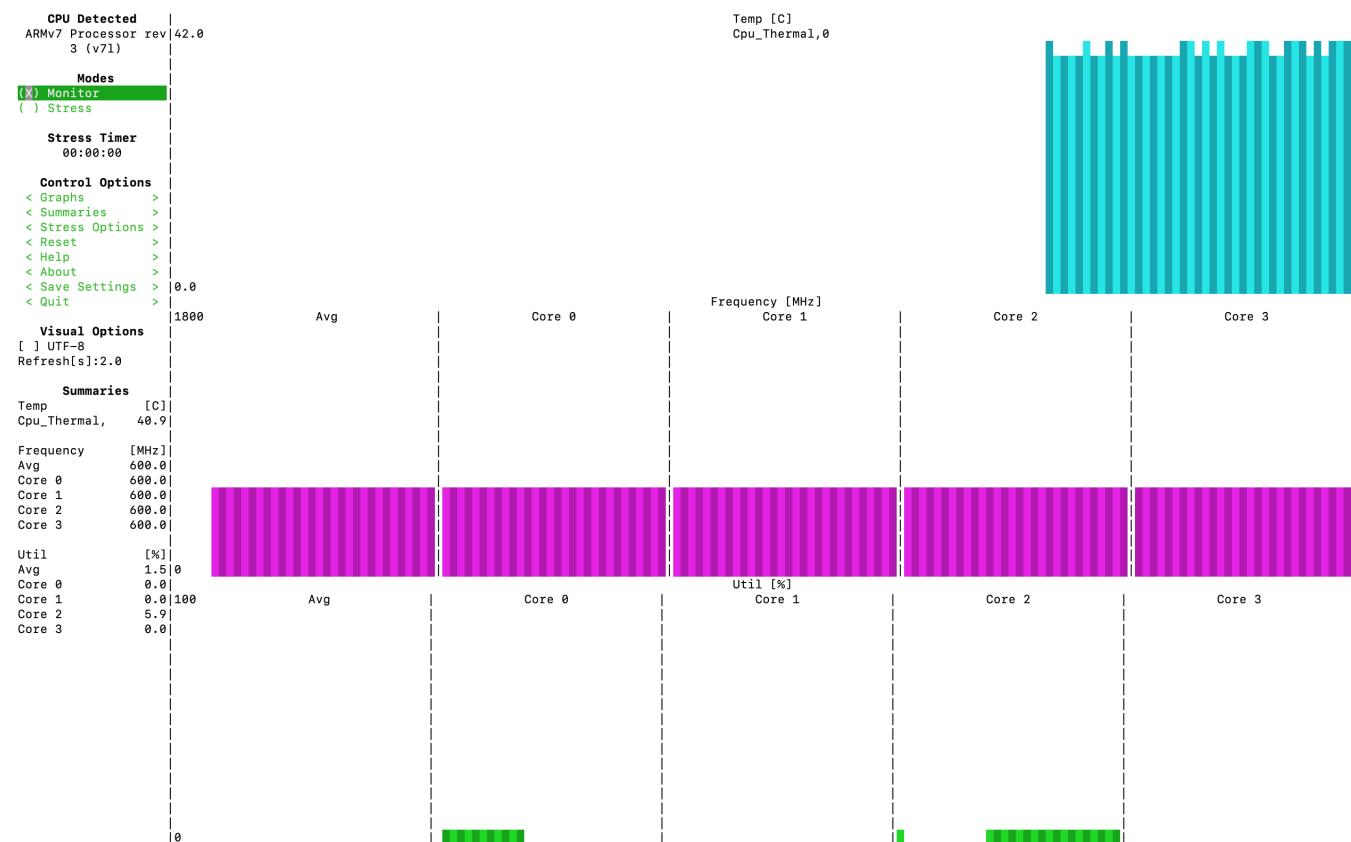
sum: 20001.29

Threads fairness:

events (avg/stddev): 1192.5000/0.50

execution time (avg/stddev): 10.0006/0.00

c. Using S-tui : S-tui is a CPU resource monitor that uses a terminal based graphical interface to display data and graphs(stress test). **\$s-tui** to launch it.



