```python
1    ## AUTHOR: Kieran Owen Wand (14yrs)
2    ## ASSISTANT: Christopher John Butcher (DAD, 35yrs)
3
4    ## CREATED JUNE 2015
5
6    ## CREDITS
7    #   - ASTROPI FORUM MEMBERS, HELP AND SUPPORT FOR SCRIPTS AND FAULT FINDING
8    #   - RASPBERRY PI FORUM MEMBERS, HELP AND SUPPORT FOR SCRIPTS AND FAULT
     FINDING
9    #   - Tsena Wand (MUM), ASSESSING THE EASE OF USE FOR THE READING DISPLAYS
     AND WARNING STATES
10
11
12   ## IMPORT MODULES REQUIRED FOR PROGRAM ##
13   import RPi.GPIO as GPIO
14   import time, logging
15   from datetime import datetime
16   import sys, os
17   import astro_pi
18   from astro_pi import AstroPi
19   from time import sleep, asctime
20
21   ## SETS ASTROPI MODULES AS FRIENDLY NAME ##
22
23   ap = astro_pi.AstroPi()
24
25   # SETTING UP RASPBERRYPI FOR FLIGHT BUTTONS TO USE GPIO PINS
26
27   GPIO.setwarnings(False)
28   GPIO.setmode(GPIO.BCM)
29
30
31   # ASSIGNING FRIENDLY NAMES FOR GPIO PINS
32
33   UP = 26
34   DOWN = 13
35   LEFT = 20
36   RIGHT = 19
37   A = 21
38   B = 16
39
40   # FORCING PROGRAM TO RUN WITHIN WHILE LOOP
41
42   running = True
43
44
45   ## CREATE TIMESTAMP AS FRIENDLY NAME ##
46
47   tmstmp = time.strftime("%Y%m%d-%H%M%S")
48
49
50   ## ASSIGNING LEVELS TO LED'S AND COLOURS ##
51
```

```python
52     # ADJUSTABLE LED LIGHT LEVELS
53
54     led_level = 150
55
56     # ASSIGNING LEVELS TO COLOURS
57
58     red = 255                              # TEMPERATURE LED LIGHT LEVEL
59     blue = 255                             # PRESSURE LED LIGHT LEVEL
60
61
62     ## ASSIGNING DEFAULTS TO TEMP + HUM OR PRESSURE PAGES ##
63
64     temp_hum_on = 0
65     psi_on = 0
66
67
68     ## ASSIGNING DEFAULTS VALUES TO ALARM TRIGGERS ##
69
70     tmp_alarm = 0
71     hum_alarm = 0
72     psi_alarm = 0
73     id_num = 0
74
75
76     ## ASSIGNING DEFAULTS TO WARNINIG PAGES (MUTE / SHOW) ##
77
78     tmp_mute = 0
79     hum_mute = 0
80     psi_mute = 0
81
82
83     ## ASSIGNING DEFAULT TO DISPLAY OFF TRIGGER ##
84
85     display_mute = 0
86
87     ## CREATES A LOG FILE WITH THE TITLE
       "log/{timestamp:%Y-%m-%d-%H-%M}watchdog.csv" ##
88     ## THIS ALSO ADDS A TIMESTAMP TO THE START OF THE FILE NAME CREATED ##
89
90     count = 0
91     file = open('log/'+(str(tmstmp))+' watchdog-log.csv', 'w')
92     file.write(
       "\"Time\",\"Display\",\"Temperature\",\"Temp_Reading\",\"Temp_Alarm\",\"Humid
       ity\",\"Hum_Reading\",\"Hum_Alarm\",\"Pressure\",\"PSI_Reading\",\"PSI_Alarm\
       ",\"Pitch\",\"Roll\",\"Yaw\"\n")
93
94
95     ## EXAMPLE FOR WRITING INFORMATION ONTO LED MATRIX PIXELS:
96
97         #ap.set_pixel(x, y, red, green, blue)
98
99
100    ## TEMPERATURE NUMBERS MATRIX BELOW ##
```

```python
101
102    def temp_num_matrix_1(num):
103
104      if num == '0':
105    # number 0_top_left – TEMPERATURE
106        ap.set_pixel(0, 0, led_level, 0, 0)
107        ap.set_pixel(0, 1, led_level, 0, 0)
108        ap.set_pixel(0, 2, led_level, 0, 0)
109        ap.set_pixel(0, 3, led_level, 0, 0)
110        ap.set_pixel(1, 0, led_level, 0, 0)
111        ap.set_pixel(1, 1, 0, 0, 0)
112        ap.set_pixel(1, 2, 0, 0, 0)
113        ap.set_pixel(1, 3, led_level, 0, 0)
114        ap.set_pixel(2, 0, led_level, 0, 0)
115        ap.set_pixel(2, 1, led_level, 0, 0)
116        ap.set_pixel(2, 2, led_level, 0, 0)
117        ap.set_pixel(2, 3, led_level, 0, 0)
118        ap.set_pixel(3, 0, 0, 0, 0)
119        ap.set_pixel(3, 1, 0, 0, 0)
120        ap.set_pixel(3, 2, 0, 0, 0)
121        ap.set_pixel(3, 3, 0, 0, 0)
122
123      if num == '1':
124        # number 1_top_left – TEMPERATURE
125        ap.set_pixel(0, 0, 0, 0, 0)
126        ap.set_pixel(0, 1, led_level, 0, 0)
127        ap.set_pixel(0, 2, 0, 0, 0)
128        ap.set_pixel(0, 3, led_level, 0, 0)
129        ap.set_pixel(1, 0, led_level, 0, 0)
130        ap.set_pixel(1, 1, led_level, 0, 0)
131        ap.set_pixel(1, 2, led_level, 0, 0)
132        ap.set_pixel(1, 3, led_level, 0, 0)
133        ap.set_pixel(2, 0, 0, 0, 0)
134        ap.set_pixel(2, 1, 0, 0, 0)
135        ap.set_pixel(2, 2, 0, 0, 0)
136        ap.set_pixel(2, 3, led_level, 0, 0)
137        ap.set_pixel(3, 0, 0, 0, 0)
138        ap.set_pixel(3, 1, 0, 0, 0)
139        ap.set_pixel(3, 2, 0, 0, 0)
140        ap.set_pixel(3, 3, 0, 0, 0)
141
142      if num == '2':
143    # number 2_top_left – TEMPERATURE
144        ap.set_pixel(0, 0, led_level, 0, 0)
145        ap.set_pixel(0, 1, 0, 0, 0)
146        ap.set_pixel(0, 2, 0, 0, 0)
147        ap.set_pixel(0, 3, led_level, 0, 0)
148        ap.set_pixel(1, 0, led_level, 0, 0)
149        ap.set_pixel(1, 1, 0, 0, 0)
150        ap.set_pixel(1, 2, led_level, 0, 0)
151        ap.set_pixel(1, 3, led_level, 0, 0)
152        ap.set_pixel(2, 0, led_level, 0, 0)
153        ap.set_pixel(2, 1, led_level, 0, 0)
```

```python
154            ap.set_pixel(2, 2, 0, 0, 0)
155            ap.set_pixel(2, 3, led_level, 0, 0)
156            ap.set_pixel(3, 0, 0, 0, 0)
157            ap.set_pixel(3, 1, 0, 0, 0)
158            ap.set_pixel(3, 2, 0, 0, 0)
159            ap.set_pixel(3, 3, 0, 0, 0)
160
161        if num == '3':
162        # number 3_top_left - TEMPERATURE
163            ap.set_pixel(0, 0, led_level, 0, 0)
164            ap.set_pixel(0, 1, 0, 0, 0)
165            ap.set_pixel(0, 2, 0, 0, 0)
166            ap.set_pixel(0, 3, led_level, 0, 0)
167            ap.set_pixel(1, 0, led_level, 0, 0)
168            ap.set_pixel(1, 1, led_level, 0, 0)
169            ap.set_pixel(1, 2, 0, 0, 0)
170            ap.set_pixel(1, 3, led_level, 0, 0)
171            ap.set_pixel(2, 0, led_level, 0, 0)
172            ap.set_pixel(2, 1, led_level, 0, 0)
173            ap.set_pixel(2, 2, led_level, 0, 0)
174            ap.set_pixel(2, 3, led_level, 0, 0)
175            ap.set_pixel(3, 0, 0, 0, 0)
176            ap.set_pixel(3, 1, 0, 0, 0)
177            ap.set_pixel(3, 2, 0, 0, 0)
178            ap.set_pixel(3, 3, 0, 0, 0)
179
180        if num == '4':
181        # number 4_top_left - TEMPERATURE
182            ap.set_pixel(0, 0, led_level, 0, 0)
183            ap.set_pixel(0, 1, led_level, 0, 0)
184            ap.set_pixel(0, 2, led_level, 0, 0)
185            ap.set_pixel(0, 3, 0, 0, 0)
186            ap.set_pixel(1, 0, 0, 0, 0)
187            ap.set_pixel(1, 1, 0, 0, 0)
188            ap.set_pixel(1, 2, led_level, 0, 0)
189            ap.set_pixel(1, 3, 0, 0, 0)
190            ap.set_pixel(2, 0, 0, 0, 0)
191            ap.set_pixel(2, 1, led_level, 0, 0)
192            ap.set_pixel(2, 2, led_level, 0, 0)
193            ap.set_pixel(2, 3, led_level, 0, 0)
194            ap.set_pixel(3, 0, 0, 0, 0)
195            ap.set_pixel(3, 1, 0, 0, 0)
196            ap.set_pixel(3, 2, 0, 0, 0)
197            ap.set_pixel(3, 3, 0, 0, 0)
198
199        if num == '5':
200        # number 5_top_left - TEMPERATURE
201            ap.set_pixel(0, 0, led_level, 0, 0)
202            ap.set_pixel(0, 1, led_level, 0, 0)
203            ap.set_pixel(0, 2, 0, 0, 0)
204            ap.set_pixel(0, 3, led_level, 0, 0)
205            ap.set_pixel(1, 0, led_level, 0, 0)
206            ap.set_pixel(1, 1, 0, 0, 0)
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```python
207        ap.set_pixel(1, 2, led_level, 0, 0)
208        ap.set_pixel(1, 3, led_level, 0, 0)
209        ap.set_pixel(2, 0, led_level, 0, 0)
210        ap.set_pixel(2, 1, 0, 0, 0)
211        ap.set_pixel(2, 2, 0, 0, 0)
212        ap.set_pixel(2, 3, led_level, 0, 0)
213        ap.set_pixel(3, 0, 0, 0, 0)
214        ap.set_pixel(3, 1, 0, 0, 0)
215        ap.set_pixel(3, 2, 0, 0, 0)
216        ap.set_pixel(3, 3, 0, 0, 0)
217
218      if num == '6':
219    # number 6_top_left – TEMPERATURE
220        ap.set_pixel(0, 0, led_level, 0, 0)
221        ap.set_pixel(0, 1, led_level, 0, 0)
222        ap.set_pixel(0, 2, led_level, 0, 0)
223        ap.set_pixel(0, 3, led_level, 0, 0)
224        ap.set_pixel(1, 0, 0, 0, 0)
225        ap.set_pixel(1, 1, led_level, 0, 0)
226        ap.set_pixel(1, 2, 0, 0, 0)
227        ap.set_pixel(1, 3, led_level, 0, 0)
228        ap.set_pixel(2, 0, 0, 0, 0)
229        ap.set_pixel(2, 1, led_level, 0, 0)
230        ap.set_pixel(2, 2, led_level, 0, 0)
231        ap.set_pixel(2, 3, led_level, 0, 0)
232        ap.set_pixel(3, 0, 0, 0, 0)
233        ap.set_pixel(3, 1, 0, 0, 0)
234        ap.set_pixel(3, 2, 0, 0, 0)
235        ap.set_pixel(3, 3, 0, 0, 0)
236
237      if num == '7':
238    # number 7_top_left – TEMPERATURE
239        ap.set_pixel(0, 0, led_level, 0, 0)
240        ap.set_pixel(0, 1, led_level, 0, 0)
241        ap.set_pixel(0, 2, 0, 0, 0)
242        ap.set_pixel(0, 3, 0, 0, 0)
243        ap.set_pixel(1, 0, led_level, 0, 0)
244        ap.set_pixel(1, 1, 0, 0, 0)
245        ap.set_pixel(1, 2, 0, 0, 0)
246        ap.set_pixel(1, 3, 0, 0, 0)
247        ap.set_pixel(2, 0, led_level, 0, 0)
248        ap.set_pixel(2, 1, led_level, 0, 0)
249        ap.set_pixel(2, 2, led_level, 0, 0)
250        ap.set_pixel(2, 3, led_level, 0, 0)
251        ap.set_pixel(3, 0, 0, 0, 0)
252        ap.set_pixel(3, 1, 0, 0, 0)
253        ap.set_pixel(3, 2, 0, 0, 0)
254        ap.set_pixel(3, 3, 0, 0, 0)
255
256      if num == '8':
257    # number 8_top_left – TEMPERATURE
258        ap.set_pixel(0, 0, led_level, 0, 0)
259        ap.set_pixel(0, 1, led_level, 0, 0)
```

```python
260        ap.set_pixel(0, 2, led_level, 0, 0)
261        ap.set_pixel(0, 3, led_level, 0, 0)
262        ap.set_pixel(1, 0, led_level, 0, 0)
263        ap.set_pixel(1, 1, 0, 0, 0)
264        ap.set_pixel(1, 2, led_level, 0, 0)
265        ap.set_pixel(1, 3, led_level, 0, 0)
266        ap.set_pixel(2, 0, led_level, 0, 0)
267        ap.set_pixel(2, 1, led_level, 0, 0)
268        ap.set_pixel(2, 2, led_level, 0, 0)
269        ap.set_pixel(2, 3, led_level, 0, 0)
270        ap.set_pixel(3, 0, 0, 0, 0)
271        ap.set_pixel(3, 1, 0, 0, 0)
272        ap.set_pixel(3, 2, 0, 0, 0)
273        ap.set_pixel(3, 3, 0, 0, 0)
274
275     if num == '9':
276    # number 9_top_left – TEMPERATURE
277        ap.set_pixel(0, 0, led_level, 0, 0)
278        ap.set_pixel(0, 1, led_level, 0, 0)
279        ap.set_pixel(0, 2, led_level, 0, 0)
280        ap.set_pixel(0, 3, 0, 0, 0)
281        ap.set_pixel(1, 0, led_level, 0, 0)
282        ap.set_pixel(1, 1, 0, 0, 0)
283        ap.set_pixel(1, 2, led_level, 0, 0)
284        ap.set_pixel(1, 3, 0, 0, 0)
285        ap.set_pixel(2, 0, led_level, 0, 0)
286        ap.set_pixel(2, 1, led_level, 0, 0)
287        ap.set_pixel(2, 2, led_level, 0, 0)
288        ap.set_pixel(2, 3, led_level, 0, 0)
289        ap.set_pixel(3, 0, 0, 0, 0)
290        ap.set_pixel(3, 1, 0, 0, 0)
291        ap.set_pixel(3, 2, 0, 0, 0)
292        ap.set_pixel(3, 3, 0, 0, 0)
293
294     def temp_num_matrix_2(num):
295
296     if num == '0':
297    # number 0_top_right – TEMPERATURE
298        ap.set_pixel(4, 0, led_level, 0, 0)
299        ap.set_pixel(4, 1, led_level, 0, 0)
300        ap.set_pixel(4, 2, led_level, 0, 0)
301        ap.set_pixel(4, 3, led_level, 0, 0)
302        ap.set_pixel(5, 0, led_level, 0, 0)
303        ap.set_pixel(5, 1, 0, 0, 0)
304        ap.set_pixel(5, 2, 0, 0, 0)
305        ap.set_pixel(5, 3, led_level, 0, 0)
306        ap.set_pixel(6, 0, led_level, 0, 0)
307        ap.set_pixel(6, 1, led_level, 0, 0)
308        ap.set_pixel(6, 2, led_level, 0, 0)
309        ap.set_pixel(6, 3, led_level, 0, 0)
310        ap.set_pixel(7, 0, 0, 0, 0)
311        ap.set_pixel(7, 1, 0, 0, 0)
312        ap.set_pixel(7, 2, 0, 0, 0)
```

```python
313        ap.set_pixel(7, 3, 0, 0, 0)
314
315    if num == '1':
316        # number 1_top_right - TEMPERATURE
317        ap.set_pixel(4, 0, 0, 0, 0)
318        ap.set_pixel(4, 1, led_level, 0, 0)
319        ap.set_pixel(4, 2, 0, 0, 0)
320        ap.set_pixel(4, 3, led_level, 0, 0)
321        ap.set_pixel(5, 0, led_level, 0, 0)
322        ap.set_pixel(5, 1, led_level, 0, 0)
323        ap.set_pixel(5, 2, led_level, 0, 0)
324        ap.set_pixel(5, 3, led_level, 0, 0)
325        ap.set_pixel(6, 0, 0, 0, 0)
326        ap.set_pixel(6, 1, 0, 0, 0)
327        ap.set_pixel(6, 2, 0, 0, 0)
328        ap.set_pixel(6, 3, led_level, 0, 0)
329        ap.set_pixel(7, 0, 0, 0, 0)
330        ap.set_pixel(7, 1, 0, 0, 0)
331        ap.set_pixel(7, 2, 0, 0, 0)
332        ap.set_pixel(7, 3, 0, 0, 0)
333
334    if num == '2':
335    # number 2_top_right - TEMPERATURE
336        ap.set_pixel(4, 0, led_level, 0, 0)
337        ap.set_pixel(4, 1, 0, 0, 0)
338        ap.set_pixel(4, 2, 0, 0, 0)
339        ap.set_pixel(4, 3, led_level, 0, 0)
340        ap.set_pixel(5, 0, led_level, 0, 0)
341        ap.set_pixel(5, 1, 0, 0, 0)
342        ap.set_pixel(5, 2, led_level, 0, 0)
343        ap.set_pixel(5, 3, led_level, 0, 0)
344        ap.set_pixel(6, 0, led_level, 0, 0)
345        ap.set_pixel(6, 1, led_level, 0, 0)
346        ap.set_pixel(6, 2, 0, 0, 0)
347        ap.set_pixel(6, 3, led_level, 0, 0)
348        ap.set_pixel(7, 0, 0, 0, 0)
349        ap.set_pixel(7, 1, 0, 0, 0)
350        ap.set_pixel(7, 2, 0, 0, 0)
351        ap.set_pixel(7, 3, 0, 0, 0)
352
353    if num == '3':
354    # number 3_top_right - TEMPERATURE
355        ap.set_pixel(4, 0, led_level, 0, 0)
356        ap.set_pixel(4, 1, 0, 0, 0)
357        ap.set_pixel(4, 2, 0, 0, 0)
358        ap.set_pixel(4, 3, led_level, 0, 0)
359        ap.set_pixel(5, 0, led_level, 0, 0)
360        ap.set_pixel(5, 1, led_level, 0, 0)
361        ap.set_pixel(5, 2, 0, 0, 0)
362        ap.set_pixel(5, 3, led_level, 0, 0)
363        ap.set_pixel(6, 0, led_level, 0, 0)
364        ap.set_pixel(6, 1, led_level, 0, 0)
365        ap.set_pixel(6, 2, led_level, 0, 0)
```

```python
366        ap.set_pixel(6, 3, led_level, 0, 0)
367        ap.set_pixel(7, 0, 0, 0, 0)
368        ap.set_pixel(7, 1, 0, 0, 0)
369        ap.set_pixel(7, 2, 0, 0, 0)
370        ap.set_pixel(7, 3, 0, 0, 0)
371
372     if num == '4':
373    # number 4_top_right - TEMPERATURE
374        ap.set_pixel(4, 0, led_level, 0, 0)
375        ap.set_pixel(4, 1, led_level, 0, 0)
376        ap.set_pixel(4, 2, led_level, 0, 0)
377        ap.set_pixel(4, 3, 0, 0, 0)
378        ap.set_pixel(5, 0, 0, 0, 0)
379        ap.set_pixel(5, 1, 0, 0, 0)
380        ap.set_pixel(5, 2, led_level, 0, 0)
381        ap.set_pixel(5, 3, 0, 0, 0)
382        ap.set_pixel(6, 0, 0, 0, 0)
383        ap.set_pixel(6, 1, led_level, 0, 0)
384        ap.set_pixel(6, 2, led_level, 0, 0)
385        ap.set_pixel(6, 3, led_level, 0, 0)
386        ap.set_pixel(7, 0, 0, 0, 0)
387        ap.set_pixel(7, 1, 0, 0, 0)
388        ap.set_pixel(7, 2, 0, 0, 0)
389        ap.set_pixel(7, 3, 0, 0, 0)
390
391     if num == '5':
392    # number 5_top_right - TEMPERATURE
393        ap.set_pixel(4, 0, led_level, 0, 0)
394        ap.set_pixel(4, 1, led_level, 0, 0)
395        ap.set_pixel(4, 2, 0, 0, 0)
396        ap.set_pixel(4, 3, led_level, 0, 0)
397        ap.set_pixel(5, 0, led_level, 0, 0)
398        ap.set_pixel(5, 1, 0, 0, 0)
399        ap.set_pixel(5, 2, led_level, 0, 0)
400        ap.set_pixel(5, 3, led_level, 0, 0)
401        ap.set_pixel(6, 0, led_level, 0, 0)
402        ap.set_pixel(6, 1, 0, 0, 0)
403        ap.set_pixel(6, 2, 0, 0, 0)
404        ap.set_pixel(6, 3, led_level, 0, 0)
405        ap.set_pixel(7, 0, 0, 0, 0)
406        ap.set_pixel(7, 1, 0, 0, 0)
407        ap.set_pixel(7, 2, 0, 0, 0)
408        ap.set_pixel(7, 3, 0, 0, 0)
409
410     if num == '6':
411    # number 6_top_right - TEMPERATURE
412        ap.set_pixel(4, 0, led_level, 0, 0)
413        ap.set_pixel(4, 1, led_level, 0, 0)
414        ap.set_pixel(4, 2, led_level, 0, 0)
415        ap.set_pixel(4, 3, led_level, 0, 0)
416        ap.set_pixel(5, 0, 0, 0, 0)
417        ap.set_pixel(5, 1, led_level, 0, 0)
418        ap.set_pixel(5, 2, 0, 0, 0)
```

```python
419        ap.set_pixel(5, 3, led_level, 0, 0)
420        ap.set_pixel(6, 0, 0, 0, 0)
421        ap.set_pixel(6, 1, led_level, 0, 0)
422        ap.set_pixel(6, 2, led_level, 0, 0)
423        ap.set_pixel(6, 3, led_level, 0, 0)
424        ap.set_pixel(7, 0, 0, 0, 0)
425        ap.set_pixel(7, 1, 0, 0, 0)
426        ap.set_pixel(7, 2, 0, 0, 0)
427        ap.set_pixel(7, 3, 0, 0, 0)
428
429    if num == '7':
430    # number 7_top_right - TEMPERATURE
431        ap.set_pixel(4, 0, led_level, 0, 0)
432        ap.set_pixel(4, 1, led_level, 0, 0)
433        ap.set_pixel(4, 2, 0, 0, 0)
434        ap.set_pixel(4, 3, 0, 0, 0)
435        ap.set_pixel(5, 0, led_level, 0, 0)
436        ap.set_pixel(5, 1, 0, 0, 0)
437        ap.set_pixel(5, 2, 0, 0, 0)
438        ap.set_pixel(5, 3, 0, 0, 0)
439        ap.set_pixel(6, 0, led_level, 0, 0)
440        ap.set_pixel(6, 1, led_level, 0, 0)
441        ap.set_pixel(6, 2, led_level, 0, 0)
442        ap.set_pixel(6, 3, led_level, 0, 0)
443        ap.set_pixel(7, 0, 0, 0, 0)
444        ap.set_pixel(7, 1, 0, 0, 0)
445        ap.set_pixel(7, 2, 0, 0, 0)
446        ap.set_pixel(7, 3, 0, 0, 0)
447
448    if num == '8':
449    # number 8_top_right - TEMPERATURE
450        ap.set_pixel(4, 0, led_level, 0, 0)
451        ap.set_pixel(4, 1, led_level, 0, 0)
452        ap.set_pixel(4, 2, led_level, 0, 0)
453        ap.set_pixel(4, 3, led_level, 0, 0)
454        ap.set_pixel(5, 0, led_level, 0, 0)
455        ap.set_pixel(5, 1, 0, 0, 0)
456        ap.set_pixel(5, 2, led_level, 0, 0)
457        ap.set_pixel(5, 3, led_level, 0, 0)
458        ap.set_pixel(6, 0, led_level, 0, 0)
459        ap.set_pixel(6, 1, led_level, 0, 0)
460        ap.set_pixel(6, 2, led_level, 0, 0)
461        ap.set_pixel(6, 3, led_level, 0, 0)
462        ap.set_pixel(7, 0, 0, 0, 0)
463        ap.set_pixel(7, 1, 0, 0, 0)
464        ap.set_pixel(7, 2, 0, 0, 0)
465        ap.set_pixel(7, 3, 0, 0, 0)
466
467    if num == '9':
468    # number 9_top_right - TEMPERATURE
469        ap.set_pixel(4, 0, led_level, 0, 0)
470        ap.set_pixel(4, 1, led_level, 0, 0)
471        ap.set_pixel(4, 2, led_level, 0, 0)
```

