Hw3 : Pork Zongzi maker!

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完成功能

▶ 1.備料台功能齊全
  ▶ 可依照備料台狀況將豬肉放入備料台或冷凍庫
  ▶ 按照FCFS運作

▶ 2.冷凍庫功能齊全
  ▶ 可判斷是否已到冷凍結束時間
  ▶ 依據備料台狀況判斷是否繼續冷凍

▶ 3.切割工廠功能齊全
  ▶ 可進入工作、維護、檢討模式
  ▶ 可等待切割時間、標示已切割豬肉
  ▶ 若備料台已滿，可將第N+1個豬肉留於切割工廠
  ▶ 切完所有豬肉後離線

▶

完成功能

▶ 4.包裝工廠功能齊全
  ▶ 可進入工作、維護、檢討模式
  ▶ 可等待包裝時間

▶ 5.時間正常推進
  ▶ 可定期發送工廠狀態訊息
  ▶ 每個工作階段達成時，發送當前時間點

▶ 6.可自訂豬肉數量與備料台容量

▶

設計技巧

▸ 根據作業要求，可畫流程圖清楚了解每個產線的動向

▸ 運用Pthread達成同步多工處理
  ▸ 分為4個thread – cutter, packer, freezer, timer.

▸ 運用mutex防止資源衝突
  ▸ 將豬肉拿出/放入備料台時，使用mutex防止搶豬肉的情況
    ▸ 主要預防豬肉來源區、切割工廠和冷凍庫同時放豬肉導致過載

共用資源

```cpp
 1 #include<iostream>
 2 #include<ctime>
 3 #include<utility>
 4 #include<queue>
 5 #include<pthread.h>
 6 #include<unistd.h>
 7
 8 using namespace std;
 9
10 struct pork
11 {
12         int id;
13         bool cut;
14 };
15
16 pthread_mutex_t mutex = PTHREAD_MUTEX_INITIALIZER;//mutex
17
18 int btime = 0;//background time
19 int porkN = 10;//the total number of pieces of pork;
20 int preQN = 5;//prepare queue capacity, size of preQ + size of preQ2 <= preQN
21 int porkid = 1;//the identifier of pork, count from 1
22 int cutcount = 10;//how many pieces of prok have not been cut
23 int packcount = 10;//how many pieces of prok have not been packed
24 bool cutWork = false, packWork = false;//Judging the status of the factories
25 queue<pork> preQ, preQ2;//prepare queue, divided into uncut and cut;
26 priority_queue<pair<pork, int>> frezQ;//freezer space
27
28 //thread function
29 void *cutter(void *noth);
30 void *packer(void *noth);
31 void *freezer(void *noth);
32 void *timer(void *noth);
```

操作功能

```cpp
34 bool operator<(pair<pork, int> a, pair<pork, int> b)//sorting rule of the priority_queue
35 {
36         return a.second > b.second;
37 }
38
39 void wait(int ms)//
40 {
41         usleep(ms*1000);
42 }
43
44 void putinQ(pork p)//put the pork in prepare queue
45 {
46         pthread_mutex_lock(&mutex);
47         p.cut == true ? preQ2.push(p) : preQ.push(p);
48         pthread_mutex_unlock(&mutex);
49 }
50
51 void freeze(pork p)//estimated freezing time and put the pork in the freezer space
52 {
53         int freztime = (rand() % 2 + 3) * 100 + rand() % 11 * 10;
54         frezQ.push(make_pair(p, btime + freztime));
55         cout << btime << "ms -- Pork#" << p.id << " has been sent to the Freezer - "<< freztime << "ms\n";
56 }
```