d. Using 7-Zip : Single threaded benchmark

```
[pi@ANUSHAO:~ $ 7z b -mmt1
```

```
7-Zip [32] 16.02 : Copyright (c) 1999-2016 Igor Pavlov : 2016-05-21
p7zip Version 16.02 (locale=en_US.UTF-8,Utf16=on,HugeFiles=on,32 bits,4 CPUs LE
```

LE

CPU Freq: 64000000 64000000 64000000 --- 512000000 - 2048000000

RAM size: 3838 MB, # CPU hardware threads: 4
 RAM usage: 435 MB, # Benchmark threads: 1

Dict	Speed KiB/s	Usage %	Compressing		Decompressing			
			R/U MIPS	Rating MIPS	Speed KiB/s	Usage %	R/U MIPS	Rating MIPS
22:	1504	100	1464	1464	27990	100	2390	2390
23:	1421	100	1449	1449	27430	100	2375	2374
24:	1349	100	1451	1451	26768	100	2350	2350
25:	1266	100	1446	1446	26063	100	2320	2320
Avr:		100	1453	1452		100	2359	2359
Tot:		100	1906	1905				

multi-thread benchmark

```
[pi@ANUSHA0:~ $ 7z b
```

```
7-Zip [32] 16.02 : Copyright (c) 1999-2016 Igor Pavlov : 2016-05-21
p7zip Version 16.02 (locale=en_US.UTF-8,Utf16=on,HugeFiles=on,32 bits,4 CPUs LE)
```

LE

CPU Freq: 32000000 -- 64000000 - 256000000 512000000 1024000000 2048000000

RAM size: 3838 MB, # CPU hardware threads: 4
 RAM usage: 882 MB, # Benchmark threads: 4