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472         ap.set_pixel(4, 3, 0, 0, 0)
473         ap.set_pixel(5, 0, led_level, 0, 0)
474         ap.set_pixel(5, 1, 0, 0, 0)
475         ap.set_pixel(5, 2, led_level, 0, 0)
476         ap.set_pixel(5, 3, 0, 0, 0)
477         ap.set_pixel(6, 0, led_level, 0, 0)
478         ap.set_pixel(6, 1, led_level, 0, 0)
479         ap.set_pixel(6, 2, led_level, 0, 0)
480         ap.set_pixel(6, 3, led_level, 0, 0)
481         ap.set_pixel(7, 0, 0, 0, 0)
482         ap.set_pixel(7, 1, 0, 0, 0)
483         ap.set_pixel(7, 2, 0, 0, 0)
484         ap.set_pixel(7, 3, 0, 0, 0)
485
486     def temp_num_error_high():
487     # error state warning for - HIGH TEMPERATURE
488         ap.set_pixel(0, 0, red, 0, 0)
489         ap.set_pixel(0, 1, red, 0, 0)
490         ap.set_pixel(0, 2, red, 0, 0)
491         ap.set_pixel(0, 3, red, 0, 0)
492         ap.set_pixel(1, 0, red, 0, 0)
493         ap.set_pixel(1, 1, red, 0, 0)
494         ap.set_pixel(1, 2, red, 0, 0)
495         ap.set_pixel(1, 3, red, 0, 0)
496         ap.set_pixel(2, 0, red, 0, 0)
497         ap.set_pixel(2, 1, red, 0, 0)
498         ap.set_pixel(2, 2, red, 0, 0)
499         ap.set_pixel(2, 3, red, 0, 0)
500         ap.set_pixel(3, 0, red, 0, 0)
501         ap.set_pixel(3, 1, red, 0, 0)
502         ap.set_pixel(3, 2, red, 0, 0)
503         ap.set_pixel(3, 3, red, 0, 0)
504         ap.set_pixel(4, 0, red, 0, 0)
505         ap.set_pixel(4, 1, red, 0, 0)
506         ap.set_pixel(4, 2, red, 0, 0)
507         ap.set_pixel(4, 3, red, 0, 0)
508         ap.set_pixel(5, 0, red, 0, 0)
509         ap.set_pixel(5, 1, red, 0, 0)
510         ap.set_pixel(5, 2, red, 0, 0)
511         ap.set_pixel(5, 3, red, 0, 0)
512         ap.set_pixel(6, 0, red, 0, 0)
513         ap.set_pixel(6, 1, red, 0, 0)
514         ap.set_pixel(6, 2, red, 0, 0)
515         ap.set_pixel(6, 3, red, 0, 0)
516         ap.set_pixel(7, 0, red, 0, 0)
517         ap.set_pixel(7, 1, red, 0, 0)
518         ap.set_pixel(7, 2, red, 0, 0)
519         ap.set_pixel(7, 3, red, 0, 0)
520
521     def temp_num_error_low():
522     # error state warning for - LOW TEMPERATURE
523         ap.set_pixel(0, 0, 0, 0, blue)
524         ap.set_pixel(0, 1, 0, 0, blue)
```

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525        ap.set_pixel(0, 2, 0, 0, blue)
526        ap.set_pixel(0, 3, 0, 0, blue)
527        ap.set_pixel(1, 0, 0, 0, blue)
528        ap.set_pixel(1, 1, 0, 0, blue)
529        ap.set_pixel(1, 2, 0, 0, blue)
530        ap.set_pixel(1, 3, 0, 0, blue)
531        ap.set_pixel(2, 0, 0, 0, blue)
532        ap.set_pixel(2, 1, 0, 0, blue)
533        ap.set_pixel(2, 2, 0, 0, blue)
534        ap.set_pixel(2, 3, 0, 0, blue)
535        ap.set_pixel(3, 0, 0, 0, blue)
536        ap.set_pixel(3, 1, 0, 0, blue)
537        ap.set_pixel(3, 2, 0, 0, blue)
538        ap.set_pixel(3, 3, 0, 0, blue)
539        ap.set_pixel(4, 0, 0, 0, blue)
540        ap.set_pixel(4, 1, 0, 0, blue)
541        ap.set_pixel(4, 2, 0, 0, blue)
542        ap.set_pixel(4, 3, 0, 0, blue)
543        ap.set_pixel(5, 0, 0, 0, blue)
544        ap.set_pixel(5, 1, 0, 0, blue)
545        ap.set_pixel(5, 2, 0, 0, blue)
546        ap.set_pixel(5, 3, 0, 0, blue)
547        ap.set_pixel(6, 0, 0, 0, blue)
548        ap.set_pixel(6, 1, 0, 0, blue)
549        ap.set_pixel(6, 2, 0, 0, blue)
550        ap.set_pixel(6, 3, 0, 0, blue)
551        ap.set_pixel(7, 0, 0, 0, blue)
552        ap.set_pixel(7, 1, 0, 0, blue)
553        ap.set_pixel(7, 2, 0, 0, blue)
554        ap.set_pixel(7, 3, 0, 0, blue)
555
556
557    ## HUMIDITY NUMBERS MATRIX BELOW ##
558
559    def hum_num_matrix_1(num):
560
561      if num == '0':
562    # number 0_bot_left - HUMIDITY
563        ap.set_pixel(0, 4, 0, led_level, 0)
564        ap.set_pixel(0, 5, 0, led_level, 0)
565        ap.set_pixel(0, 6, 0, led_level, 0)
566        ap.set_pixel(0, 7, 0, led_level, 0)
567        ap.set_pixel(1, 4, 0, led_level, 0)
568        ap.set_pixel(1, 5, 0, 0, 0)
569        ap.set_pixel(1, 6, 0, 0, 0)
570        ap.set_pixel(1, 7, 0, led_level, 0)
571        ap.set_pixel(2, 4, 0, led_level, 0)
572        ap.set_pixel(2, 5, 0, led_level, 0)
573        ap.set_pixel(2, 6, 0, led_level, 0)
574        ap.set_pixel(2, 7, 0, led_level, 0)
575        ap.set_pixel(3, 4, 0, 0, 0)
576        ap.set_pixel(3, 5, 0, 0, 0)
577        ap.set_pixel(3, 6, 0, 0, 0)
```

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578             ap.set_pixel(3, 7, 0, 0, 0)
579
580         if num == '1':
581             # number 1_bot_left - HUMIDITY
582             ap.set_pixel(0, 4, 0, 0, 0)
583             ap.set_pixel(0, 5, 0, led_level, 0)
584             ap.set_pixel(0, 6, 0, 0, 0)
585             ap.set_pixel(0, 7, 0, led_level, 0)
586             ap.set_pixel(1, 4, 0, led_level, 0)
587             ap.set_pixel(1, 5, 0, led_level, 0)
588             ap.set_pixel(1, 6, 0, led_level, 0)
589             ap.set_pixel(1, 7, 0, led_level, 0)
590             ap.set_pixel(2, 4, 0, 0, 0)
591             ap.set_pixel(2, 5, 0, 0, 0)
592             ap.set_pixel(2, 6, 0, 0, 0)
593             ap.set_pixel(2, 7, 0, led_level, 0)
594             ap.set_pixel(3, 4, 0, 0, 0)
595             ap.set_pixel(3, 5, 0, 0, 0)
596             ap.set_pixel(3, 6, 0, 0, 0)
597             ap.set_pixel(3, 7, 0, 0, 0)
598
599         if num == '2':
600         # number 2_bot_left - HUMIDITY
601             ap.set_pixel(0, 4, 0, led_level, 0)
602             ap.set_pixel(0, 5, 0, 0, 0)
603             ap.set_pixel(0, 6, 0, 0, 0)
604             ap.set_pixel(0, 7, 0, led_level, 0)
605             ap.set_pixel(1, 4, 0, led_level, 0)
606             ap.set_pixel(1, 5, 0, 0, 0)
607             ap.set_pixel(1, 6, 0, led_level, 0)
608             ap.set_pixel(1, 7, 0, led_level, 0)
609             ap.set_pixel(2, 4, 0, led_level, 0)
610             ap.set_pixel(2, 5, 0, led_level, 0)
611             ap.set_pixel(2, 6, 0, 0, 0)
612             ap.set_pixel(2, 7, 0, led_level, 0)
613             ap.set_pixel(3, 4, 0, 0, 0)
614             ap.set_pixel(3, 5, 0, 0, 0)
615             ap.set_pixel(3, 6, 0, 0, 0)
616             ap.set_pixel(3, 7, 0, 0, 0)
617
618         if num == '3':
619         # number 3_bot_left - HUMIDITY
620             ap.set_pixel(0, 4, 0, led_level, 0)
621             ap.set_pixel(0, 5, 0, 0, 0)
622             ap.set_pixel(0, 6, 0, 0, 0)
623             ap.set_pixel(0, 7, 0, led_level, 0)
624             ap.set_pixel(1, 4, 0, led_level, 0)
625             ap.set_pixel(1, 5, 0, led_level, 0)
626             ap.set_pixel(1, 6, 0, 0, 0)
627             ap.set_pixel(1, 7, 0, led_level, 0)
628             ap.set_pixel(2, 4, 0, led_level, 0)
629             ap.set_pixel(2, 5, 0, led_level, 0)
630             ap.set_pixel(2, 6, 0, led_level, 0)
```