Main function

```cpp
58 int main(int argc, char *argv[])
59 {
60      //input
61      if(argc>1)
62      {
63              porkN = atoi(argv[1]);
64              cutcount = porkN;
65              packcount = porkN;
66              if(argc == 3)
67                      preQN = atoi(argv[2]);
68      }
69
70      //initial threads
71      pthread_t cutid, packid, frezid, timeid;
72      pthread_attr_t cutattr, packattr, frezattr, timeattr;
73
74      pthread_attr_init(&cutattr);
75      pthread_attr_init(&packattr);
76      pthread_attr_init(&frezattr);
77      pthread_attr_init(&timeattr);
78
79      //create threads
80      pthread_create(&cutid, NULL, cutter, NULL);
81      pthread_create(&packid, NULL, packer, NULL);
82      pthread_create(&frezid, NULL, freezer, NULL);
83      pthread_create(&timeid, NULL, timer, NULL);
84
85      srand(3);
86      while(porkN)
87      {
88              wait((rand() % 6 + 5) * 10);
89              if((preQ.size() + preQ2.size()) >= preQN)//if the prepare queue is full, sent the pork to the freezer
90                      freeze({porkid, false});
91              else//put the pork in the prepare queue
92              {
93                      putinQ({porkid, false});
94                      cout << btime << "ms -- Pork#" << porkid << ": waiting in the slot\n";
95              }
96              --porkN, ++porkid;
97      }
98
99      //wait for the threads to exit
100     pthread_join(cutid, NULL);
101     pthread_join(packid, NULL);
102     pthread_join(frezid, NULL);
103     pthread_join(timeid, NULL);
```

切割工廠

```
108 void *cutter(void *noth)
109 {
110     while(cutcount)
111     {
112             while(preQ.empty());
113
114             //take out from the prepare queue
115             pthread_mutex_lock(&mutex);
116             pork p = preQ.front();
117             preQ.pop();
118             pthread_mutex_unlock(&mutex);
119
120             cout << btime << "ms -- Pork#" << p.id << ": enters the CUTTER\n";
121
122
123             //start to cut
124             cutWork = true;
125             //cutting
126             int cuttime = (rand() % 2 + 1) * 100 + rand() % 11 * 10;
127             cout << btime << "ms -- CUTTER: cutting... cutting... Pork#" << p.id << " -- " << cuttime << "ms\n";
128             wait(cuttime);
129             p.cut = true;
130             --cutcount;
131             cout << btime << "ms -- Pork#" << p.id << ": Leaves CUTTER(Complete 1st stage)\n";
132             //finish cutting
133             cutWork = false;
134
135
136             //prepare queue is full and the next prok is cut -> place here and wait
137             while((preQ.size() + preQ2.size()) == preQN  && preQ.front().cut == true);
138
139             putinQ(p);
140             cout << btime << "ms -- Pork#" << p.id << ": waiting in the slot(cutted)\n";
141     }
142     pthread_exit(0);
143 }
```

包裝工廠

```
145 void *packer(void *noth)
146 {
147     while(packcount)
148     {
149         while(preQ2.empty());
150
151         //take out from the prepare queue
152         pthread_mutex_lock(&mutex);
153         pork p = preQ2.front();
154         preQ2.pop();
155         pthread_mutex_unlock(&mutex);
156
157         cout << btime << "ms -- Pork#" << p.id << ": enters to the factory(PACKER)\n";
158
159
160         //start to pack
161         packWork = true;
162         //packing
163         int packtime = (rand() % 5 + 5) * 100 + rand() % 11 * 10;
164         cout << btime << "ms -- PACKER: processing & Paking the Pork#" << p.id << " -- " << packtime << "ms\n";
165         wait(packtime);
166         --packcount;
167         cout << btime << "ms -- Pork#" << p.id << ": Leaves PACKER(Complete)\n";
168         //finish packing
169         packWork = false;
170     }
171     pthread_exit(0);
172 }
```

冷凍庫

```
L74 void *freezer(void *noth)
L75 {
L76        while(packcount)
L77        {
L78                if(!frezQ.empty() && frezQ.top().second <= btime)//its time to defrost
L79                {
L80                        pork p = frezQ.top().first;
L81                        if((preQ.size() + preQ2.size()) >= preQN)//the prepare queue is still full -> keep freezing
L82                                freeze(p);
L83                        else//take the prok out from the freezer and put it in the prepare queue
L84                        {
L85                                putinQ(p);
L86                                cout << btime << "ms -- Pork#" << p.id << ": waiting in the slot\n";
L87                        }
L88                        frezQ.pop();
L89                }
L90        }
L91        pthread_exit(0);
L92 }
```