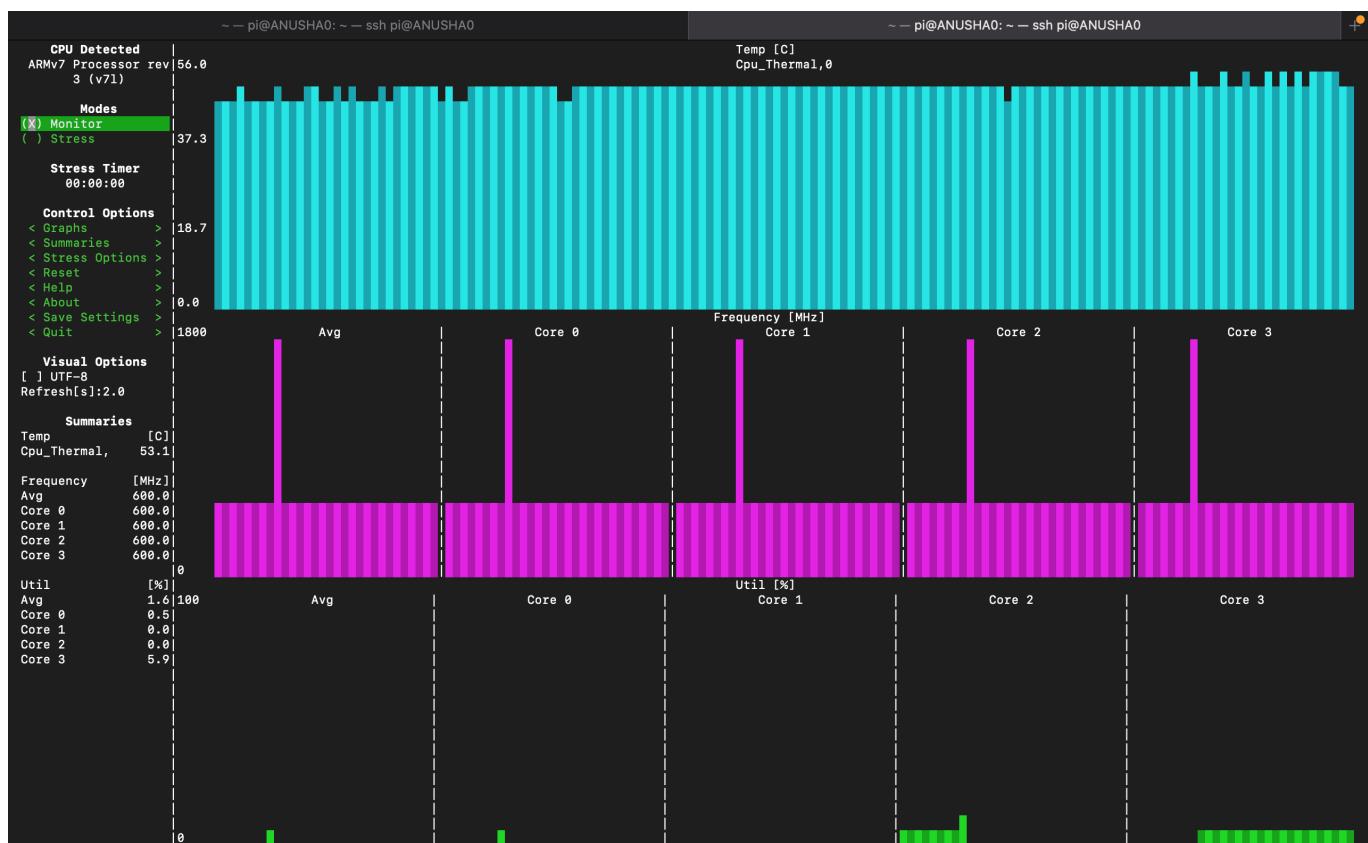
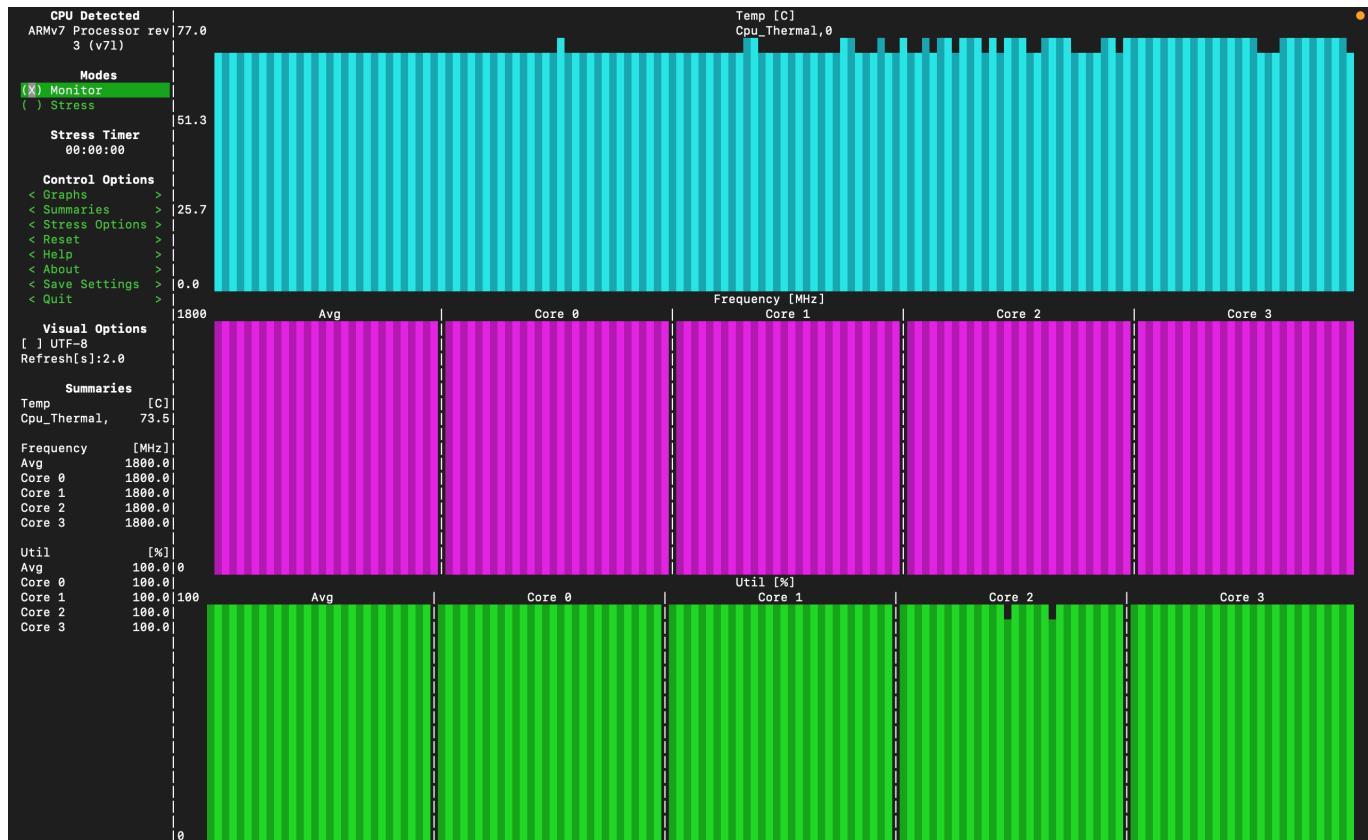
Dict	Speed KiB/s	Usage %	Compressing		Decompressing			
			R/U MIPS	Rating MIPS	Speed KiB/s	Usage %	R/U MIPS	Rating MIPS
22:	4073	353	1124	3963	107874	399	2307	9203
23:	3914	370	1079	3988	105438	399	2289	9123
24:	3819	374	1097	4107	103047	399	2265	9046
25:	3582	366	1117	4091	100038	399	2230	8903
Avr:		366	1104	4037		399	2273	9069
Tot:		382	1689	6553				