```
631            ap.set_pixel(2, 7, 0, led_level, 0)
632            ap.set_pixel(3, 4, 0, 0, 0)
633            ap.set_pixel(3, 5, 0, 0, 0)
634            ap.set_pixel(3, 6, 0, 0, 0)
635            ap.set_pixel(3, 7, 0, 0, 0)
636
637        if num == '4':
638        # number 4_bot_left – HUMIDITY
639            ap.set_pixel(0, 4, 0, led_level, 0)
640            ap.set_pixel(0, 5, 0, led_level, 0)
641            ap.set_pixel(0, 6, 0, led_level, 0)
642            ap.set_pixel(0, 7, 0, 0, 0)
643            ap.set_pixel(1, 4, 0, 0, 0)
644            ap.set_pixel(1, 5, 0, 0, 0)
645            ap.set_pixel(1, 6, 0, led_level, 0)
646            ap.set_pixel(1, 7, 0, 0, 0)
647            ap.set_pixel(2, 4, 0, 0, 0)
648            ap.set_pixel(2, 5, 0, led_level, 0)
649            ap.set_pixel(2, 6, 0, led_level, 0)
650            ap.set_pixel(2, 7, 0, led_level, 0)
651            ap.set_pixel(3, 4, 0, 0, 0)
652            ap.set_pixel(3, 5, 0, 0, 0)
653            ap.set_pixel(3, 6, 0, 0, 0)
654            ap.set_pixel(3, 7, 0, 0, 0)
655
656        if num == '5':
657        # number 5_bot_left – HUMIDITY
658            ap.set_pixel(0, 4, 0, led_level, 0)
659            ap.set_pixel(0, 5, 0, led_level, 0)
660            ap.set_pixel(0, 6, 0, 0, 0)
661            ap.set_pixel(0, 7, 0, led_level, 0)
662            ap.set_pixel(1, 4, 0, led_level, 0)
663            ap.set_pixel(1, 5, 0, 0, 0)
664            ap.set_pixel(1, 6, 0, led_level, 0)
665            ap.set_pixel(1, 7, 0, led_level, 0)
666            ap.set_pixel(2, 4, 0, led_level, 0)
667            ap.set_pixel(2, 5, 0, 0, 0)
668            ap.set_pixel(2, 6, 0, 0, 0)
669            ap.set_pixel(2, 7, 0, led_level, 0)
670            ap.set_pixel(3, 4, 0, 0, 0)
671            ap.set_pixel(3, 5, 0, 0, 0)
672            ap.set_pixel(3, 6, 0, 0, 0)
673            ap.set_pixel(3, 7, 0, 0, 0)
674
675        if num == '6':
676        # number 6_bot_left – HUMIDITY
677            ap.set_pixel(0, 4, 0, led_level, 0)
678            ap.set_pixel(0, 5, 0, led_level, 0)
679            ap.set_pixel(0, 6, 0, led_level, 0)
680            ap.set_pixel(0, 7, 0, led_level, 0)
681            ap.set_pixel(1, 4, 0, 0, 0)
682            ap.set_pixel(1, 5, 0, led_level, 0)
683            ap.set_pixel(1, 6, 0, 0, 0)
```

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684        ap.set_pixel(1, 7, 0, led_level, 0)
685        ap.set_pixel(2, 4, 0, 0, 0)
686        ap.set_pixel(2, 5, 0, led_level, 0)
687        ap.set_pixel(2, 6, 0, led_level, 0)
688        ap.set_pixel(2, 7, 0, led_level, 0)
689        ap.set_pixel(3, 4, 0, 0, 0)
690        ap.set_pixel(3, 5, 0, 0, 0)
691        ap.set_pixel(3, 6, 0, 0, 0)
692        ap.set_pixel(3, 7, 0, 0, 0)
693
694     if num == '7':
695    # number 7_bot_left – HUMIDITY
696        ap.set_pixel(0, 4, 0, led_level, 0)
697        ap.set_pixel(0, 5, 0, led_level, 0)
698        ap.set_pixel(0, 6, 0, 0, 0)
699        ap.set_pixel(0, 7, 0, 0, 0)
700        ap.set_pixel(1, 4, 0, led_level, 0)
701        ap.set_pixel(1, 5, 0, 0, 0)
702        ap.set_pixel(1, 6, 0, 0, 0)
703        ap.set_pixel(1, 7, 0, 0, 0)
704        ap.set_pixel(2, 4, 0, led_level, 0)
705        ap.set_pixel(2, 5, 0, led_level, 0)
706        ap.set_pixel(2, 6, 0, led_level, 0)
707        ap.set_pixel(2, 7, 0, led_level, 0)
708        ap.set_pixel(3, 4, 0, 0, 0)
709        ap.set_pixel(3, 5, 0, 0, 0)
710        ap.set_pixel(3, 6, 0, 0, 0)
711        ap.set_pixel(3, 7, 0, 0, 0)
712
713     if num == '8':
714    # number 8_bot_left – HUMIDITY
715        ap.set_pixel(0, 4, 0, led_level, 0)
716        ap.set_pixel(0, 5, 0, led_level, 0)
717        ap.set_pixel(0, 6, 0, led_level, 0)
718        ap.set_pixel(0, 7, 0, led_level, 0)
719        ap.set_pixel(1, 4, 0, led_level, 0)
720        ap.set_pixel(1, 5, 0, 0, 0)
721        ap.set_pixel(1, 6, 0, led_level, 0)
722        ap.set_pixel(1, 7, 0, led_level, 0)
723        ap.set_pixel(2, 4, 0, led_level, 0)
724        ap.set_pixel(2, 5, 0, led_level, 0)
725        ap.set_pixel(2, 6, 0, led_level, 0)
726        ap.set_pixel(2, 7, 0, led_level, 0)
727        ap.set_pixel(3, 4, 0, 0, 0)
728        ap.set_pixel(3, 5, 0, 0, 0)
729        ap.set_pixel(3, 6, 0, 0, 0)
730        ap.set_pixel(3, 7, 0, 0, 0)
731
732     if num == '9':
733    # number 9_bot_left – HUMIDITY
734        ap.set_pixel(0, 4, 0, led_level, 0)
735        ap.set_pixel(0, 5, 0, led_level, 0)
736        ap.set_pixel(0, 6, 0, led_level, 0)
```

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737         ap.set_pixel(0, 7, 0, 0, 0)
738         ap.set_pixel(1, 4, 0, led_level, 0)
739         ap.set_pixel(1, 5, 0, 0, 0)
740         ap.set_pixel(1, 6, 0, led_level, 0)
741         ap.set_pixel(1, 7, 0, 0, 0)
742         ap.set_pixel(2, 4, 0, led_level, 0)
743         ap.set_pixel(2, 5, 0, led_level, 0)
744         ap.set_pixel(2, 6, 0, led_level, 0)
745         ap.set_pixel(2, 7, 0, led_level, 0)
746         ap.set_pixel(3, 4, 0, 0, 0)
747         ap.set_pixel(3, 5, 0, 0, 0)
748         ap.set_pixel(3, 6, 0, 0, 0)
749         ap.set_pixel(3, 7, 0, 0, 0)
750
751     def hum_num_matrix_2(num):
752
753         if num == '0':
754     # number 0_bottom_left - HUMIDITY
755         ap.set_pixel(4, 4, 0, led_level, 0)
756         ap.set_pixel(4, 5, 0, led_level, 0)
757         ap.set_pixel(4, 6, 0, led_level, 0)
758         ap.set_pixel(4, 7, 0, led_level, 0)
759         ap.set_pixel(5, 4, 0, led_level, 0)
760         ap.set_pixel(5, 5, 0, 0, 0)
761         ap.set_pixel(5, 6, 0, 0, 0)
762         ap.set_pixel(5, 7, 0, led_level, 0)
763         ap.set_pixel(6, 4, 0, led_level, 0)
764         ap.set_pixel(6, 5, 0, led_level, 0)
765         ap.set_pixel(6, 6, 0, led_level, 0)
766         ap.set_pixel(6, 7, 0, led_level, 0)
767         ap.set_pixel(7, 4, 0, 0, 0)
768         ap.set_pixel(7, 5, 0, 0, 0)
769         ap.set_pixel(7, 6, 0, 0, 0)
770         ap.set_pixel(7, 7, 0, 0, 0)
771
772         if num == '1':
773     # number 1_bottom_left - HUMIDITY
774         ap.set_pixel(4, 4, 0, 0, 0)
775         ap.set_pixel(4, 5, 0, led_level, 0)
776         ap.set_pixel(4, 6, 0, 0, 0)
777         ap.set_pixel(4, 7, 0, led_level, 0)
778         ap.set_pixel(5, 4, 0, led_level, 0)
779         ap.set_pixel(5, 5, 0, led_level, 0)
780         ap.set_pixel(5, 6, 0, led_level, 0)
781         ap.set_pixel(5, 7, 0, led_level, 0)
782         ap.set_pixel(6, 4, 0, 0, 0)
783         ap.set_pixel(6, 5, 0, 0, 0)
784         ap.set_pixel(6, 6, 0, 0, 0)
785         ap.set_pixel(6, 7, 0, led_level, 0)
786         ap.set_pixel(7, 4, 0, 0, 0)
787         ap.set_pixel(7, 5, 0, 0, 0)
788         ap.set_pixel(7, 6, 0, 0, 0)
789         ap.set_pixel(7, 7, 0, 0, 0)
```

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790
791        if num == '2':
792    # number 2_bot_left – HUMIDITY
793        ap.set_pixel(4, 4, 0, led_level, 0)
794        ap.set_pixel(4, 5, 0, 0, 0)
795        ap.set_pixel(4, 6, 0, 0, 0)
796        ap.set_pixel(4, 7, 0, led_level, 0)
797        ap.set_pixel(5, 4, 0, led_level, 0)
798        ap.set_pixel(5, 5, 0, 0, 0)
799        ap.set_pixel(5, 6, 0, led_level, 0)
800        ap.set_pixel(5, 7, 0, led_level, 0)
801        ap.set_pixel(6, 4, 0, led_level, 0)
802        ap.set_pixel(6, 5, 0, led_level, 0)
803        ap.set_pixel(6, 6, 0, 0, 0)
804        ap.set_pixel(6, 7, 0, led_level, 0)
805        ap.set_pixel(7, 4, 0, 0, 0)
806        ap.set_pixel(7, 5, 0, 0, 0)
807        ap.set_pixel(7, 6, 0, 0, 0)
808        ap.set_pixel(7, 7, 0, 0, 0)
809
810        if num == '3':
811    # number 3_bot_left – HUMIDITY
812        ap.set_pixel(4, 4, 0, led_level, 0)
813        ap.set_pixel(4, 5, 0, 0, 0)
814        ap.set_pixel(4, 6, 0, 0, 0)
815        ap.set_pixel(4, 7, 0, led_level, 0)
816        ap.set_pixel(5, 4, 0, led_level, 0)
817        ap.set_pixel(5, 5, 0, led_level, 0)
818        ap.set_pixel(5, 6, 0, 0, 0)
819        ap.set_pixel(5, 7, 0, led_level, 0)
820        ap.set_pixel(6, 4, 0, led_level, 0)
821        ap.set_pixel(6, 5, 0, led_level, 0)
822        ap.set_pixel(6, 6, 0, led_level, 0)
823        ap.set_pixel(6, 7, 0, led_level, 0)
824        ap.set_pixel(7, 4, 0, 0, 0)
825        ap.set_pixel(7, 5, 0, 0, 0)
826        ap.set_pixel(7, 6, 0, 0, 0)
827        ap.set_pixel(7, 7, 0, 0, 0)
828
829        if num == '4':
830    # number 4_bot_left – HUMIDITY
831        ap.set_pixel(4, 4, 0, led_level, 0)
832        ap.set_pixel(4, 5, 0, led_level, 0)
833        ap.set_pixel(4, 6, 0, led_level, 0)
834        ap.set_pixel(4, 7, 0, 0, 0)
835        ap.set_pixel(5, 4, 0, 0, 0)
836        ap.set_pixel(5, 5, 0, 0, 0)
837        ap.set_pixel(5, 6, 0, led_level, 0)
838        ap.set_pixel(5, 7, 0, 0, 0)
839        ap.set_pixel(6, 4, 0, 0, 0)
840        ap.set_pixel(6, 5, 0, led_level, 0)
841        ap.set_pixel(6, 6, 0, led_level, 0)
842        ap.set_pixel(6, 7, 0, led_level, 0)
```

```
843        ap.set_pixel(7, 4, 0, 0, 0)
844        ap.set_pixel(7, 5, 0, 0, 0)
845        ap.set_pixel(7, 6, 0, 0, 0)
846        ap.set_pixel(7, 7, 0, 0, 0)
847
848     if num == '5':
849    # number 5_bot_left – HUMIDITY
850        ap.set_pixel(4, 4, 0, led_level, 0)
851        ap.set_pixel(4, 5, 0, led_level, 0)
852        ap.set_pixel(4, 6, 0, 0, 0)
853        ap.set_pixel(4, 7, 0, led_level, 0)
854        ap.set_pixel(5, 4, 0, led_level, 0)
855        ap.set_pixel(5, 5, 0, 0, 0)
856        ap.set_pixel(5, 6, 0, led_level, 0)
857        ap.set_pixel(5, 7, 0, led_level, 0)
858        ap.set_pixel(6, 4, 0, led_level, 0)
859        ap.set_pixel(6, 5, 0, 0, 0)
860        ap.set_pixel(6, 6, 0, 0, 0)
861        ap.set_pixel(6, 7, 0, led_level, 0)
862        ap.set_pixel(7, 4, 0, 0, 0)
863        ap.set_pixel(7, 5, 0, 0, 0)
864        ap.set_pixel(7, 6, 0, 0, 0)
865        ap.set_pixel(7, 7, 0, 0, 0)
866
867     if num == '6':
868    # number 6_bot_left – HUMIDITY
869        ap.set_pixel(4, 4, 0, led_level, 0)
870        ap.set_pixel(4, 5, 0, led_level, 0)
871        ap.set_pixel(4, 6, 0, led_level, 0)
872        ap.set_pixel(4, 7, 0, led_level, 0)
873        ap.set_pixel(5, 4, 0, 0, 0)
874        ap.set_pixel(5, 5, 0, led_level, 0)
875        ap.set_pixel(5, 6, 0, 0, 0)
876        ap.set_pixel(5, 7, 0, led_level, 0)
877        ap.set_pixel(6, 4, 0, 0, 0)
878        ap.set_pixel(6, 5, 0, led_level, 0)
879        ap.set_pixel(6, 6, 0, led_level, 0)
880        ap.set_pixel(6, 7, 0, led_level, 0)
881        ap.set_pixel(7, 4, 0, 0, 0)
882        ap.set_pixel(7, 5, 0, 0, 0)
883        ap.set_pixel(7, 6, 0, 0, 0)
884        ap.set_pixel(7, 7, 0, 0, 0)
885
886     if num == '7':
887    # number 7_bot_left – HUMIDITY
888        ap.set_pixel(4, 4, 0, led_level, 0)
889        ap.set_pixel(4, 5, 0, led_level, 0)
890        ap.set_pixel(4, 6, 0, 0, 0)
891        ap.set_pixel(4, 7, 0, 0, 0)
892        ap.set_pixel(5, 4, 0, led_level, 0)
893        ap.set_pixel(5, 5, 0, 0, 0)
894        ap.set_pixel(5, 6, 0, 0, 0)
895        ap.set_pixel(5, 7, 0, 0, 0)
```

