Introduction to Software Engineering

Team Project

-Digital Watch Final-

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Introduction

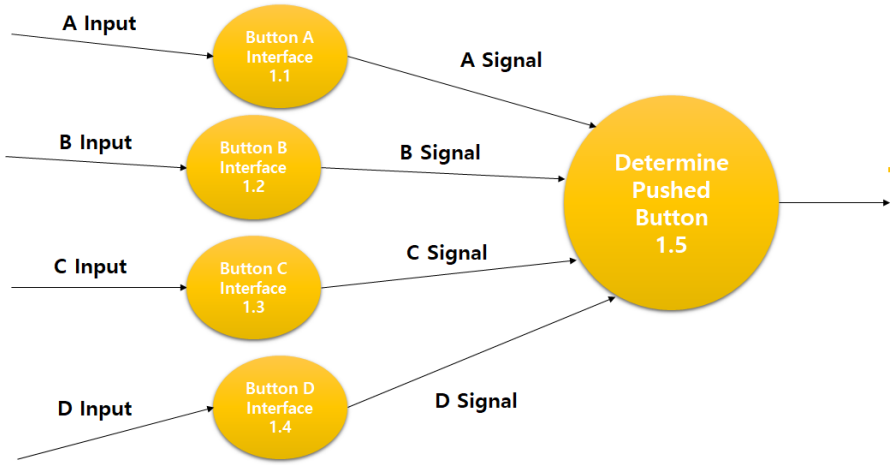
- Development Environment

: Ubuntu, VSCode, GitHub

- Main Point

: Signal Handler, Thread, Setitimer

Overall DFD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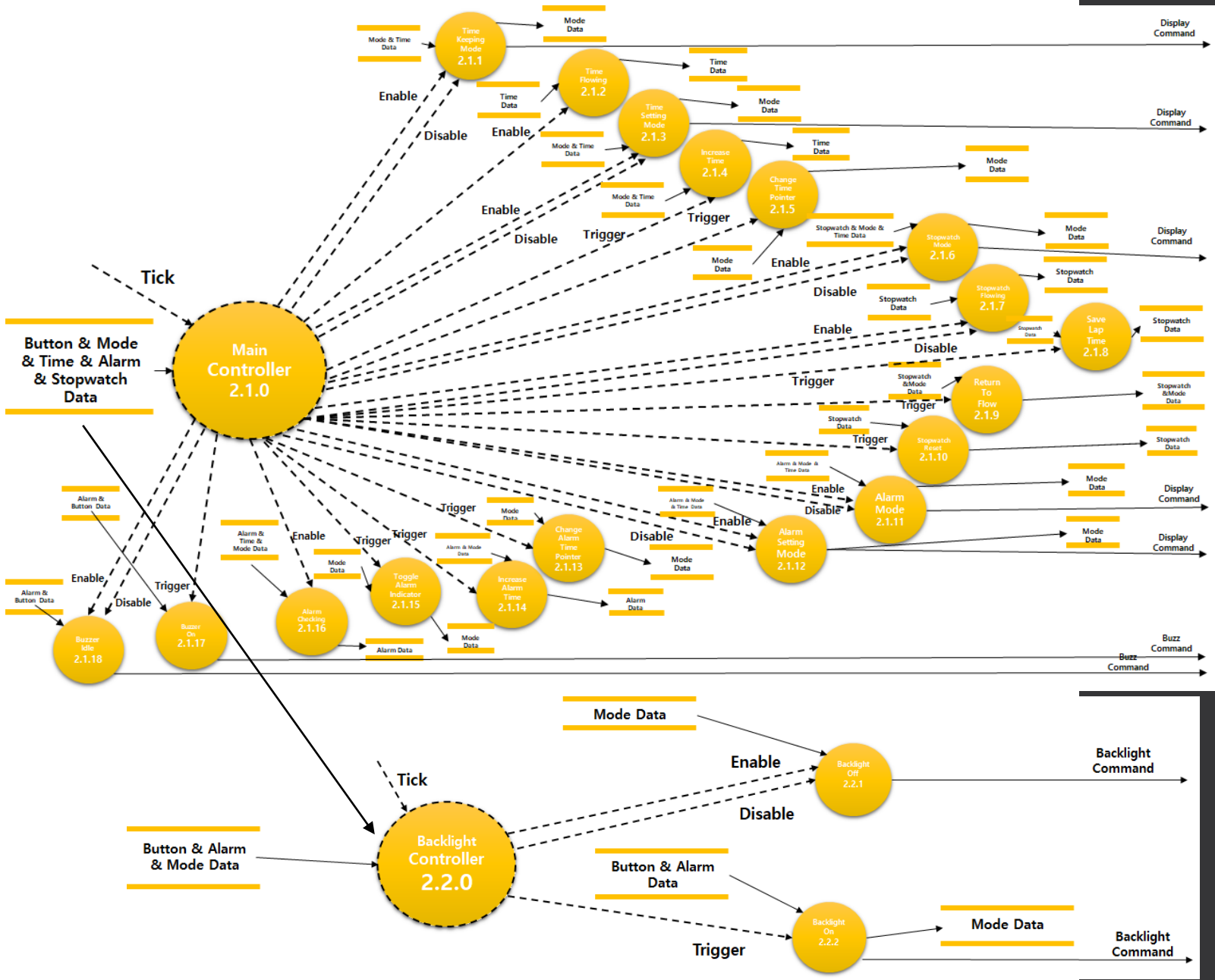
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Timer

```
static void timer_handler( int sig, siginfo_t *si, void *uc ) {
    timer_t *tidp;
    tidp = si->si_value.sival_ptr;

    if ( *tidp == firstTimerID ) {

        time_flowing(time_data);
        alarm_checking(alarm_data, mode_data, time_data);
    }
    else if ( *tidp == secondTimerID ) {

        stop_watch_flowing(stopwatch_data, mode_data);
    }
}
```