計時器

```
194 void *timer(void *noth)
195 {
196         while(packcount)
197         {
198                 //Transfer the massages of the factory status regularly
199                 if(!cutWork && !packWork)
200                         cout << btime << "ms -- CUTTER & PACKER: under reviewing together...\n";
201                 else if(!cutWork && cutcount > 0)
202                         cout << btime << "ms -- CUTTER: under maintenance.\n";
203                 else if(!packWork)
204                         cout << btime << "ms -- PACKER: under maintenance.\n";
205
206                 //clock
207                 wait(10);
208                 pthread_mutex_lock(&mutex);
209                 btime += 10;
210                 pthread_mutex_unlock(&mutex);
211         }
212         cout << btime << "ms -- CUTTER & PACKER: under reviewing together...\n";
213         pthread_exit(0);
214 }
```

執行過程


```
zackchen@zackchen-VirtualBox:~$ cd s1083345_OShw3
zackchen@zackchen-VirtualBox:~/s1083345_OShw3$ g++ s1083345_OShw3.cpp -lpthread -o hw3.out
zackchen@zackchen-VirtualBox:~/s1083345_OShw3$ ./hw3.out 12 6
0ms -- CUTTER & PACKER: under reviewing together...
10ms -- CUTTER & PACKER: under reviewing together...
20ms -- CUTTER & PACKER: under reviewing together...
30ms -- CUTTER & PACKER: under reviewing together...
40ms -- CUTTER & PACKER: under reviewing together...
40ms -- Pork#1: waiting in the slot
40ms -- Pork#1: enters the CUTTER
40ms -- CUTTER: cutting... cutting... Pork#1 -- 190ms
50ms -- PACKER: under maintenance.
60ms -- PACKER: under maintenance.
70ms -- PACKER: under maintenance.
80ms -- PACKER: under maintenance.
90ms -- PACKER: under maintenance.
90ms -- Pork#2: waiting in the slot
100ms -- PACKER: under maintenance.
110ms -- PACKER: under maintenance.
120ms -- PACKER: under maintenance.
130ms -- PACKER: under maintenance.
140ms -- PACKER: under maintenance.
150ms -- PACKER: under maintenance.
160ms -- PACKER: under maintenance.
160ms -- Pork#3: waiting in the slot
170ms -- PACKER: under maintenance.
180ms -- PACKER: under maintenance.
190ms -- PACKER: under maintenance.
200ms -- PACKER: under maintenance.
210ms -- PACKER: under maintenance.
210ms -- Pork#1: Leaves CUTTER(Complete 1st stage)
220ms -- Pork#1: waiting in the slot(cutted)
220ms -- Pork#2: enters the CUTTER
220ms -- CUTTER: cutting... cutting... Pork#2 -- 170ms
220ms -- PACKER: under maintenance.
220ms -- Pork#1: enters to the factory(PACKER)
220ms -- PACKER: processing & Paking the Pork#1 -- 600ms
240ms -- Pork#4: waiting in the slot
330ms -- Pork#5: waiting in the slot
370ms -- Pork#2: Leaves CUTTER(Complete 1st stage)
370ms -- Pork#2: waiting in the slot(cutted)
370ms -- Pork#3: enters the CUTTER
370ms -- CUTTER: cutting... cutting... Pork#3 -- 250ms
410ms -- Pork#6: waiting in the slot
490ms -- Pork#7: waiting in the slot
570ms -- Pork#8: waiting in the slot
610ms -- Pork#3: Leaves CUTTER(Complete 1st stage)
610ms -- Pork#3: waiting in the slot(cutted)
```