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896        ap.set_pixel(6, 4, 0, led_level, 0)
897        ap.set_pixel(6, 5, 0, led_level, 0)
898        ap.set_pixel(6, 6, 0, led_level, 0)
899        ap.set_pixel(6, 7, 0, led_level, 0)
900        ap.set_pixel(7, 4, 0, 0, 0)
901        ap.set_pixel(7, 5, 0, 0, 0)
902        ap.set_pixel(7, 6, 0, 0, 0)
903        ap.set_pixel(7, 7, 0, 0, 0)
904
905      if num == '8':
906    # number 8_bot_left - HUMIDITY
907        ap.set_pixel(4, 4, 0, led_level, 0)
908        ap.set_pixel(4, 5, 0, led_level, 0)
909        ap.set_pixel(4, 6, 0, led_level, 0)
910        ap.set_pixel(4, 7, 0, led_level, 0)
911        ap.set_pixel(5, 4, 0, led_level, 0)
912        ap.set_pixel(5, 5, 0, 0, 0)
913        ap.set_pixel(5, 6, 0, led_level, 0)
914        ap.set_pixel(5, 7, 0, led_level, 0)
915        ap.set_pixel(6, 4, 0, led_level, 0)
916        ap.set_pixel(6, 5, 0, led_level, 0)
917        ap.set_pixel(6, 6, 0, led_level, 0)
918        ap.set_pixel(6, 7, 0, led_level, 0)
919        ap.set_pixel(7, 4, 0, 0, 0)
920        ap.set_pixel(7, 5, 0, 0, 0)
921        ap.set_pixel(7, 6, 0, 0, 0)
922        ap.set_pixel(7, 7, 0, 0, 0)
923
924      if num == '9':
925    # number 9_bot_left - HUMIDITY
926        ap.set_pixel(4, 4, 0, led_level, 0)
927        ap.set_pixel(4, 5, 0, led_level, 0)
928        ap.set_pixel(4, 6, 0, led_level, 0)
929        ap.set_pixel(4, 7, 0, 0, 0)
930        ap.set_pixel(5, 4, 0, led_level, 0)
931        ap.set_pixel(5, 5, 0, 0, 0)
932        ap.set_pixel(5, 6, 0, led_level, 0)
933        ap.set_pixel(5, 7, 0, 0, 0)
934        ap.set_pixel(6, 4, 0, led_level, 0)
935        ap.set_pixel(6, 5, 0, led_level, 0)
936        ap.set_pixel(6, 6, 0, led_level, 0)
937        ap.set_pixel(6, 7, 0, led_level, 0)
938        ap.set_pixel(7, 4, 0, 0, 0)
939        ap.set_pixel(7, 5, 0, 0, 0)
940        ap.set_pixel(7, 6, 0, 0, 0)
941        ap.set_pixel(7, 7, 0, 0, 0)
942
943    def hum_num_error_high():
944    # error state warning for - HIGH HUMIDITY
945        ap.set_pixel(0, 4, red, 0, 0)
946        ap.set_pixel(0, 5, red, 0, 0)
947        ap.set_pixel(0, 6, red, 0, 0)
948        ap.set_pixel(0, 7, red, 0, 0)
```

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949         ap.set_pixel(1, 4, red, 0, 0)
950         ap.set_pixel(1, 5, red, 0, 0)
951         ap.set_pixel(1, 6, red, 0, 0)
952         ap.set_pixel(1, 7, red, 0, 0)
953         ap.set_pixel(2, 4, red, 0, 0)
954         ap.set_pixel(2, 5, red, 0, 0)
955         ap.set_pixel(2, 6, red, 0, 0)
956         ap.set_pixel(2, 7, red, 0, 0)
957         ap.set_pixel(3, 4, red, 0, 0)
958         ap.set_pixel(3, 5, red, 0, 0)
959         ap.set_pixel(3, 6, red, 0, 0)
960         ap.set_pixel(3, 7, red, 0, 0)
961         ap.set_pixel(4, 4, red, 0, 0)
962         ap.set_pixel(4, 5, red, 0, 0)
963         ap.set_pixel(4, 6, red, 0, 0)
964         ap.set_pixel(4, 7, red, 0, 0)
965         ap.set_pixel(5, 4, red, 0, 0)
966         ap.set_pixel(5, 5, red, 0, 0)
967         ap.set_pixel(5, 6, red, 0, 0)
968         ap.set_pixel(5, 7, red, 0, 0)
969         ap.set_pixel(6, 4, red, 0, 0)
970         ap.set_pixel(6, 5, red, 0, 0)
971         ap.set_pixel(6, 6, red, 0, 0)
972         ap.set_pixel(6, 7, red, 0, 0)
973         ap.set_pixel(7, 4, red, 0, 0)
974         ap.set_pixel(7, 5, red, 0, 0)
975         ap.set_pixel(7, 6, red, 0, 0)
976         ap.set_pixel(7, 7, red, 0, 0)
977
978     def hum_num_error_low():
979     # error state warning for - LOW HUMIDITY
980         ap.set_pixel(0, 4, 0, 0, blue)
981         ap.set_pixel(0, 5, 0, 0, blue)
982         ap.set_pixel(0, 6, 0, 0, blue)
983         ap.set_pixel(0, 7, 0, 0, blue)
984         ap.set_pixel(1, 4, 0, 0, blue)
985         ap.set_pixel(1, 5, 0, 0, blue)
986         ap.set_pixel(1, 6, 0, 0, blue)
987         ap.set_pixel(1, 7, 0, 0, blue)
988         ap.set_pixel(2, 4, 0, 0, blue)
989         ap.set_pixel(2, 5, 0, 0, blue)
990         ap.set_pixel(2, 6, 0, 0, blue)
991         ap.set_pixel(2, 7, 0, 0, blue)
992         ap.set_pixel(3, 4, 0, 0, blue)
993         ap.set_pixel(3, 5, 0, 0, blue)
994         ap.set_pixel(3, 6, 0, 0, blue)
995         ap.set_pixel(3, 7, 0, 0, blue)
996         ap.set_pixel(4, 4, 0, 0, blue)
997         ap.set_pixel(4, 5, 0, 0, blue)
998         ap.set_pixel(4, 6, 0, 0, blue)
999         ap.set_pixel(4, 7, 0, 0, blue)
1000        ap.set_pixel(5, 4, 0, 0, blue)
1001        ap.set_pixel(5, 5, 0, 0, blue)
```

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1002        ap.set_pixel(5, 6, 0, 0, blue)
1003        ap.set_pixel(5, 7, 0, 0, blue)
1004        ap.set_pixel(6, 4, 0, 0, blue)
1005        ap.set_pixel(6, 5, 0, 0, blue)
1006        ap.set_pixel(6, 6, 0, 0, blue)
1007        ap.set_pixel(6, 7, 0, 0, blue)
1008        ap.set_pixel(7, 4, 0, 0, blue)
1009        ap.set_pixel(7, 5, 0, 0, blue)
1010        ap.set_pixel(7, 6, 0, 0, blue)
1011        ap.set_pixel(7, 7, 0, 0, blue)
1012
1013
1014    ## PRESSURE NUMBERS MATRIX BELOW #
1015
1016    def psi_num_matrix_1(num):
1017
1018      if num == '0':
1019    # number 0_top_left – PRESSURE
1020        ap.set_pixel(0, 0, 0, 0, led_level)
1021        ap.set_pixel(0, 1, 0, 0, led_level)
1022        ap.set_pixel(0, 2, 0, 0, led_level)
1023        ap.set_pixel(0, 3, 0, 0, led_level)
1024        ap.set_pixel(1, 0, 0, 0, led_level)
1025        ap.set_pixel(1, 1, 0, 0, 0)
1026        ap.set_pixel(1, 2, 0, 0, 0)
1027        ap.set_pixel(1, 3, 0, 0, led_level)
1028        ap.set_pixel(2, 0, 0, 0, led_level)
1029        ap.set_pixel(2, 1, 0, 0, led_level)
1030        ap.set_pixel(2, 2, 0, 0, led_level)
1031        ap.set_pixel(2, 3, 0, 0, led_level)
1032        ap.set_pixel(3, 0, 0, 0, 0)
1033        ap.set_pixel(3, 1, 0, 0, 0)
1034        ap.set_pixel(3, 2, 0, 0, 0)
1035        ap.set_pixel(3, 3, 0, 0, 0)
1036
1037      if num == '1':
1038    # number 1_top_left – PRESSURE
1039        ap.set_pixel(0, 0, 0, 0, 0)
1040        ap.set_pixel(0, 1, 0, 0, led_level)
1041        ap.set_pixel(0, 2, 0, 0, 0)
1042        ap.set_pixel(0, 3, 0, 0, led_level)
1043        ap.set_pixel(1, 0, 0, 0, led_level)
1044        ap.set_pixel(1, 1, 0, 0, led_level)
1045        ap.set_pixel(1, 2, 0, 0, led_level)
1046        ap.set_pixel(1, 3, 0, 0, led_level)
1047        ap.set_pixel(2, 0, 0, 0, 0)
1048        ap.set_pixel(2, 1, 0, 0, 0)
1049        ap.set_pixel(2, 2, 0, 0, 0)
1050        ap.set_pixel(2, 3, 0, 0, led_level)
1051        ap.set_pixel(3, 0, 0, 0, 0)
1052        ap.set_pixel(3, 1, 0, 0, 0)
1053        ap.set_pixel(3, 2, 0, 0, 0)
1054        ap.set_pixel(3, 3, 0, 0, 0)
```

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1055
1056     if num == '2':
1057    # number 2_top_left – PRESSURE
1058        ap.set_pixel(0, 0, 0, 0, led_level)
1059        ap.set_pixel(0, 1, 0, 0, 0)
1060        ap.set_pixel(0, 2, 0, 0, 0)
1061        ap.set_pixel(0, 3, 0, 0, led_level)
1062        ap.set_pixel(1, 0, 0, 0, led_level)
1063        ap.set_pixel(1, 1, 0, 0, 0)
1064        ap.set_pixel(1, 2, 0, 0, led_level)
1065        ap.set_pixel(1, 3, 0, 0, led_level)
1066        ap.set_pixel(2, 0, 0, 0, led_level)
1067        ap.set_pixel(2, 1, 0, 0, led_level)
1068        ap.set_pixel(2, 2, 0, 0, 0)
1069        ap.set_pixel(2, 3, 0, 0, led_level)
1070        ap.set_pixel(3, 0, 0, 0, 0)
1071        ap.set_pixel(3, 1, 0, 0, 0)
1072        ap.set_pixel(3, 2, 0, 0, 0)
1073        ap.set_pixel(3, 3, 0, 0, 0)
1074
1075     if num == '3':
1076    # number 3_top_left – PRESSURE
1077        ap.set_pixel(0, 0, 0, 0, led_level)
1078        ap.set_pixel(0, 1, 0, 0, 0)
1079        ap.set_pixel(0, 2, 0, 0, 0)
1080        ap.set_pixel(0, 3, 0, 0, led_level)
1081        ap.set_pixel(1, 0, 0, 0, led_level)
1082        ap.set_pixel(1, 1, 0, 0, led_level)
1083        ap.set_pixel(1, 2, 0, 0, 0)
1084        ap.set_pixel(1, 3, 0, 0, led_level)
1085        ap.set_pixel(2, 0, 0, 0, led_level)
1086        ap.set_pixel(2, 1, 0, 0, led_level)
1087        ap.set_pixel(2, 2, 0, 0, led_level)
1088        ap.set_pixel(2, 3, 0, 0, led_level)
1089        ap.set_pixel(3, 0, 0, 0, 0)
1090        ap.set_pixel(3, 1, 0, 0, 0)
1091        ap.set_pixel(3, 2, 0, 0, 0)
1092        ap.set_pixel(3, 3, 0, 0, 0)
1093
1094     if num == '4':
1095    # number 4_top_left – PRESSURE
1096        ap.set_pixel(0, 0, 0, 0, led_level)
1097        ap.set_pixel(0, 1, 0, 0, led_level)
1098        ap.set_pixel(0, 2, 0, 0, led_level)
1099        ap.set_pixel(0, 3, 0, 0, 0)
1100        ap.set_pixel(1, 0, 0, 0, 0)
1101        ap.set_pixel(1, 1, 0, 0, 0)
1102        ap.set_pixel(1, 2, 0, 0, led_level)
1103        ap.set_pixel(1, 3, 0, 0, 0)
1104        ap.set_pixel(2, 0, 0, 0, 0)
1105        ap.set_pixel(2, 1, 0, 0, led_level)
1106        ap.set_pixel(2, 2, 0, 0, led_level)
1107        ap.set_pixel(2, 3, 0, 0, led_level)
```

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1108            ap.set_pixel(3, 0, 0, 0, 0)
1109            ap.set_pixel(3, 1, 0, 0, 0)
1110            ap.set_pixel(3, 2, 0, 0, 0)
1111            ap.set_pixel(3, 3, 0, 0, 0)
1112
1113        if num == '5':
1114        # number 5_top_left - PRESSURE
1115            ap.set_pixel(0, 0, 0, 0, led_level)
1116            ap.set_pixel(0, 1, 0, 0, led_level)
1117            ap.set_pixel(0, 2, 0, 0, 0)
1118            ap.set_pixel(0, 3, 0, 0, led_level)
1119            ap.set_pixel(1, 0, 0, 0, led_level)
1120            ap.set_pixel(1, 1, 0, 0, 0)
1121            ap.set_pixel(1, 2, 0, 0, led_level)
1122            ap.set_pixel(1, 3, 0, 0, led_level)
1123            ap.set_pixel(2, 0, 0, 0, led_level)
1124            ap.set_pixel(2, 1, 0, 0, 0)
1125            ap.set_pixel(2, 2, 0, 0, 0)
1126            ap.set_pixel(2, 3, 0, 0, led_level)
1127            ap.set_pixel(3, 0, 0, 0, 0)
1128            ap.set_pixel(3, 1, 0, 0, 0)
1129            ap.set_pixel(3, 2, 0, 0, 0)
1130            ap.set_pixel(3, 3, 0, 0, 0)
1131
1132        if num == '6':
1133        # number 6_top_left - PRESSURE
1134            ap.set_pixel(0, 0, 0, 0, led_level)
1135            ap.set_pixel(0, 1, 0, 0, led_level)
1136            ap.set_pixel(0, 2, 0, 0, led_level)
1137            ap.set_pixel(0, 3, 0, 0, led_level)
1138            ap.set_pixel(1, 0, 0, 0, 0)
1139            ap.set_pixel(1, 1, 0, 0, led_level)
1140            ap.set_pixel(1, 2, 0, 0, 0)
1141            ap.set_pixel(1, 3, 0, 0, led_level)
1142            ap.set_pixel(2, 0, 0, 0, 0)
1143            ap.set_pixel(2, 1, 0, 0, led_level)
1144            ap.set_pixel(2, 2, 0, 0, led_level)
1145            ap.set_pixel(2, 3, 0, 0, led_level)
1146            ap.set_pixel(3, 0, 0, 0, 0)
1147            ap.set_pixel(3, 1, 0, 0, 0)
1148            ap.set_pixel(3, 2, 0, 0, 0)
1149            ap.set_pixel(3, 3, 0, 0, 0)
1150
1151        if num == '7':
1152        # number 7_top_left - PRESSURE
1153            ap.set_pixel(0, 0, 0, 0, led_level)
1154            ap.set_pixel(0, 1, 0, 0, led_level)
1155            ap.set_pixel(0, 2, 0, 0, 0)
1156            ap.set_pixel(0, 3, 0, 0, 0)
1157            ap.set_pixel(1, 0, 0, 0, led_level)
1158            ap.set_pixel(1, 1, 0, 0, 0)
1159            ap.set_pixel(1, 2, 0, 0, 0)
1160            ap.set_pixel(1, 3, 0, 0, 0)
```

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1161        ap.set_pixel(2, 0, 0, 0, led_level)
1162        ap.set_pixel(2, 1, 0, 0, led_level)
1163        ap.set_pixel(2, 2, 0, 0, led_level)
1164        ap.set_pixel(2, 3, 0, 0, led_level)
1165        ap.set_pixel(3, 0, 0, 0, 0)
1166        ap.set_pixel(3, 1, 0, 0, 0)
1167        ap.set_pixel(3, 2, 0, 0, 0)
1168        ap.set_pixel(3, 3, 0, 0, 0)
1169
1170     if num == '8':
1171    # number 8_top_left - PRESSURE
1172        ap.set_pixel(0, 0, 0, 0, led_level)
1173        ap.set_pixel(0, 1, 0, 0, led_level)
1174        ap.set_pixel(0, 2, 0, 0, led_level)
1175        ap.set_pixel(0, 3, 0, 0, led_level)
1176        ap.set_pixel(1, 0, 0, 0, led_level)
1177        ap.set_pixel(1, 1, 0, 0, 0)
1178        ap.set_pixel(1, 2, 0, 0, led_level)
1179        ap.set_pixel(1, 3, 0, 0, led_level)
1180        ap.set_pixel(2, 0, 0, 0, led_level)
1181        ap.set_pixel(2, 1, 0, 0, led_level)
1182        ap.set_pixel(2, 2, 0, 0, led_level)
1183        ap.set_pixel(2, 3, 0, 0, led_level)
1184        ap.set_pixel(3, 0, 0, 0, 0)
1185        ap.set_pixel(3, 1, 0, 0, 0)
1186        ap.set_pixel(3, 2, 0, 0, 0)
1187        ap.set_pixel(3, 3, 0, 0, 0)
1188
1189     if num == '9':
1190    # number 9_top_left - PRESSURE
1191        ap.set_pixel(0, 0, 0, 0, led_level)
1192        ap.set_pixel(0, 1, 0, 0, led_level)
1193        ap.set_pixel(0, 2, 0, 0, led_level)
1194        ap.set_pixel(0, 3, 0, 0, 0)
1195        ap.set_pixel(1, 0, 0, 0, led_level)
1196        ap.set_pixel(1, 1, 0, 0, 0)
1197        ap.set_pixel(1, 2, 0, 0, led_level)
1198        ap.set_pixel(1, 3, 0, 0, 0)
1199        ap.set_pixel(2, 0, 0, 0, led_level)
1200        ap.set_pixel(2, 1, 0, 0, led_level)
1201        ap.set_pixel(2, 2, 0, 0, led_level)
1202        ap.set_pixel(2, 3, 0, 0, led_level)
1203        ap.set_pixel(3, 0, 0, 0, 0)
1204        ap.set_pixel(3, 1, 0, 0, 0)
1205        ap.set_pixel(3, 2, 0, 0, 0)
1206        ap.set_pixel(3, 3, 0, 0, 0)
1207
1208     def psi_num_matrix_2(num):
1209
1210     if num == '0':
1211    # number 0_top_right - PRESSURE
1212        ap.set_pixel(4, 0, 0, 0, led_level)
1213        ap.set_pixel(4, 1, 0, 0, led_level)
```