13. What would be a useful stress test to determine reliability?

A stress test that would max out specific component of the system(CPU, GPU, RAM, storage, network card) for prolonged period of time and also monitoring the module being tested (such as performance, temperature etc) would help determining reliability of component. Alternatively we can use stress test which would touch up on all these aspects to determine reliability of the overall board. One such example is S-tui test for CPU testing.

14. Is active cooling necessary to maintain performance.

By looking at the difference between the performance of the CPU in the below images we can see the CPU throttling. When the fan was attached to the board the frequency of operation was high (1800MHz). When the fan and heat sink was removed the operating frequency has decreased significantly.



15. What is the compiler name and version?

```
[pi@ANUSHA0:~ $ gcc --version
gcc (Raspbian 10.2.1-6+rpi1) 10.2.1 20210110
Copyright (C) 2020 Free Software Foundation, Inc.
This is free software; see the source for copying conditions. There is NO
warranty; not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.
```

16. Reading from moisture sensor

As a start to my final project, I began with reading from moisture sensor using C and python with WiringPi library. Since I am new to C ,I started coding with python to help understand the process of reading sensor. I have attached my python code below.

Users > anushahegde > Desktop >  test.py > ...

```
1  import RPi.GPIO as GPIO
2  import time
3
4  channel=4
5  GPIO.setmode(GPIO.BCM)
6  GPIO.setup(channel,GPIO.IN)
7
8  def callback(channel):
9      if GPIO.input(channel):
10          print("moisture threshold not reached")
11      else:
12          print("moisture threshold reached")
13
14
15 GPIO.add_event_detect(channel,GPIO.BOTH,bouncetime=300)
16 GPIO.add_event_callback(channel,callback)
17
18
19 while True:
20     time.sleep(2)
```