執行過程


```
610ms -- Pork#4: enters the CUTTER
610ms -- CUTTER: cutting... cutting... Pork#4 -- 220ms
620ms -- Pork#9 has been sent to the Freezer - 420ms
670ms -- Pork#10 has been sent to the Freezer - 310ms
730ms -- Pork#11 has been sent to the Freezer - 470ms
760ms -- Pork#1: Leaves PACKER(Complete)
760ms -- Pork#2: enters to the factory(PACKER)
760ms -- PACKER: processing & Paking the Pork#2 -- 830ms
790ms -- Pork#4: Leaves CUTTER(Complete 1st stage)
790ms -- Pork#4: waiting in the slot(cutted)
790ms -- Pork#5: enters the CUTTER
790ms -- CUTTER: cutting... cutting... Pork#5 -- 160ms
810ms -- Pork#12: waiting in the slot
920ms -- Pork#5: Leaves CUTTER(Complete 1st stage)
920ms -- Pork#5: waiting in the slot(cutted)
920ms -- Pork#6: enters the CUTTER
920ms -- CUTTER: cutting... cutting... Pork#6 -- 200ms
980ms -- Pork#10 has been sent to the Freezer - 360ms
1040ms -- Pork#9 has been sent to the Freezer - 440ms
1060ms -- Pork#6: Leaves CUTTER(Complete 1st stage)
1060ms -- Pork#6: waiting in the slot(cutted)
1060ms -- Pork#7: enters the CUTTER
1060ms -- CUTTER: cutting... cutting... Pork#7 -- 180ms
1190ms -- Pork#7: Leaves CUTTER(Complete 1st stage)
1190ms -- Pork#7: waiting in the slot(cutted)
1190ms -- Pork#8: enters the CUTTER
1190ms -- CUTTER: cutting... cutting... Pork#8 -- 100ms
1200ms -- Pork#11 has been sent to the Freezer - 310ms
1270ms -- Pork#8: Leaves CUTTER(Complete 1st stage)
1270ms -- Pork#8: waiting in the slot(cutted)
1270ms -- Pork#12: enters the CUTTER
1270ms -- CUTTER: cutting... cutting... Pork#12 -- 160ms
1340ms -- Pork#10 has been sent to the Freezer - 500ms
1400ms -- Pork#2: Leaves PACKER(Complete)
1400ms -- Pork#3: enters to the factory(PACKER)
1400ms -- PACKER: processing & Paking the Pork#3 -- 720ms
1400ms -- Pork#12: Leaves CUTTER(Complete 1st stage)
1410ms -- Pork#12: waiting in the slot(cutted)
1420ms -- CUTTER: under maintenance.
1430ms -- CUTTER: under maintenance.
1440ms -- CUTTER: under maintenance.
1450ms -- CUTTER: under maintenance.
1460ms -- CUTTER: under maintenance.
1470ms -- CUTTER: under maintenance.
1480ms -- CUTTER: under maintenance.
1480ms -- Pork#9 has been sent to the Freezer - 450ms
1490ms -- CUTTER: under maintenance.
1500ms -- CUTTER: under maintenance.
```