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1214        ap.set_pixel(4, 2, 0, 0, led_level)
1215        ap.set_pixel(4, 3, 0, 0, led_level)
1216        ap.set_pixel(5, 0, 0, 0, led_level)
1217        ap.set_pixel(5, 1, 0, 0, 0)
1218        ap.set_pixel(5, 2, 0, 0, 0)
1219        ap.set_pixel(5, 3, 0, 0, led_level)
1220        ap.set_pixel(6, 0, 0, 0, led_level)
1221        ap.set_pixel(6, 1, 0, 0, led_level)
1222        ap.set_pixel(6, 2, 0, 0, led_level)
1223        ap.set_pixel(6, 3, 0, 0, led_level)
1224        ap.set_pixel(7, 0, 0, 0, 0)
1225        ap.set_pixel(7, 1, 0, 0, 0)
1226        ap.set_pixel(7, 2, 0, 0, 0)
1227        ap.set_pixel(7, 3, 0, 0, 0)
1228
1229    if num == '1':
1230        # number 1_top_right - PRESSURE
1231        ap.set_pixel(4, 0, 0, 0, 0)
1232        ap.set_pixel(4, 1, 0, 0, led_level)
1233        ap.set_pixel(4, 2, 0, 0, 0)
1234        ap.set_pixel(4, 3, 0, 0, led_level)
1235        ap.set_pixel(5, 0, 0, 0, led_level)
1236        ap.set_pixel(5, 1, 0, 0, led_level)
1237        ap.set_pixel(5, 2, 0, 0, led_level)
1238        ap.set_pixel(5, 3, 0, 0, led_level)
1239        ap.set_pixel(6, 0, 0, 0, 0)
1240        ap.set_pixel(6, 1, 0, 0, 0)
1241        ap.set_pixel(6, 2, 0, 0, 0)
1242        ap.set_pixel(6, 3, 0, 0, led_level)
1243        ap.set_pixel(7, 0, 0, 0, 0)
1244        ap.set_pixel(7, 1, 0, 0, 0)
1245        ap.set_pixel(7, 2, 0, 0, 0)
1246        ap.set_pixel(7, 3, 0, 0, 0)
1247
1248    if num == '2':
1249    # number 2_top_right - PRESSURE
1250        ap.set_pixel(4, 0, 0, 0, led_level)
1251        ap.set_pixel(4, 1, 0, 0, 0)
1252        ap.set_pixel(4, 2, 0, 0, 0)
1253        ap.set_pixel(4, 3, 0, 0, led_level)
1254        ap.set_pixel(5, 0, 0, 0, led_level)
1255        ap.set_pixel(5, 1, 0, 0, 0)
1256        ap.set_pixel(5, 2, 0, 0, led_level)
1257        ap.set_pixel(5, 3, 0, 0, led_level)
1258        ap.set_pixel(6, 0, 0, 0, led_level)
1259        ap.set_pixel(6, 1, 0, 0, led_level)
1260        ap.set_pixel(6, 2, 0, 0, 0)
1261        ap.set_pixel(6, 3, 0, 0, led_level)
1262        ap.set_pixel(7, 0, 0, 0, 0)
1263        ap.set_pixel(7, 1, 0, 0, 0)
1264        ap.set_pixel(7, 2, 0, 0, 0)
1265        ap.set_pixel(7, 3, 0, 0, 0)
1266
```

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1267        if num == '3':
1268     # number 3_top_right - PRESSURE
1269        ap.set_pixel(4, 0, 0, 0, led_level)
1270        ap.set_pixel(4, 1, 0, 0, 0)
1271        ap.set_pixel(4, 2, 0, 0, 0)
1272        ap.set_pixel(4, 3, 0, 0, led_level)
1273        ap.set_pixel(5, 0, 0, 0, led_level)
1274        ap.set_pixel(5, 1, 0, 0, led_level)
1275        ap.set_pixel(5, 2, 0, 0, 0)
1276        ap.set_pixel(5, 3, 0, 0, led_level)
1277        ap.set_pixel(6, 0, 0, 0, led_level)
1278        ap.set_pixel(6, 1, 0, 0, led_level)
1279        ap.set_pixel(6, 2, 0, 0, led_level)
1280        ap.set_pixel(6, 3, 0, 0, led_level)
1281        ap.set_pixel(7, 0, 0, 0, 0)
1282        ap.set_pixel(7, 1, 0, 0, 0)
1283        ap.set_pixel(7, 2, 0, 0, 0)
1284        ap.set_pixel(7, 3, 0, 0, 0)
1285
1286        if num == '4':
1287     # number 4_top_right - PRESSURE
1288        ap.set_pixel(4, 0, 0, 0, led_level)
1289        ap.set_pixel(4, 1, 0, 0, led_level)
1290        ap.set_pixel(4, 2, 0, 0, led_level)
1291        ap.set_pixel(4, 3, 0, 0, 0)
1292        ap.set_pixel(5, 0, 0, 0, 0)
1293        ap.set_pixel(5, 1, 0, 0, 0)
1294        ap.set_pixel(5, 2, 0, 0, led_level)
1295        ap.set_pixel(5, 3, 0, 0, 0)
1296        ap.set_pixel(6, 0, 0, 0, 0)
1297        ap.set_pixel(6, 1, 0, 0, led_level)
1298        ap.set_pixel(6, 2, 0, 0, led_level)
1299        ap.set_pixel(6, 3, 0, 0, led_level)
1300        ap.set_pixel(7, 0, 0, 0, 0)
1301        ap.set_pixel(7, 1, 0, 0, 0)
1302        ap.set_pixel(7, 2, 0, 0, 0)
1303        ap.set_pixel(7, 3, 0, 0, 0)
1304
1305        if num == '5':
1306     # number 5_top_right - PRESSURE
1307        ap.set_pixel(4, 0, 0, 0, led_level)
1308        ap.set_pixel(4, 1, 0, 0, led_level)
1309        ap.set_pixel(4, 2, 0, 0, 0)
1310        ap.set_pixel(4, 3, 0, 0, led_level)
1311        ap.set_pixel(5, 0, 0, 0, led_level)
1312        ap.set_pixel(5, 1, 0, 0, 0)
1313        ap.set_pixel(5, 2, 0, 0, led_level)
1314        ap.set_pixel(5, 3, 0, 0, led_level)
1315        ap.set_pixel(6, 0, 0, 0, led_level)
1316        ap.set_pixel(6, 1, 0, 0, 0)
1317        ap.set_pixel(6, 2, 0, 0, 0)
1318        ap.set_pixel(6, 3, 0, 0, led_level)
1319        ap.set_pixel(7, 0, 0, 0, 0)
```

```
1320          ap.set_pixel(7, 1, 0, 0, 0)
1321          ap.set_pixel(7, 2, 0, 0, 0)
1322          ap.set_pixel(7, 3, 0, 0, 0)
1323
1324      if num == '6':
1325    # number 6_top_right - PRESSURE
1326          ap.set_pixel(4, 0, 0, 0, led_level)
1327          ap.set_pixel(4, 1, 0, 0, led_level)
1328          ap.set_pixel(4, 2, 0, 0, led_level)
1329          ap.set_pixel(4, 3, 0, 0, led_level)
1330          ap.set_pixel(5, 0, 0, 0, 0)
1331          ap.set_pixel(5, 1, 0, 0, led_level)
1332          ap.set_pixel(5, 2, 0, 0, 0)
1333          ap.set_pixel(5, 3, 0, 0, led_level)
1334          ap.set_pixel(6, 0, 0, 0, 0)
1335          ap.set_pixel(6, 1, 0, 0, led_level)
1336          ap.set_pixel(6, 2, 0, 0, led_level)
1337          ap.set_pixel(6, 3, 0, 0, led_level)
1338          ap.set_pixel(7, 0, 0, 0, 0)
1339          ap.set_pixel(7, 1, 0, 0, 0)
1340          ap.set_pixel(7, 2, 0, 0, 0)
1341          ap.set_pixel(7, 3, 0, 0, 0)
1342
1343      if num == '7':
1344    # number 7_top_right - PRESSURE
1345          ap.set_pixel(4, 0, 0, 0, led_level)
1346          ap.set_pixel(4, 1, 0, 0, led_level)
1347          ap.set_pixel(4, 2, 0, 0, 0)
1348          ap.set_pixel(4, 3, 0, 0, 0)
1349          ap.set_pixel(5, 0, 0, 0, led_level)
1350          ap.set_pixel(5, 1, 0, 0, 0)
1351          ap.set_pixel(5, 2, 0, 0, 0)
1352          ap.set_pixel(5, 3, 0, 0, 0)
1353          ap.set_pixel(6, 0, 0, 0, led_level)
1354          ap.set_pixel(6, 1, 0, 0, led_level)
1355          ap.set_pixel(6, 2, 0, 0, led_level)
1356          ap.set_pixel(6, 3, 0, 0, led_level)
1357          ap.set_pixel(7, 0, 0, 0, 0)
1358          ap.set_pixel(7, 1, 0, 0, 0)
1359          ap.set_pixel(7, 2, 0, 0, 0)
1360          ap.set_pixel(7, 3, 0, 0, 0)
1361
1362      if num == '8':
1363    # number 8_top_right - PRESSURE
1364          ap.set_pixel(4, 0, 0, 0, led_level)
1365          ap.set_pixel(4, 1, 0, 0, led_level)
1366          ap.set_pixel(4, 2, 0, 0, led_level)
1367          ap.set_pixel(4, 3, 0, 0, led_level)
1368          ap.set_pixel(5, 0, 0, 0, led_level)
1369          ap.set_pixel(5, 1, 0, 0, 0)
1370          ap.set_pixel(5, 2, 0, 0, led_level)
1371          ap.set_pixel(5, 3, 0, 0, led_level)
1372          ap.set_pixel(6, 0, 0, 0, led_level)
```