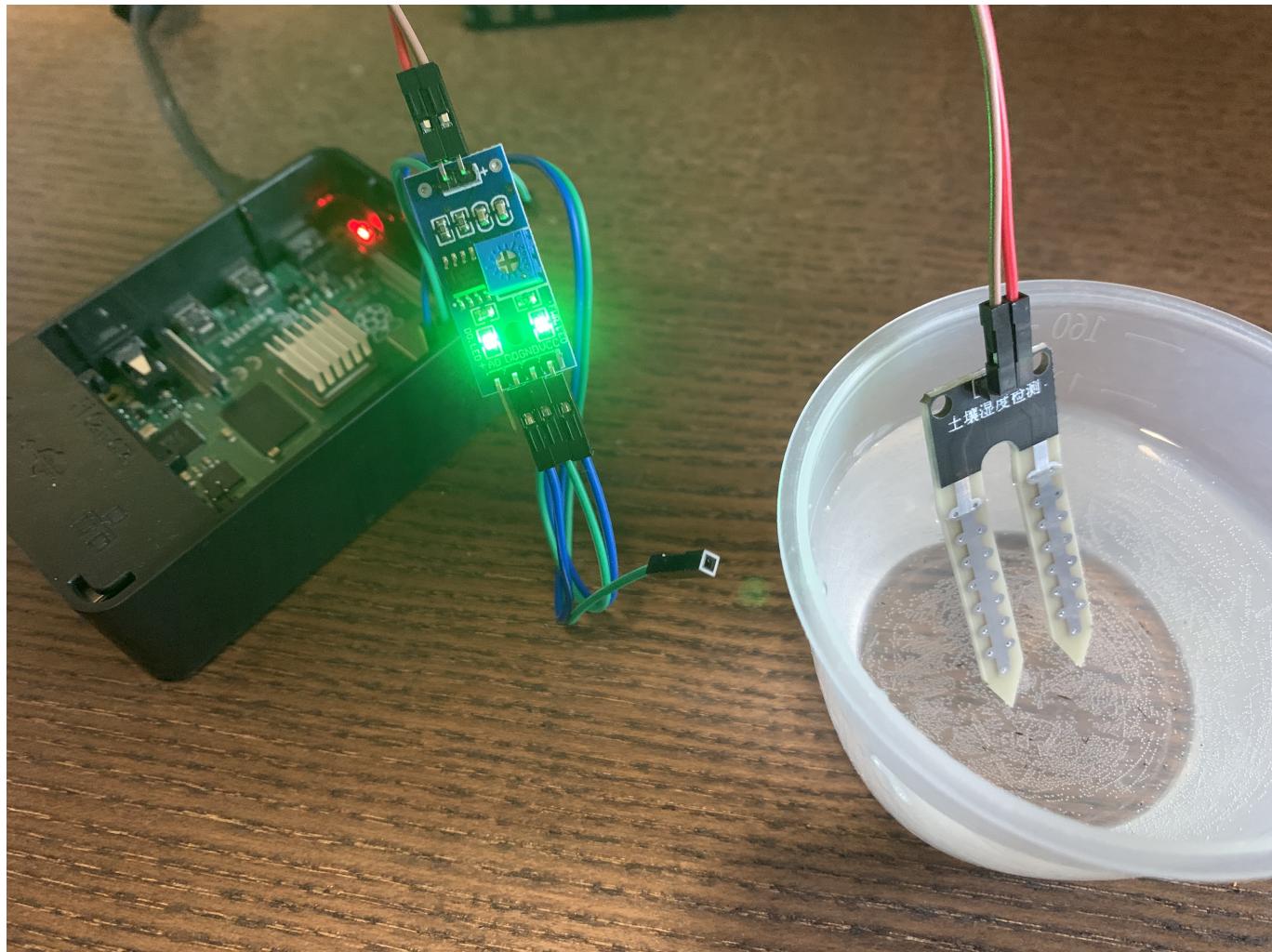
C code is shown below

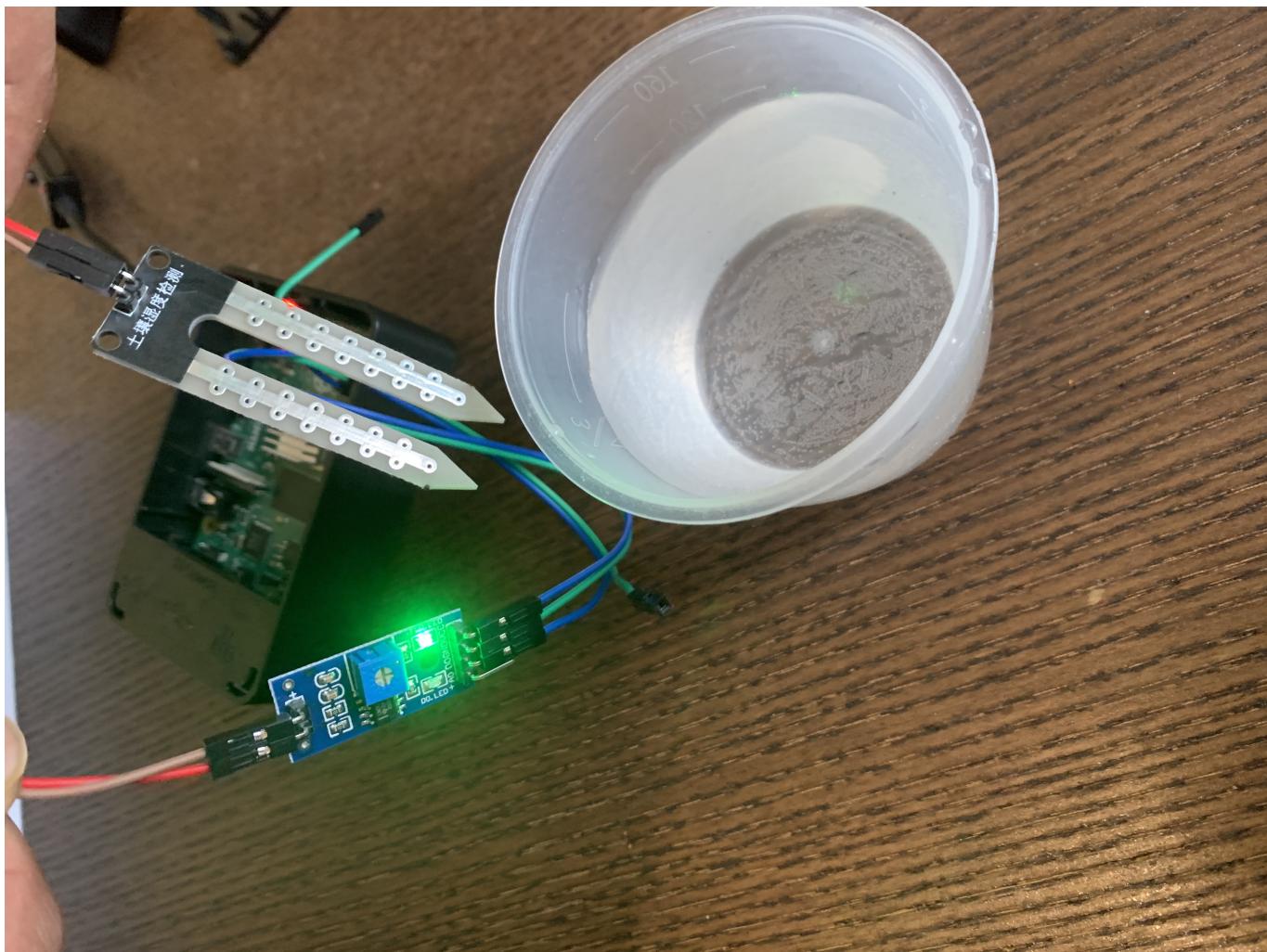
Users > anushahegde > Desktop > C code.c > main(void)

```
1 #include <stdio.h>
2 #include <wiringPi.h>
3 #define MOIST 7 //GPIO 4 pin 7 maps to WiringPi pin number 7
4 int main (void)
5 {
6     printf ("Testing raspberry pi moisture sensor\n") ;
7     wiringPiSetup();
8     pinMode(MOIST, INPUT);
9     for(;;)
10    {
11         if (digitalRead(MOIST))
12             printf("moisture threshold not reached\n");
13         else
14             printf("moisture threshold reached \n");
15         delay(2000);
16     }
17     return 0 ;
18 }
```

Output of the C code

```
[pi@ANUSHA0:~/Documents $ gcc code.c -o test -l wiringPi
[pi@ANUSHA0:~/Documents $ ./test
Testing raspberry pi moisture sensor
moisture threshold not reached
moisture threshold not reached
moisture threshold not reached
moisture threshold reached
moisture threshold reached
moisture threshold not reached
moisture threshold not reached
moisture threshold not reached
moisture threshold not reached
```





Conclusion

Characterization of the board is achieved with understanding of the features of raspberry pi 4 board and running some code in C and python. Time taken was around 8-9 hours. If the prototype is scaled up to 1000 or 10000 units, 3-4 moisture sensors can be accommodated in one raspberry pi, and sensors are not expensive. Only major cost contribution would be from the raspberry pi boards. From this assignment I learned more about raspberry pi features and how to work with it using few examples. Hoping to explore more in next few weeks.

References

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