執行過程

執行過程


```
1930ms -- CUTTER: under maintenance.
1930ms -- Pork#9 has been sent to the Freezer - 300ms
1930ms -- Pork#3: Leaves PACKER(Complete)
1930ms -- Pork#4: enters to the factory(PACKER)
1930ms -- PACKER: processing & Paking the Pork#4 -- 590ms
1940ms -- CUTTER: under maintenance.
1950ms -- CUTTER: under maintenance.
1960ms -- CUTTER: under maintenance.
1970ms -- CUTTER: under maintenance.
1980ms -- CUTTER: under maintenance.
1990ms -- CUTTER: under maintenance.
2000ms -- CUTTER: under maintenance.
2010ms -- CUTTER: under maintenance.
2020ms -- CUTTER: under maintenance.
2030ms -- CUTTER: under maintenance.
2040ms -- CUTTER: under maintenance.
2050ms -- CUTTER: under maintenance.
2060ms -- CUTTER: under maintenance.
2070ms -- CUTTER: under maintenance.
2080ms -- CUTTER: under maintenance.
2090ms -- CUTTER: under maintenance.
2100ms -- CUTTER: under maintenance.
2110ms -- CUTTER: under maintenance.
2120ms -- CUTTER: under maintenance.
2130ms -- CUTTER: under maintenance.
2140ms -- CUTTER: under maintenance.
2140ms -- Pork#11: waiting in the slot
2150ms -- CUTTER: under maintenance.
2150ms -- Pork#10 has been sent to the Freezer - 450ms
2150ms -- Pork#11: enters the CUTTER
2150ms -- CUTTER: cutting... cutting... Pork#11 -- 270ms
2230ms -- Pork#9: waiting in the slot
2370ms -- Pork#11: Leaves CUTTER(Complete 1st stage)
2370ms -- Pork#11: waiting in the slot(cutted)
2370ms -- Pork#9: enters the CUTTER
2370ms -- CUTTER: cutting... cutting... Pork#9 -- 210ms
2400ms -- Pork#4: Leaves PACKER(Complete)
2400ms -- Pork#5: enters to the factory(PACKER)
2400ms -- PACKER: processing & Paking the Pork#5 -- 820ms
2540ms -- Pork#9: Leaves CUTTER(Complete 1st stage)
2540ms -- Pork#9: waiting in the slot(cutted)
2550ms -- CUTTER: under maintenance.
2560ms -- CUTTER: under maintenance.
2570ms -- CUTTER: under maintenance.
2580ms -- CUTTER: under maintenance.
2590ms -- CUTTER: under maintenance.
2600ms -- CUTTER: under maintenance.
2600ms -- Pork#10 has been sent to the Freezer - 310ms
```

執行過程

```
2610ms -- CUTTER: under maintenance.
2620ms -- CUTTER: under maintenance.
2630ms -- CUTTER: under maintenance.
2640ms -- CUTTER: under maintenance.
2650ms -- CUTTER: under maintenance.
2660ms -- CUTTER: under maintenance.
2670ms -- CUTTER: under maintenance.
2680ms -- CUTTER: under maintenance.
2690ms -- CUTTER: under maintenance.
2700ms -- CUTTER: under maintenance.
2710ms -- CUTTER: under maintenance.
2720ms -- CUTTER: under maintenance.
2730ms -- CUTTER: under maintenance.
2740ms -- CUTTER: under maintenance.
2750ms -- CUTTER: under maintenance.
2760ms -- CUTTER: under maintenance.
2770ms -- CUTTER: under maintenance.
2780ms -- CUTTER: under maintenance.
2790ms -- CUTTER: under maintenance.
2800ms -- CUTTER: under maintenance.
2810ms -- CUTTER: under maintenance.
2820ms -- CUTTER: under maintenance.
2830ms -- CUTTER: under maintenance.
2840ms -- CUTTER: under maintenance.
2850ms -- CUTTER: under maintenance.
2860ms -- CUTTER: under maintenance.
2870ms -- CUTTER: under maintenance.
2880ms -- CUTTER: under maintenance.
2890ms -- CUTTER: under maintenance.
2900ms -- CUTTER: under maintenance.
2910ms -- CUTTER: under maintenance.
2920ms -- CUTTER: under maintenance.
2920ms -- Pork#10 has been sent to the Freezer - 430ms
2930ms -- CUTTER: under maintenance.
2940ms -- CUTTER: under maintenance.
2950ms -- CUTTER: under maintenance.
2960ms -- CUTTER: under maintenance.
2970ms -- CUTTER: under maintenance.
2980ms -- CUTTER: under maintenance.
2990ms -- CUTTER: under maintenance.
3000ms -- CUTTER: under maintenance.
3010ms -- CUTTER: under maintenance.
3020ms -- CUTTER: under maintenance.
3020ms -- Pork#5: Leaves PACKER(Complete)
3030ms -- Pork#6: enters to the factory(PACKER)
3030ms -- PACKER: processing & Paking the Pork#6 -- 560ms
3030ms -- CUTTER: under maintenance.
3040ms -- CUTTER: under maintenance.
3050ms -- CUTTER: under maintenance.
```

執行過程

執行過程

END