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1373        ap.set_pixel(6, 1, 0, 0, led_level)
1374        ap.set_pixel(6, 2, 0, 0, led_level)
1375        ap.set_pixel(6, 3, 0, 0, led_level)
1376        ap.set_pixel(7, 0, 0, 0, 0)
1377        ap.set_pixel(7, 1, 0, 0, 0)
1378        ap.set_pixel(7, 2, 0, 0, 0)
1379        ap.set_pixel(7, 3, 0, 0, 0)
1380
1381     if num == '9':
1382   # number 9_top_right - PRESSURE
1383        ap.set_pixel(4, 0, 0, 0, led_level)
1384        ap.set_pixel(4, 1, 0, 0, led_level)
1385        ap.set_pixel(4, 2, 0, 0, led_level)
1386        ap.set_pixel(4, 3, 0, 0, 0)
1387        ap.set_pixel(5, 0, 0, 0, led_level)
1388        ap.set_pixel(5, 1, 0, 0, 0)
1389        ap.set_pixel(5, 2, 0, 0, led_level)
1390        ap.set_pixel(5, 3, 0, 0, 0)
1391        ap.set_pixel(6, 0, 0, 0, led_level)
1392        ap.set_pixel(6, 1, 0, 0, led_level)
1393        ap.set_pixel(6, 2, 0, 0, led_level)
1394        ap.set_pixel(6, 3, 0, 0, led_level)
1395        ap.set_pixel(7, 0, 0, 0, 0)
1396        ap.set_pixel(7, 1, 0, 0, 0)
1397        ap.set_pixel(7, 2, 0, 0, 0)
1398        ap.set_pixel(7, 3, 0, 0, 0)
1399
1400     def psi_num_matrix_3(num):
1401
1402     if num == '0':
1403   # number 0_bot_left - PRESSURE
1404        ap.set_pixel(0, 4, 0, 0, led_level)
1405        ap.set_pixel(0, 5, 0, 0, led_level)
1406        ap.set_pixel(0, 6, 0, 0, led_level)
1407        ap.set_pixel(0, 7, 0, 0, led_level)
1408        ap.set_pixel(1, 4, 0, 0, led_level)
1409        ap.set_pixel(1, 5, 0, 0, 0)
1410        ap.set_pixel(1, 6, 0, 0, 0)
1411        ap.set_pixel(1, 7, 0, 0, led_level)
1412        ap.set_pixel(2, 4, 0, 0, led_level)
1413        ap.set_pixel(2, 5, 0, 0, led_level)
1414        ap.set_pixel(2, 6, 0, 0, led_level)
1415        ap.set_pixel(2, 7, 0, 0, led_level)
1416        ap.set_pixel(3, 4, 0, 0, 0)
1417        ap.set_pixel(3, 5, 0, 0, 0)
1418        ap.set_pixel(3, 6, 0, 0, 0)
1419        ap.set_pixel(3, 7, 0, 0, 0)
1420
1421     if num == '1':
1422        # number 1_bot_left - PRESSURE
1423        ap.set_pixel(0, 4, 0, 0, 0)
1424        ap.set_pixel(0, 5, 0, 0, led_level)
1425        ap.set_pixel(0, 6, 0, 0, 0)
```

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1426         ap.set_pixel(0, 7, 0, 0, led_level)
1427         ap.set_pixel(1, 4, 0, 0, led_level)
1428         ap.set_pixel(1, 5, 0, 0, led_level)
1429         ap.set_pixel(1, 6, 0, 0, led_level)
1430         ap.set_pixel(1, 7, 0, 0, led_level)
1431         ap.set_pixel(2, 4, 0, 0, 0)
1432         ap.set_pixel(2, 5, 0, 0, 0)
1433         ap.set_pixel(2, 6, 0, 0, 0)
1434         ap.set_pixel(2, 7, 0, 0, led_level)
1435         ap.set_pixel(3, 4, 0, 0, 0)
1436         ap.set_pixel(3, 5, 0, 0, 0)
1437         ap.set_pixel(3, 6, 0, 0, 0)
1438         ap.set_pixel(3, 7, 0, 0, 0)
1439
1440      if num == '2':
1441    # number 2_bot_left - PRESSURE
1442         ap.set_pixel(0, 4, 0, 0, led_level)
1443         ap.set_pixel(0, 5, 0, 0, 0)
1444         ap.set_pixel(0, 6, 0, 0, 0)
1445         ap.set_pixel(0, 7, 0, 0, led_level)
1446         ap.set_pixel(1, 4, 0, 0, led_level)
1447         ap.set_pixel(1, 5, 0, 0, 0)
1448         ap.set_pixel(1, 6, 0, 0, led_level)
1449         ap.set_pixel(1, 7, 0, 0, led_level)
1450         ap.set_pixel(2, 4, 0, 0, led_level)
1451         ap.set_pixel(2, 5, 0, 0, led_level)
1452         ap.set_pixel(2, 6, 0, 0, 0)
1453         ap.set_pixel(2, 7, 0, 0, led_level)
1454         ap.set_pixel(3, 4, 0, 0, 0)
1455         ap.set_pixel(3, 5, 0, 0, 0)
1456         ap.set_pixel(3, 6, 0, 0, 0)
1457         ap.set_pixel(3, 7, 0, 0, 0)
1458
1459      if num == '3':
1460    # number 3_bot_left - PRESSURE
1461         ap.set_pixel(0, 4, 0, 0, led_level)
1462         ap.set_pixel(0, 5, 0, 0, 0)
1463         ap.set_pixel(0, 6, 0, 0, 0)
1464         ap.set_pixel(0, 7, 0, 0, led_level)
1465         ap.set_pixel(1, 4, 0, 0, led_level)
1466         ap.set_pixel(1, 5, 0, 0, led_level)
1467         ap.set_pixel(1, 6, 0, 0, 0)
1468         ap.set_pixel(1, 7, 0, 0, led_level)
1469         ap.set_pixel(2, 4, 0, 0, led_level)
1470         ap.set_pixel(2, 5, 0, 0, led_level)
1471         ap.set_pixel(2, 6, 0, 0, led_level)
1472         ap.set_pixel(2, 7, 0, 0, led_level)
1473         ap.set_pixel(3, 4, 0, 0, 0)
1474         ap.set_pixel(3, 5, 0, 0, 0)
1475         ap.set_pixel(3, 6, 0, 0, 0)
1476         ap.set_pixel(3, 7, 0, 0, 0)
1477
1478      if num == '4':
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1479        # number 4_bot_left – PRESSURE
1480            ap.set_pixel(0, 4, 0, 0, led_level)
1481            ap.set_pixel(0, 5, 0, 0, led_level)
1482            ap.set_pixel(0, 6, 0, 0, led_level)
1483            ap.set_pixel(0, 7, 0, 0, 0)
1484            ap.set_pixel(1, 4, 0, 0, 0)
1485            ap.set_pixel(1, 5, 0, 0, 0)
1486            ap.set_pixel(1, 6, 0, 0, led_level)
1487            ap.set_pixel(1, 7, 0, 0, 0)
1488            ap.set_pixel(2, 4, 0, 0, 0)
1489            ap.set_pixel(2, 5, 0, 0, led_level)
1490            ap.set_pixel(2, 6, 0, 0, led_level)
1491            ap.set_pixel(2, 7, 0, 0, led_level)
1492            ap.set_pixel(3, 4, 0, 0, 0)
1493            ap.set_pixel(3, 5, 0, 0, 0)
1494            ap.set_pixel(3, 6, 0, 0, 0)
1495            ap.set_pixel(3, 7, 0, 0, 0)
1496
1497        if num == '5':
1498        # number 5_bot_left – PRESSURE
1499            ap.set_pixel(0, 4, 0, 0, led_level)
1500            ap.set_pixel(0, 5, 0, 0, led_level)
1501            ap.set_pixel(0, 6, 0, 0, 0)
1502            ap.set_pixel(0, 7, 0, 0, led_level)
1503            ap.set_pixel(1, 4, 0, 0, led_level)
1504            ap.set_pixel(1, 5, 0, 0, 0)
1505            ap.set_pixel(1, 6, 0, 0, led_level)
1506            ap.set_pixel(1, 7, 0, 0, led_level)
1507            ap.set_pixel(2, 4, 0, 0, led_level)
1508            ap.set_pixel(2, 5, 0, 0, 0)
1509            ap.set_pixel(2, 6, 0, 0, 0)
1510            ap.set_pixel(2, 7, 0, 0, led_level)
1511            ap.set_pixel(3, 4, 0, 0, 0)
1512            ap.set_pixel(3, 5, 0, 0, 0)
1513            ap.set_pixel(3, 6, 0, 0, 0)
1514            ap.set_pixel(3, 7, 0, 0, 0)
1515
1516        if num == '6':
1517        # number 6_bot_left – PRESSURE
1518            ap.set_pixel(0, 4, 0, 0, led_level)
1519            ap.set_pixel(0, 5, 0, 0, led_level)
1520            ap.set_pixel(0, 6, 0, 0, led_level)
1521            ap.set_pixel(0, 7, 0, 0, led_level)
1522            ap.set_pixel(1, 4, 0, 0, 0)
1523            ap.set_pixel(1, 5, 0, 0, led_level)
1524            ap.set_pixel(1, 6, 0, 0, 0)
1525            ap.set_pixel(1, 7, 0, 0, led_level)
1526            ap.set_pixel(2, 4, 0, 0, 0)
1527            ap.set_pixel(2, 5, 0, 0, led_level)
1528            ap.set_pixel(2, 6, 0, 0, led_level)
1529            ap.set_pixel(2, 7, 0, 0, led_level)
1530            ap.set_pixel(3, 4, 0, 0, 0)
1531            ap.set_pixel(3, 5, 0, 0, 0)
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1532        ap.set_pixel(3, 6, 0, 0, 0)
1533        ap.set_pixel(3, 7, 0, 0, 0)
1534
1535    if num == '7':
1536    # number 7_bot_left - PRESSURE
1537        ap.set_pixel(0, 4, 0, 0, led_level)
1538        ap.set_pixel(0, 5, 0, 0, led_level)
1539        ap.set_pixel(0, 6, 0, 0, 0)
1540        ap.set_pixel(0, 7, 0, 0, 0)
1541        ap.set_pixel(1, 4, 0, 0, led_level)
1542        ap.set_pixel(1, 5, 0, 0, 0)
1543        ap.set_pixel(1, 6, 0, 0, 0)
1544        ap.set_pixel(1, 7, 0, 0, 0)
1545        ap.set_pixel(2, 4, 0, 0, led_level)
1546        ap.set_pixel(2, 5, 0, 0, led_level)
1547        ap.set_pixel(2, 6, 0, 0, led_level)
1548        ap.set_pixel(2, 7, 0, 0, led_level)
1549        ap.set_pixel(3, 4, 0, 0, 0)
1550        ap.set_pixel(3, 5, 0, 0, 0)
1551        ap.set_pixel(3, 6, 0, 0, 0)
1552        ap.set_pixel(3, 7, 0, 0, 0)
1553
1554    if num == '8':
1555    # number 8_bot_left - PRESSURE
1556        ap.set_pixel(0, 4, 0, 0, led_level)
1557        ap.set_pixel(0, 5, 0, 0, led_level)
1558        ap.set_pixel(0, 6, 0, 0, led_level)
1559        ap.set_pixel(0, 7, 0, 0, led_level)
1560        ap.set_pixel(1, 4, 0, 0, led_level)
1561        ap.set_pixel(1, 5, 0, 0, 0)
1562        ap.set_pixel(1, 6, 0, 0, led_level)
1563        ap.set_pixel(1, 7, 0, 0, led_level)
1564        ap.set_pixel(2, 4, 0, 0, led_level)
1565        ap.set_pixel(2, 5, 0, 0, led_level)
1566        ap.set_pixel(2, 6, 0, 0, led_level)
1567        ap.set_pixel(2, 7, 0, 0, led_level)
1568        ap.set_pixel(3, 4, 0, 0, 0)
1569        ap.set_pixel(3, 5, 0, 0, 0)
1570        ap.set_pixel(3, 6, 0, 0, 0)
1571        ap.set_pixel(3, 7, 0, 0, 0)
1572
1573    if num == '9':
1574    # number 9_bot_left - PRESSURE
1575        ap.set_pixel(0, 4, 0, 0, led_level)
1576        ap.set_pixel(0, 5, 0, 0, led_level)
1577        ap.set_pixel(0, 6, 0, 0, led_level)
1578        ap.set_pixel(0, 7, 0, 0, 0)
1579        ap.set_pixel(1, 4, 0, 0, led_level)
1580        ap.set_pixel(1, 5, 0, 0, 0)
1581        ap.set_pixel(1, 6, 0, 0, led_level)
1582        ap.set_pixel(1, 7, 0, 0, 0)
1583        ap.set_pixel(2, 4, 0, 0, led_level)
1584        ap.set_pixel(2, 5, 0, 0, led_level)
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1585            ap.set_pixel(2, 6, 0, 0, led_level)
1586            ap.set_pixel(2, 7, 0, 0, led_level)
1587            ap.set_pixel(3, 4, 0, 0, 0)
1588            ap.set_pixel(3, 5, 0, 0, 0)
1589            ap.set_pixel(3, 6, 0, 0, 0)
1590            ap.set_pixel(3, 7, 0, 0, 0)
1591
1592    def psi_num_matrix_4(num):
1593
1594        if num == '0':
1595    # number 0_bottom_right – PRESSURE
1596            ap.set_pixel(4, 4, 0, 0, led_level)
1597            ap.set_pixel(4, 5, 0, 0, led_level)
1598            ap.set_pixel(4, 6, 0, 0, led_level)
1599            ap.set_pixel(4, 7, 0, 0, led_level)
1600            ap.set_pixel(5, 4, 0, 0, led_level)
1601            ap.set_pixel(5, 5, 0, 0, 0)
1602            ap.set_pixel(5, 6, 0, 0, 0)
1603            ap.set_pixel(5, 7, 0, 0, led_level)
1604            ap.set_pixel(6, 4, 0, 0, led_level)
1605            ap.set_pixel(6, 5, 0, 0, led_level)
1606            ap.set_pixel(6, 6, 0, 0, led_level)
1607            ap.set_pixel(6, 7, 0, 0, led_level)
1608            ap.set_pixel(7, 4, 0, 0, 0)
1609            ap.set_pixel(7, 5, 0, 0, 0)
1610            ap.set_pixel(7, 6, 0, 0, 0)
1611            ap.set_pixel(7, 7, 0, 0, 0)
1612
1613        if num == '1':
1614            # number 1_bottom_right – PRESSURE
1615            ap.set_pixel(4, 4, 0, 0, 0)
1616            ap.set_pixel(4, 5, 0, 0, led_level)
1617            ap.set_pixel(4, 6, 0, 0, 0)
1618            ap.set_pixel(4, 7, 0, 0, led_level)
1619            ap.set_pixel(5, 4, 0, 0, led_level)
1620            ap.set_pixel(5, 5, 0, 0, led_level)
1621            ap.set_pixel(5, 6, 0, 0, led_level)
1622            ap.set_pixel(5, 7, 0, 0, led_level)
1623            ap.set_pixel(6, 4, 0, 0, 0)
1624            ap.set_pixel(6, 5, 0, 0, 0)
1625            ap.set_pixel(6, 6, 0, 0, 0)
1626            ap.set_pixel(6, 7, 0, 0, led_level)
1627            ap.set_pixel(7, 4, 0, 0, 0)
1628            ap.set_pixel(7, 5, 0, 0, 0)
1629            ap.set_pixel(7, 6, 0, 0, 0)
1630            ap.set_pixel(7, 7, 0, 0, 0)
1631
1632        if num == '2':
1633    # number 2_bot_right – PRESSURE
1634            ap.set_pixel(4, 4, 0, 0, led_level)
1635            ap.set_pixel(4, 5, 0, 0, 0)
1636            ap.set_pixel(4, 6, 0, 0, 0)
1637            ap.set_pixel(4, 7, 0, 0, led_level)
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1638        ap.set_pixel(5, 4, 0, 0, led_level)
1639        ap.set_pixel(5, 5, 0, 0, 0)
1640        ap.set_pixel(5, 6, 0, 0, led_level)
1641        ap.set_pixel(5, 7, 0, 0, led_level)
1642        ap.set_pixel(6, 4, 0, 0, led_level)
1643        ap.set_pixel(6, 5, 0, 0, led_level)
1644        ap.set_pixel(6, 6, 0, 0, 0)
1645        ap.set_pixel(6, 7, 0, 0, led_level)
1646        ap.set_pixel(7, 4, 0, 0, 0)
1647        ap.set_pixel(7, 5, 0, 0, 0)
1648        ap.set_pixel(7, 6, 0, 0, 0)
1649        ap.set_pixel(7, 7, 0, 0, 0)
1650
1651     if num == '3':
1652    # number 3_bot_right - PRESSURE
1653        ap.set_pixel(4, 4, 0, 0, led_level)
1654        ap.set_pixel(4, 5, 0, 0, 0)
1655        ap.set_pixel(4, 6, 0, 0, 0)
1656        ap.set_pixel(4, 7, 0, 0, led_level)
1657        ap.set_pixel(5, 4, 0, 0, led_level)
1658        ap.set_pixel(5, 5, 0, 0, led_level)
1659        ap.set_pixel(5, 6, 0, 0, 0)
1660        ap.set_pixel(5, 7, 0, 0, led_level)
1661        ap.set_pixel(6, 4, 0, 0, led_level)
1662        ap.set_pixel(6, 5, 0, 0, led_level)
1663        ap.set_pixel(6, 6, 0, 0, led_level)
1664        ap.set_pixel(6, 7, 0, 0, led_level)
1665        ap.set_pixel(7, 4, 0, 0, 0)
1666        ap.set_pixel(7, 5, 0, 0, 0)
1667        ap.set_pixel(7, 6, 0, 0, 0)
1668        ap.set_pixel(7, 7, 0, 0, 0)
1669
1670     if num == '4':
1671    # number 4_bot_right - PRESSURE
1672        ap.set_pixel(4, 4, 0, 0, led_level)
1673        ap.set_pixel(4, 5, 0, 0, led_level)
1674        ap.set_pixel(4, 6, 0, 0, led_level)
1675        ap.set_pixel(4, 7, 0, 0, 0)
1676        ap.set_pixel(5, 4, 0, 0, 0)
1677        ap.set_pixel(5, 5, 0, 0, 0)
1678        ap.set_pixel(5, 6, 0, 0, led_level)
1679        ap.set_pixel(5, 7, 0, 0, 0)
1680        ap.set_pixel(6, 4, 0, 0, 0)
1681        ap.set_pixel(6, 5, 0, 0, led_level)
1682        ap.set_pixel(6, 6, 0, 0, led_level)
1683        ap.set_pixel(6, 7, 0, 0, led_level)
1684        ap.set_pixel(7, 4, 0, 0, 0)
1685        ap.set_pixel(7, 5, 0, 0, 0)
1686        ap.set_pixel(7, 6, 0, 0, 0)
1687        ap.set_pixel(7, 7, 0, 0, 0)
1688
1689     if num == '5':
1690    # number 5_bot_right - PRESSURE
```

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1691        ap.set_pixel(4, 4, 0, 0, led_level)
1692        ap.set_pixel(4, 5, 0, 0, led_level)
1693        ap.set_pixel(4, 6, 0, 0, 0)
1694        ap.set_pixel(4, 7, 0, 0, led_level)
1695        ap.set_pixel(5, 4, 0, 0, led_level)
1696        ap.set_pixel(5, 5, 0, 0, 0)
1697        ap.set_pixel(5, 6, 0, 0, led_level)
1698        ap.set_pixel(5, 7, 0, 0, led_level)
1699        ap.set_pixel(6, 4, 0, 0, led_level)
1700        ap.set_pixel(6, 5, 0, 0, 0)
1701        ap.set_pixel(6, 6, 0, 0, 0)
1702        ap.set_pixel(6, 7, 0, 0, led_level)
1703        ap.set_pixel(7, 4, 0, 0, 0)
1704        ap.set_pixel(7, 5, 0, 0, 0)
1705        ap.set_pixel(7, 6, 0, 0, 0)
1706        ap.set_pixel(7, 7, 0, 0, 0)
1707
1708     if num == '6':
1709    # number 6_bot_right - PRESSURE
1710        ap.set_pixel(4, 4, 0, 0, led_level)
1711        ap.set_pixel(4, 5, 0, 0, led_level)
1712        ap.set_pixel(4, 6, 0, 0, led_level)
1713        ap.set_pixel(4, 7, 0, 0, led_level)
1714        ap.set_pixel(5, 4, 0, 0, 0)
1715        ap.set_pixel(5, 5, 0, 0, led_level)
1716        ap.set_pixel(5, 6, 0, 0, 0)
1717        ap.set_pixel(5, 7, 0, 0, led_level)
1718        ap.set_pixel(6, 4, 0, 0, 0)
1719        ap.set_pixel(6, 5, 0, 0, led_level)
1720        ap.set_pixel(6, 6, 0, 0, led_level)
1721        ap.set_pixel(6, 7, 0, 0, led_level)
1722        ap.set_pixel(7, 4, 0, 0, 0)
1723        ap.set_pixel(7, 5, 0, 0, 0)
1724        ap.set_pixel(7, 6, 0, 0, 0)
1725        ap.set_pixel(7, 7, 0, 0, 0)
1726
1727     if num == '7':
1728    # number 7_bot_right - PRESSURE
1729        ap.set_pixel(4, 4, 0, 0, led_level)
1730        ap.set_pixel(4, 5, 0, 0, led_level)
1731        ap.set_pixel(4, 6, 0, 0, 0)
1732        ap.set_pixel(4, 7, 0, 0, 0)
1733        ap.set_pixel(5, 4, 0, 0, led_level)
1734        ap.set_pixel(5, 5, 0, 0, 0)
1735        ap.set_pixel(5, 6, 0, 0, 0)
1736        ap.set_pixel(5, 7, 0, 0, 0)
1737        ap.set_pixel(6, 4, 0, 0, led_level)
1738        ap.set_pixel(6, 5, 0, 0, led_level)
1739        ap.set_pixel(6, 6, 0, 0, led_level)
1740        ap.set_pixel(6, 7, 0, 0, led_level)
1741        ap.set_pixel(7, 4, 0, 0, 0)
1742        ap.set_pixel(7, 5, 0, 0, 0)
1743        ap.set_pixel(7, 6, 0, 0, 0)
```