Timer

```
static int install_timer (char *name, timer_t *timerID, int sec, int nsec) {
    struct sigevent         te;
    struct itimerspec       its;
    struct sigaction        sa;
    int                     sigNo = SIGRTMIN;

    /* Set up signal handler. */
    sa.sa_flags = SA_SIGINFO;
    sa.sa_sigaction = timer_handler;
    sigemptyset(&sa.sa_mask);

    if (sigaction(sigNo, &sa, NULL) == -1) {
        printf("sigaction error\n");
        return -1;
    }
```

```
    /* Set and enable alarm */
    te.sigev_notify = SIGEV_SIGNAL;
    te.sigev_signo = sigNo;
    te.sigev_value.sival_ptr = timerID;
    timer_create(CLOCK_REALTIME, &te, timerID);

    its.it_interval.tv_sec = sec;
    its.it_interval.tv_nsec = nsec;
    its.it_value.tv_sec = sec;
    its.it_value.tv_nsec = nsec;
    timer_settime(*timerID, 0, &its, NULL);

    return 0;
}
```

Time Flowing

```
void time_flowing(timedata_t *curr_time) {
    if (++(curr_time->sec) == 60) {
        curr_time->min++;
        curr_time->sec = 0;
    }
    if (curr_time->min == 60) {
        curr_time->hour++;
        curr_time->min = 0;
    }
    if (curr_time->hour == 24) {
        curr_time->date++;
        curr_time->hour = 0;
    }
    if (curr_time->month == 2) {
        if (leap_year(curr_time->year)){
            if (curr_time->date == 30) {
                curr_time->date == 1;
                curr_time->month++;
            }
        }
        else {
            if (curr_time->date == 29) {
                curr_time->date == 1;
                curr_time->month++;

 else if (curr_time->month==1||curr_time->month==3|
|curr_time->month==5||curr_time->month==7||curr_t
ime->month==8||curr_time->month==10||curr_time->
month==12) {
            if (curr_time->date == 32) {
                curr_time->date == 1;
                curr_time->date++;
            }
        }
        else {
            if (curr_time->date == 31) {
                curr_time->date == 1;
                curr_time->date++;
            }
        }
}
```

Determine Pushed Button

```
//get keyboard input in nonblocking manner
int determine_pushed_button() {
  char ch;
  int nread;
  int ich;
    new_term.c_cc[VMIN] = 0;
    new_term.c_cc[VTIME] = 0;
    tcsetattr(0, TCSANOW, &new_term);
    nread = read(0, &ch, 1);
    new_term.c_cc[VMIN] = 1;
    new_term.c_cc[VTIME] = 0;
    tcsetattr(0, TCSANOW, &new_term);
    if (nread >= 1) {
      ch_read = (int) ch;
      return ch_read;
    }
    else {
      return -1;
    }
}
```