```python
1744          ap.set_pixel(7, 7, 0, 0, 0)
1745
1746      if num == '8':
1747   # number 8_bot_right - PRESSURE
1748          ap.set_pixel(4, 4, 0, 0, led_level)
1749          ap.set_pixel(4, 5, 0, 0, led_level)
1750          ap.set_pixel(4, 6, 0, 0, led_level)
1751          ap.set_pixel(4, 7, 0, 0, led_level)
1752          ap.set_pixel(5, 4, 0, 0, led_level)
1753          ap.set_pixel(5, 5, 0, 0, 0)
1754          ap.set_pixel(5, 6, 0, 0, led_level)
1755          ap.set_pixel(5, 7, 0, 0, led_level)
1756          ap.set_pixel(6, 4, 0, 0, led_level)
1757          ap.set_pixel(6, 5, 0, 0, led_level)
1758          ap.set_pixel(6, 6, 0, 0, led_level)
1759          ap.set_pixel(6, 7, 0, 0, led_level)
1760          ap.set_pixel(7, 4, 0, 0, 0)
1761          ap.set_pixel(7, 5, 0, 0, 0)
1762          ap.set_pixel(7, 6, 0, 0, 0)
1763          ap.set_pixel(7, 7, 0, 0, 0)
1764
1765      if num == '9':
1766   # number 9_bot_right - PRESSURE
1767          ap.set_pixel(4, 4, 0, 0, led_level)
1768          ap.set_pixel(4, 5, 0, 0, led_level)
1769          ap.set_pixel(4, 6, 0, 0, led_level)
1770          ap.set_pixel(4, 7, 0, 0, 0)
1771          ap.set_pixel(5, 4, 0, 0, led_level)
1772          ap.set_pixel(5, 5, 0, 0, 0)
1773          ap.set_pixel(5, 6, 0, 0, led_level)
1774          ap.set_pixel(5, 7, 0, 0, 0)
1775          ap.set_pixel(6, 4, 0, 0, led_level)
1776          ap.set_pixel(6, 5, 0, 0, led_level)
1777          ap.set_pixel(6, 6, 0, 0, led_level)
1778          ap.set_pixel(6, 7, 0, 0, led_level)
1779          ap.set_pixel(7, 4, 0, 0, 0)
1780          ap.set_pixel(7, 5, 0, 0, 0)
1781          ap.set_pixel(7, 6, 0, 0, 0)
1782          ap.set_pixel(7, 7, 0, 0, 0)
1783
1784      def psi_num_error_high():
1785   # error state warning for - HIGH PRESSURE
1786          ap.set_pixel(0, 0, red, 0, 0)
1787          ap.set_pixel(0, 1, red, 0, 0)
1788          ap.set_pixel(0, 2, red, 0, 0)
1789          ap.set_pixel(0, 3, red, 0, 0)
1790          ap.set_pixel(1, 0, red, 0, 0)
1791          ap.set_pixel(1, 1, red, 0, 0)
1792          ap.set_pixel(1, 2, red, 0, 0)
1793          ap.set_pixel(1, 3, red, 0, 0)
1794          ap.set_pixel(2, 0, red, 0, 0)
1795          ap.set_pixel(2, 1, red, 0, 0)
1796          ap.set_pixel(2, 2, red, 0, 0)
```

```
1797        ap.set_pixel(2, 3, red, 0, 0)
1798        ap.set_pixel(3, 0, red, 0, 0)
1799        ap.set_pixel(3, 1, red, 0, 0)
1800        ap.set_pixel(3, 2, red, 0, 0)
1801        ap.set_pixel(3, 3, red, 0, 0)
1802        ap.set_pixel(4, 0, red, 0, 0)
1803        ap.set_pixel(4, 1, red, 0, 0)
1804        ap.set_pixel(4, 2, red, 0, 0)
1805        ap.set_pixel(4, 3, red, 0, 0)
1806        ap.set_pixel(5, 0, red, 0, 0)
1807        ap.set_pixel(5, 1, red, 0, 0)
1808        ap.set_pixel(5, 2, red, 0, 0)
1809        ap.set_pixel(5, 3, red, 0, 0)
1810        ap.set_pixel(6, 0, red, 0, 0)
1811        ap.set_pixel(6, 1, red, 0, 0)
1812        ap.set_pixel(6, 2, red, 0, 0)
1813        ap.set_pixel(6, 3, red, 0, 0)
1814        ap.set_pixel(7, 0, red, 0, 0)
1815        ap.set_pixel(7, 1, red, 0, 0)
1816        ap.set_pixel(7, 2, red, 0, 0)
1817        ap.set_pixel(7, 3, red, 0, 0)
1818        ap.set_pixel(0, 4, red, 0, 0)
1819        ap.set_pixel(0, 5, red, 0, 0)
1820        ap.set_pixel(0, 6, red, 0, 0)
1821        ap.set_pixel(0, 7, red, 0, 0)
1822        ap.set_pixel(1, 4, red, 0, 0)
1823        ap.set_pixel(1, 5, red, 0, 0)
1824        ap.set_pixel(1, 6, red, 0, 0)
1825        ap.set_pixel(1, 7, red, 0, 0)
1826        ap.set_pixel(2, 4, red, 0, 0)
1827        ap.set_pixel(2, 5, red, 0, 0)
1828        ap.set_pixel(2, 6, red, 0, 0)
1829        ap.set_pixel(2, 7, red, 0, 0)
1830        ap.set_pixel(3, 4, red, 0, 0)
1831        ap.set_pixel(3, 5, red, 0, 0)
1832        ap.set_pixel(3, 6, red, 0, 0)
1833        ap.set_pixel(3, 7, red, 0, 0)
1834        ap.set_pixel(4, 4, red, 0, 0)
1835        ap.set_pixel(4, 5, red, 0, 0)
1836        ap.set_pixel(4, 6, red, 0, 0)
1837        ap.set_pixel(4, 7, red, 0, 0)
1838        ap.set_pixel(5, 4, red, 0, 0)
1839        ap.set_pixel(5, 5, red, 0, 0)
1840        ap.set_pixel(5, 6, red, 0, 0)
1841        ap.set_pixel(5, 7, red, 0, 0)
1842        ap.set_pixel(6, 4, red, 0, 0)
1843        ap.set_pixel(6, 5, red, 0, 0)
1844        ap.set_pixel(6, 6, red, 0, 0)
1845        ap.set_pixel(6, 7, red, 0, 0)
1846        ap.set_pixel(7, 4, red, 0, 0)
1847        ap.set_pixel(7, 5, red, 0, 0)
1848        ap.set_pixel(7, 6, red, 0, 0)
1849        ap.set_pixel(7, 7, red, 0, 0)
```

```python
1850
1851    def psi_num_error_low():
1852    # error state warning for – LOW PRESSURE
1853        ap.set_pixel(0, 0, 0, 0, blue)
1854        ap.set_pixel(0, 1, 0, 0, blue)
1855        ap.set_pixel(0, 2, 0, 0, blue)
1856        ap.set_pixel(0, 3, 0, 0, blue)
1857        ap.set_pixel(1, 0, 0, 0, blue)
1858        ap.set_pixel(1, 1, 0, 0, blue)
1859        ap.set_pixel(1, 2, 0, 0, blue)
1860        ap.set_pixel(1, 3, 0, 0, blue)
1861        ap.set_pixel(2, 0, 0, 0, blue)
1862        ap.set_pixel(2, 1, 0, 0, blue)
1863        ap.set_pixel(2, 2, 0, 0, blue)
1864        ap.set_pixel(2, 3, 0, 0, blue)
1865        ap.set_pixel(3, 0, 0, 0, blue)
1866        ap.set_pixel(3, 1, 0, 0, blue)
1867        ap.set_pixel(3, 2, 0, 0, blue)
1868        ap.set_pixel(3, 3, 0, 0, blue)
1869        ap.set_pixel(4, 0, 0, 0, blue)
1870        ap.set_pixel(4, 1, 0, 0, blue)
1871        ap.set_pixel(4, 2, 0, 0, blue)
1872        ap.set_pixel(4, 3, 0, 0, blue)
1873        ap.set_pixel(5, 0, 0, 0, blue)
1874        ap.set_pixel(5, 1, 0, 0, blue)
1875        ap.set_pixel(5, 2, 0, 0, blue)
1876        ap.set_pixel(5, 3, 0, 0, blue)
1877        ap.set_pixel(6, 0, 0, 0, blue)
1878        ap.set_pixel(6, 1, 0, 0, blue)
1879        ap.set_pixel(6, 2, 0, 0, blue)
1880        ap.set_pixel(6, 3, 0, 0, blue)
1881        ap.set_pixel(7, 0, 0, 0, blue)
1882        ap.set_pixel(7, 1, 0, 0, blue)
1883        ap.set_pixel(7, 2, 0, 0, blue)
1884        ap.set_pixel(7, 3, 0, 0, blue)
1885        ap.set_pixel(0, 4, 0, 0, blue)
1886        ap.set_pixel(0, 5, 0, 0, blue)
1887        ap.set_pixel(0, 6, 0, 0, blue)
1888        ap.set_pixel(0, 7, 0, 0, blue)
1889        ap.set_pixel(1, 4, 0, 0, blue)
1890        ap.set_pixel(1, 5, 0, 0, blue)
1891        ap.set_pixel(1, 6, 0, 0, blue)
1892        ap.set_pixel(1, 7, 0, 0, blue)
1893        ap.set_pixel(2, 4, 0, 0, blue)
1894        ap.set_pixel(2, 5, 0, 0, blue)
1895        ap.set_pixel(2, 6, 0, 0, blue)
1896        ap.set_pixel(2, 7, 0, 0, blue)
1897        ap.set_pixel(3, 4, 0, 0, blue)
1898        ap.set_pixel(3, 5, 0, 0, blue)
1899        ap.set_pixel(3, 6, 0, 0, blue)
1900        ap.set_pixel(3, 7, 0, 0, blue)
1901        ap.set_pixel(4, 4, 0, 0, blue)
1902        ap.set_pixel(4, 5, 0, 0, blue)
```

```python
1903        ap.set_pixel(4, 6, 0, 0, blue)
1904        ap.set_pixel(4, 7, 0, 0, blue)
1905        ap.set_pixel(5, 4, 0, 0, blue)
1906        ap.set_pixel(5, 5, 0, 0, blue)
1907        ap.set_pixel(5, 6, 0, 0, blue)
1908        ap.set_pixel(5, 7, 0, 0, blue)
1909        ap.set_pixel(6, 4, 0, 0, blue)
1910        ap.set_pixel(6, 5, 0, 0, blue)
1911        ap.set_pixel(6, 6, 0, 0, blue)
1912        ap.set_pixel(6, 7, 0, 0, blue)
1913        ap.set_pixel(7, 4, 0, 0, blue)
1914        ap.set_pixel(7, 5, 0, 0, blue)
1915        ap.set_pixel(7, 6, 0, 0, blue)
1916        ap.set_pixel(7, 7, 0, 0, blue)
1917
1918
1919    ## SETTING UP FLIGHT BUTTONS FOR USE AND ASSIGNING COMMANDS
1920
1921    def button_pressed(button):          ## CONTINUOUSLY MONITORS FOR BUTTON
        EVENTS
1922        global running
1923        global ap
1924        global led_level
1925        global temp_hum_on
1926        global psi_on
1927        global tmp_mute
1928        global hum_mute
1929        global alarm_count
1930
1931        if button == UP and led_level < 250:    ## ADJUST LED MATRIX BRIGHTNESS
        - UP
1932            led_level = led_level + 10
1933
1934        if button == DOWN and led_level > 40:   ## ADJUST LED MATRIX BRIGHTNESS
        - DOWN
1935            led_level = led_level - 10
1936
1937        if button == LEFT:                      ## FORCE TEMPERATURE AND HUMIDITY
        PAGE ON (5s)
1938            temp_hum_on = 1
1939
1940            temp_num_matrix_1(temp[0])       ## FIRST DIGIT - TEMPERATURE
1941            temp_num_matrix_2(temp[1])       ## SECOND DIGIT - TEMPERATURE
1942            hum_num_matrix_1(hum[0])         ## FIRST DIGIT - HUMIDITY
1943            hum_num_matrix_2(hum[1])         ## SECOND DIGIT - HUMIDITY
1944
1945            time.sleep(5.0)                  ## WAIT 5 SECONDS TO ENSURE READING
            CAN BE RECORDED
1946
1947            temp_hum_on = 0                  ## CLOSE TEMPERATURE AND HUMIDITY
            PAGE OFF
1948
1949            tmp_mute = 0                     ## SHOWS THE WARNING FOR TEMPERATURE
```

```python
1950             hum_mute = 0                       ## SHOWS THE WARNING FOR HUMIDITY
1951
1952         if button == RIGHT:                    ## FORCE PRESSURE PAGE ON (5s)
1953             psi_on = 1
1954
1955             psi_num_matrix_1(psi[0])           ## FIRST DIGIT - PRESSURE
1956             psi_num_matrix_2(psi[1])           ## SECOND DIGIT - PRESSURE
1957             psi_num_matrix_3(psi[2])           ## THIRD DIGIT - PRESSURE
1958             psi_num_matrix_4(psi[3])           ## FOURTH DIGIT - PRESSURE
1959
1960             time.sleep(5.0)                    ## WAIT 5 SECONDS TO ENSURE READING
                 CAN BE RECORDED
1961
1962             psi_on = 0                         ## FORCE PRESSURE PAGE OFF
1963
1964         if button == A:                        ## ALLOWS ASTRONAUT (Tim) TO MUTE
             ALARMS
1965             alarm_count = 0                    # RESETS 'alarm_count' TO ZERO TO
                 START COUNTDOWN
1966             tmp_mute = 1                       # MUTES THE WARNING FOR TEMPERATURE
1967             hum_mute = 1                       # MUTES THE WARNING FOR HUMIDITY
1968             psi_mute = 1                       # MUTES THE WARNING FOR PRESSURE
1969
1970         if button == B:
1971             alarm_count = 0                    # RESETS 'alarm_count' TO ZERO TO
                 START COUNTDOWN
1972             tmp_mute = 0                       # SHOWS THE WARNING FOR TEMPERATURE
1973             hum_mute = 0                       # SHOWS THE WARNING FOR HUMIDITY
1974             psi_mute = 0                       # SHOWS THE WARNING FOR PRESSURE
1975
1976     for pin in [UP, DOWN, LEFT, RIGHT, A, B]:## SETUP GPIP PIN VALUES
1977         GPIO.setup(pin, GPIO.IN, pull_up_down=GPIO.PUD_UP)
1978         GPIO.add_event_detect(pin, GPIO.FALLING, callback=button_pressed,
             bouncetime=500)
1979
1980
1981     ## SET PREVIOUS TEMPERATURE, HUMIDITY, & PRESSURE VALUES TO ZERO  ##
1982
1983     temp_prev = 0                                # PREVIOUS TEMPERATURE READING
1984     temp_int = 0                                 # CURRENT TEMPERATURE READING
1985     hum_prev = 0                                 # PREVIOUS HUMIDITY READING
1986     hum_int = 0                                  # CURRENT HUMIDITY READING
1987     psi_prev = 0                                 # PREVIOUS PRESSURE READING
1988     psi_int = 0                                  # CURRENT PRESSURE READING
1989     pitch = 0                                    # CURRENT PITCH (ORIENTATION) READING
1990     roll = 0                                     # CURRENT ROLL (ORIENTATION) READING
1991     yaw = 0                                      # CURRENT YAW (ORIENTATION) READING
1992
1993     sec_count = 0                               # CURRENT TRIGGER READING FOR
         RECORDING RESULTS INTO LOG
1994
1995     alarm_count = 0                             # TRIGGER FOR RE-ENABLING ALARM
         AFTER A SET PERIOD OF TIME
```

```python
1996     alarm_timer = 0
1997
1998     ## NEW ASTROPI CLASS FILE TO ENSURE ORIENTATION READING IS DISPLAYED
         CORRECTLY ##
1999
2000     ap = AstroPi()
2001
2002     class AstroPiContinuous(AstroPi):         # NEW CLASS FILE WRITEN BY
         'LetHopeItsSnowing' (ASTROPI FORUM)
2003         """
2004         A class which continuously reads orientation data from AstroPi as without
2005         it the orientatin data looses sync
2006         """
2007         def __init__(self,
2008                 fb_device='/dev/fb1',
2009                 imu_settings_file='RTIMULib',
2010                 text_assets='astro_pi_text',
2011                 sample_rate = 0.1):
2012
2013             AstroPi.__init__(self, fb_device, imu_settings_file, text_assets)
2014
2015             self.sample_rate = sample_rate
2016             self.stopped = True
2017             self.running = False
2018
2019         def start(self):
2020             """
2021             starts the thread that continuously reads the astro pi orientation
                 data
2022             """
2023             #initialise the IMU by getting the orientation
2024             self.get_orientation()
2025             #start the orientation thread
2026             thread.start_new_thread(self._get_orientation_threaded, ())
2027
2028         def _get_orientation_threaded(self):
2029             """
2030             reads the orientation data every sample rate to ensure astro pi is
                 kept in sync
2031             """
2032             self.stopped = False
2033             self.running = True
2034
2035             #keep reading the orientation data, this keeps AstroPi in sync
2036             while(not self.stopped):
2037                 self.get_orientation()
2038                 sleep(self.sample_rate)
2039
2040             self.running = False
2041
2042         def stop(self):
2043             """
2044             stops the continous read thread
```

```python
2045                """
2046            self.stopped = True
2047            #wait for the thread to stop
2048            while(self.running):
2049                sleep(0.01)
2050
2051        def __enter__(self):
2052            self.start()
2053            return self
2054
2055        def __exit__(self, type, value, traceback):
2056            self.stop()
2057
2058
2059    ## NEW CLASS FILE TO ALLOW CPU_TEMP TO BE RECALLED AS NEEDED ##
2060
2061    class CPUTemp:
2062        def __init__(self, tempfilename =
2063        "/sys/class/thermal/thermal_zone0/temp"):
2063            self.tempfilename = tempfilename
2064
2065        def __enter__(self):
2066            self.open()
2067            return self
2068
2069        def open(self):
2070            self.tempfile = open(self.tempfilename, "r")
2071
2072        def read(self):
2073            self.tempfile.seek(0)
2074            return self.tempfile.read().rstrip()
2075
2076        def get_temperature(self):
2077            return self.get_temperature_in_c()
2078
2079        def get_temperature_in_c(self):
2080            tempraw = self.read()
2081            return float(tempraw[:-3] + "." + tempraw[-3:])
2082
2083        def get_temperature_in_f(self):
2084            return self.convert_c_to_f(self.get_temperature_in_c())
2085
2086        def convert_c_to_f(self, c):
2087            return c * 9.0 / 5.0 + 32.0
2088
2089        def __exit__(self, type, value, traceback):
2090            self.close()
2091
2092        def close(self):
2093            self.tempfile.close()
2094
2095
2096    ## MAIN PROGRAM LOOP ##
```

```python
2097
2098    try:
2099      while running:                        ## ENSURES THAT THE SCRIPT IS
         ALWAYS RUNNING IN A LOOP
2100        import thread                       ## ALLOWS THE SCRIPT TO IMPORT THE
           NEW CLASS FILE
2101        with AstroPiContinuous() as ap:     ## FORCES SYSTEM TO USE NEW
           ORIENTATION CLASS FILE
2102          while(True):                      ## SCRIPT LOOP FOR DISPLAYING
             READINGS AND RECORDING DATA
2103            o = ap.get_orientation()
2104            pitch = o["pitch"]           # SEPARATES OUT THE PITCH SECTION
               FROM ORIENTATION READINGS
2105            roll = o["roll"]             # SEPARATES OUT THE ROLL SECTION
               FROM ORIENTATION READING
2106            yaw = o["yaw"]               # SEPARATES OUT THE YAW SECTION
               FROM ORIENTATION READING
2107
2108
2109            ## ALLOWS THE LOG SECTION TO RECALL INFORMATION FROM THE
               VARIOUS SECTIONS OF THIS SCRIPT
2110
2111            global display_f
2112            global temp_f
2113            global temp_reading_f
2114            global temp_alarm_f
2115            global hum_f
2116            global hum_reading_f
2117            global hum_alarm_f
2118            global psi_f
2119            global psi_reading_f
2120            global psi_alarm_f
2121
2122
2123            ## SET VALUES FOR LOGGING INFORMATION ##
2124
2125            if sec_count == 15:          ## ONLY WRITES THE LOGGING
               INFORMATION EVERY 30 SECONDS(APPROX.)
2126
2127              print("Logged {}".format(count))  #KEEPS ASTRONAUT (Tim) UP
                 TO DATE WITH READINGS RECORDED
2128              file.write(
                 "\"{}\",\"{:0.2f}\",\"{:0.2f}\",\"{:0.2f}\",\"{:0.2f}\",\"{:0
                 .2f}\",\"{:0.2f}\",\"{:0.2f}\",\"{:0.2f}\",\"{:0.2f}\",\"{:0.
                 2f}\",\"{:0.2f}\",\"{:0.2f}\",\"{:0.2f}\"\n".format(asctime
                 (),display_f,temp_f,tmp_reading_f,tmp_alarm_f,hum_f,
                 hum_reading_f,hum_alarm_f,psi_f,psi_reading_f,psi_alarm_f,
                 pitch,roll,yaw))
2129              sec_count = 0
2130              count+=1
2131              alarm_timer = alarm_timer + 1     # ADDS 1 TO THE
                 'alarm_timer' TRIGGER
2132
```

```python
2133
2134            ## COUNTER TO RE-ENABLE ALARMS FOR THE TEMPERATURE, HUMIDITY
                AND PRESSURE READINGS
2135
2136            if alarm_timer >= 5:
2137                alarm_count+=1          # ONCE 'alarm_timer' EQUALS 5,
                    ADDS ONE TO 'alarm_count',
2138                alarm_timer = 0          # THIS ENSURES THE TIMERS ARE
                    CLEARED ON A BUTTON PRESS
2139
2140
2141            ## RE-ENABLE ALARMS FOR THE TEMPERATURE, HUMIDITY AND PRESSURE
                READINGS
2142
2143            if alarm_count >= 35:        ## WAITS FOR 30mins (APPROX.)
                BEFORE RE-ENABLING ALARMS
2144                tmp_mute = 0
2145                hum_mute = 0
2146                psi_mute = 0
2147                alarm_count = 0          # RESETS 'alarm_count' TO ZERO TO
                    START COUNTDOWN AGAIN
2148
2149
2150            ## CALCULATIONS FOR TEMPERATURE TO COMPENSATE FOR CPU_TEMP
                AFFECTING TEMPERATURE READINGS
2151
2152            t = ap.get_temperature()
2153            p = ap.get_temperature_from_pressure()
2154            h = ap.get_temperature_from_humidity()
2155            with CPUTemp() as cpu_temp:
2156                c = cpu_temp.get_temperature()
2157
2158            temp_calc = ((t+p+h)/3) - (c/4.2)        ## CALCULATION FOR
                CORRECTING FOR CPU TEMPERATURE AFFECT ON TEMPERATURE SENSORS ##
2159                                                     ## VERIFIED WITH
                                                        STANDALONE TEMPERATURE
                                                        GUAGE ##
2160
2161
2162            ## GET TEMPERATURE, HUMIDITY, & PRESSURE READINGS FROM ASTROPI
                SENSORS ##
2163            ## also CREATES INTERGAR FOR LOGGING INFORMATION CORRECTLY ON A
                TABLE ##
2164
2165            temp_f = temp_calc              ## STORES TEMPERATURE READING
                WITHIN temp_f
2166            temp_int = int(temp_f)          ## CREATES INTERGAR FROM
                TEMPERATURE READING
2167
2168            hum_f = ap.get_humidity()       ## STORES TEMPERATURE READING
                WITHIN hum_f
2169            hum_int = int(hum_f)            ## CREATES INTERGAR FROM
                HUMIDITY READING
```

```python
2170
2171                psi_f = ap.get_pressure()        ## STORES TEMPERATURE READING
                    WITHIN psi_f
2172                psi_int = int(psi_f)            ##CREATES INTERGAR FROM
                    PRESSURE READING
2173
2174
2175            ## LOG IF THE DISPLAY HAS BEEN MUTED (BLACK BOX STYLE) ##
2176
2177            if led_level < 50:              # DOUBLE CHECK LED LIGHT LEVELS
                TO CONFIRM DISPLAY ACTIVE
2178                display_mute = 1
2179            elif led_level > 40:
2180                display_mute = 0
2181
2182            if display_mute == 1:          # TRANSLATES DISPLAY MUTE TO ON
                AND OFF FOR LOG FILE
2183                display_f = 0
2184            elif display_mute == 0:
2185                display_f = 1
2186
2187
2188            ## LOG IF THE TEMPERATURE ALARM READING AND IF IT HAS BEEN
                MUTED (BLACK BOX STYLE) ##
2189
2190            if tmp_mute == 1:              # TRANSLATES THE ALARM MUTE
                INTO ON AND OFF FOR LOG FILE
2191                tmp_alarm_f = 0
2192            elif tmp_mute == 0:
2193                tmp_alarm_f = 1
2194
2195            if tmp_alarm == 2:            # TRANSLATES THE READINGS INTO
                HIGH, LOW AND OK FOR LOG FILE
2196                tmp_reading_f = 1
2197            elif tmp_alarm == 1:
2198                tmp_reading_f = -1
2199            elif tmp_alarm == 0:
2200                tmp_reading_f = 0
2201
2202
2203            ## LOG IF THE HUMIDITY ALARM READING AND IF IT HAS BEEN MUTED
                (BLACK BOX STYLE)  ##
2204
2205            if hum_mute == 1:              # TRANSLATES THE ALARM MUTE
                INTO ON AND OFF FOR LOG FILE
2206                hum_alarm_f = 0
2207            elif hum_mute == 0:
2208                hum_alarm_f = 1
2209
2210            if hum_alarm == 2:            # TRANSLATES THE READINGS INTO
                HIGH, LOW AND OK FOR LOG FILE
2211                hum_reading_f = 1
2212            elif hum_alarm == 1:
```

```python
2213                    hum_reading_f = -1
2214                elif hum_alarm == 0:
2215                    hum_reading_f = 0
2216
2217
2218            ## LOG IF THE PRESSURE ALARM READING AND IF IT HAS BEEN MUTED
                (BLACK BOX STYLE)
2219
2220            if psi_mute == 1:              # TRANSLATES THE ALARM MUTE
                INTO ON AND OFF FOR LOG FILE
2221                psi_alarm_f = 0
2222            elif psi_mute == 0:
2223                psi_alarm_f = 1
2224
2225            if psi_alarm == 2:             # TRANSLATES THE READINGS INTO
                HIGH, LOW AND OK FOR LOG FILE
2226                psi_reading_f = 1
2227            elif psi_alarm == 1:
2228                psi_reading_f = -1
2229            elif psi_alarm == 0:
2230                psi_reading_f = 0
2231
2232
2233            ## CONVERTS TEMPERATURE, HUMIDITY, PRESSURE READINGS TO A
                STRING ##
2234            ## also OVERWRITES AND STORES SENSOR READINGS WITHIN PREVIOUS
                READINGS ##
2235
2236            temp_prev = temp_int          # STORE READING IN temp_prev
2237            temp =  str(temp_int)         # CONVERT TEMPERATURE READING
                TO STRING ##
2238
2239            hum_prev = hum_int            # STORE READING IN temp_prev
2240            hum =  str(hum_int)           # CONVERT HUMIDITY READING TO
                STRING ##
2241
2242            psi_prev = psi_int            # STORE READING IN temp_prev
2243            psi =  str(psi_int)           # CONVERT PRESSURE READING TO
                STRING ##
2244
2245
2246
2247
2248            ## ROTATE THE LED MATRIX DISPLAY (if required) ##
2249
2250            ap.set_rotation(270)          ## ROTATION ENABLED TO WORK WITH
                ASTROPI NASA CASE
2251
2252
2253            ## WRITES VALUES ONTO THE LED MATRIX FOR THE TEMPERATURE,
                HUMIDITY, & PRESSURE ##
2254
2255            ## WRITES TO TOP_LINE ONLY – TEMPERATURE (2 DIGITS)##
```

```python
2256
2257                 temp_num_matrix_1(temp[0])              # FIRST DIGIT - TEMPERATURE
2258                 temp_num_matrix_2(temp[1])              # SECOND DIGIT - TEMPERATURE
2259
2260
2261             ## WRITE TO BOTTOM_LINE ONLY - HUMIDITY (2 DIGITS)##
2262
2263             hum_num_matrix_1(hum[0])              # FIRST DIGIT - HUMIDITY
2264             hum_num_matrix_2(hum[1])              # SECOND DIGIT - HUMIDITY
2265
2266
2267             ## TEMPERATURE - ERROR STATE CHECKING ##
2268
2269             if temp_hum_on == 1:               # IF TEMP+HUMIDITY PAGE
                 ACTIVE DISPLAY PREVIOUS READING FOR 5s
2270                 time.sleep(5.0)
2271             elif temp_hum_on == 0:
2272                 time.sleep(0.5)                # IF NOT ONLY WAIT FOR 0.5s
2273
2274             if tmp_mute == 0:                  # ONLY WORKOUT ALARM STATES
                 FOR READINGS WITHIN TEMPERATURE IF NOT MUTED
2275                 if temp_int - 3 > temp_prev:   # IF RISE OF 3 DEGREES
                     BETWEEN READINGS - ALARM STATE
2276                     temp_num_error_high()
2277                     t_h_wait = 1
2278                     tmp_alarm = 2
2279
2280                 elif temp_int + 3 < temp_prev: # IF FALL OF 3 DEGREES
                     BETWEEN READING - ALARM STATE
2281                     temp_num_error_low()
2282                     t_h_wait = 1
2283                     tmp_alarm = 1
2284
2285                 elif temp_int > 36:            ## CHECKED AGAINST ISS
                     REQUIREMENTS INC CPU READING
2286                     temp_num_error_high()
2287                     t_h_wait = 1
2288                     tmp_alarm = 2
2289
2290                 elif temp_int < 18:            ## CHECKED AGAINST ISS
                     REQUIREMENTS INC CPU READING
2291                     temp_num_error_low()
2292                     t_h_wait = 1
2293                     tmp_alarm = 1
2294
2295                 else:
2296                     t_h_wait = 1               # IF NOTHING MATCHES WAIT
                     ANOTHER 0.5s BEFORE MOVING FORWARD
2297                     tmp_alarm = 0
2298
2299
2300             ## HUMIDITY - ERROR STATE CHECKING ##
2301
```

```python
2302                    if hum_mute == 0:                       # ONLY WORKOUT ALARM STATES
                        FOR READINGS WITHIN HUMIDITY IF NOT MUTED
2303                        if hum_int - 3 > hum_prev:       # IF RISE OF 3 BETWEEN
                            READINGS - ALARM STATE
2304                            hum_num_error_high()
2305                            t_h_wait = 1
2306                            hum_alarm = 2
2307
2308                        elif hum_int + 3 < hum_prev:     # IF FALL OF 3 BETWEEN
                            READINGS - ALARM STATE
2309                            hum_num_error_low()
2310                            t_h_wait = 1
2311                            hum_alarm = 1
2312
2313                        elif hum_int > 70:               ## CHECKED AGAINST ISS
                            REQUIREMENTS
2314                            hum_num_error_high()
2315                            t_h_wait = 1
2316                            hum_alarm = 2
2317
2318                        elif hum_int < 50:               ## CHECKED AGAINST ISS
                            REQUIREMENTS
2319                            hum_num_error_low()
2320                            t_h_wait = 1
2321                            hum_alarm = 1
2322
2323                        else:
2324                            t_h_wait = 1                 # IF NOTHING MATCHES WAIT
                            ANOTHER 0.5s BEFORE MOVING FORWARD
2325                            hum_alarm = 0
2326
2327
2328                    ## ALLOW ASTRONAUT (Tim) TO READ THE PREVIOUS TEMPERATURE &
                    HUMIDITY READINGS ON LED MATRIX ##
2329
2330                    if t_h_wait == 1:
2331                        time.sleep(0.5)
2332                    else:
2333                        time.sleep(0.5)
2334
2335
2336                    ## WRITE TO BOTH TOP_LINE & BOTTOM_LINE - PRESSURE (4 DIGITS) ##
2337
2338                    psi_num_matrix_1(psi[0])             # FIRST DIGIT - PRESSURE
2339                    psi_num_matrix_2(psi[1])             # SECOND DIGIT - PRESSURE
2340                    psi_num_matrix_3(psi[2])             # THIRD DIGIT - PRESSURE
2341                    psi_num_matrix_4(psi[3])             # FOURTH DIGIT - PRESSURE
2342
2343
2344                    ## PRESSURE - ERROR STATE CHECKING ##
2345
2346                    if psi_on == 1:                      # IF PRESSURE PAGE ACTIVE
                    DISPLAY PREVIOUS READING FOR 5s
```

```python
2347                    time.sleep(5.0)
2348                elif psi_on == 0:
2349                    time.sleep(0.5)                  # IF NOT ONLY WAIT FOR 0.5s
2350
2351                if psi_int - 5 > psi_prev:          # ONLY WORKOUT ALARM STATES
                    FOR READINGS WITHIN PRESSURE IF NOT MUTED
2352                    psi_num_error_high()            # IF RISE OF 5 BETWEEN
                        READINGS - ALARM STATE
2353                    psi_wait = 1
2354                    psi_alarm = 2
2355
2356                elif psi_int + 5 < psi_prev:        # IF FALL OF 5 BETWEEN
                    READINGS - ALARM STATE
2357                    psi_num_error_low()
2358                    psi_wait = 1
2359                    psi_alarm = 1
2360
2361                elif psi_int > 1040:                ## CHECKED AGAINST ISS
                    REQUIREMENTS
2362                    psi_num_error_high()
2363                    psi_wait = 1
2364                    psi_alarm = 2
2365
2366                elif psi_int < 1000:                ## CHECKED AGAINST ISS
                    REQUIREMENTS
2367                    psi_num_error_low()
2368                    psi_wait = 1
2369                    psi_alarm = 1
2370
2371                else:
2372                    psi_wait = 1
2373                    psi_alarm = 0
2374
2375
2376                ## ALLOW ASTRONAUT (Tim) TO READ THE PREVIOUS PRESSURE READING
                    ON LED MATRIX ##
2377
2378                if psi_wait == 1:
2379                    time.sleep(0.5)
2380                else:
2381                    time.sleep(0.5)
2382
2383
2384                ## RESETS THE LOGGING COUNTER & START LOOP AGAIN ##
2385
2386                sec_count+=1                         ## ADD 1 TO SEC_COUNT FOR LOGGING
2387
2388
2389    ## PROGRAMMIG TO CLEANLY EXIT THE PYTHON PROGRAM AND STOP RECORDING
        READINGS (if required) ##
2390
2391    finally:
2392
```

```
2393          ## CLEARS THE LED MATRIX ON ASTROPI ##
2394
2395          file.close()                       ## CLOSE CSV FILE TO ENSURE READINGS
              ARE RECORDED
2396
2397          ap.show_letter(    " ", back_colour = [0, 0, 0])     ## SETS BACKGROUND
              COLOUR TO BLACK (off)
2398
2399          ap.clear                           ## CLEARS LED MATRIX
2400
2401          os.system("clear")                 ## CLEARS THE SSH DISPLAY
2402
2403          sys.exit()                         ## FORCES THE PYTHON PROGRAM TO EXIT
```