Time Keeping Mode

```
int time_keeping_mode(modedata_t *modedata, timedata_t *curr_time) {
    char button;
    while (1) {
        backlight_curr_sec = curr_time->sec;
        if (backlight_curr_sec == backlight_finish_sec) {
            printf("₩033[0m"); //reset
        }

        if (!(modedata->buzzing)&&((button = determine_pushed_button()) > 0)) {
            if (button == 'A') { //change to time setting mode
                modedata->s_m_data = 1;
                time_setting_mode(modedata, curr_time);
            }
            else if (button == 'C') { //change to alarm mode
                modedata->mode = 1;
                return 0;
            }
```

```
            else if (button == 'D') {
                        if
(backlight_curr_sec == 58 ||
backlight_curr_sec == 59)

backlight_finish_sec =
(backlight_curr_sec + 2 )- 60;
                        else {

backlight_finish_sec =
backlight_curr_sec + 2;
                        }
                        printf("₩033[1;33m");
//yellow

                    }
                    else {
                        continue;
                    }
                }

                system("clear");
                printf("%s-%04d-%02d-
%02d₩n%02d:%02d:%02d %02d₩n", curr_time-
>day[get_day(curr_time->year,
curr_time->month, curr_time->date)],
curr_time->year, curr_time->month,
curr_time->date,
                        curr_time->hour,
curr_time->min, curr_time->sec);
                usleep(100000);
            }
}
```

Time Setting Mode

```c
void time_setting_mode(modedata_t *modedata, timedata_t *curr_time) {
    char button;
    while (1) {
        backlight_curr_sec = curr_time->sec;
        if (backlight_curr_sec == backlight_finish_sec) {
            printf("₩033[0m"); //reset
        }
        if(!(modedata->buzzing)&&((button = determine_pushed_button()) > 0)) {
            if (backlight_curr_sec == backlight_finish_sec) {
                printf("₩033[0m"); //reset
            }
            if (button == 'A') { //return to to time keeping mode
                modedata->s_m_data = 0;
                modedata->time_pointer == 0;
                return;
            }
            else if (button == 'B') { //change to alarm mode
                increase_time(modedata, curr_time);
            }
            else if (button == 'C') { //change cursor
                change_time_pointer(modedata);
            }
            else if (button == 'D') {
                if (backlight_curr_sec == 58 || backlight_curr_sec == 59)
                    backlight_finish_sec = (backlight_curr_sec + 2 )- 60;
                else {
                    backlight_finish_sec = backlight_curr_sec + 2;
                }
                printf("₩033[1;33m"); //yellow
            }
        }
```

```c
        switch (modedata->time_pointer) {
            case 0: //flicker second
                system("clear");
                printf("%04d-%02d-%02d₩n%02d:%02d %02d₩n", curr_time->year,
curr_time->month, curr_time->date,
                        curr_time->hour, curr_time->min, curr_time->sec);
                usleep(50000);
                system("clear");
                printf("%04d-%02d-%02d₩n%02d:%02d   ₩n", curr_time->year,
curr_time->month, curr_time->date,
                        curr_time->hour, curr_time->min);
                usleep(50000);
                break;
            case 1: //flicker hour
                system("clear");
                printf("%04d-%02d-%02d₩n%02d:%02d %02d₩n", curr_time->year,
curr_time->month, curr_time->date,
                        curr_time->hour, curr_time->min, curr_time->sec);
                usleep(50000);
                system("clear");
                printf("%04d-%02d-%02d₩n  :%02d %02d₩n", curr_time->year,
curr_time->month, curr_time->date,
                        curr_time->min, curr_time->sec);
                usleep(50000);
                break;
```

Time Setting Mode

```
case 2: //flicker minute
                system("clear");
                printf("%04d-%02d-%02dWn%02d:%02d %02dWn", curr_time->year,
curr_time->month, curr_time->date,
                        curr_time->hour, curr_time->min, curr_time->sec);
                usleep(50000);
                system("clear");
                printf("%04d-%02d-%02dWn%02d:   %02dWn", curr_time->year,
curr_time->month, curr_time->date,
                        curr_time->hour, curr_time->sec);
                usleep(50000);
                break;
case 3: //flicker year
                system("clear");
                printf("%04d-%02d-%02dWn%02d:%02d %02dWn", curr_time->year,
curr_time->month, curr_time->date,
                        curr_time->hour, curr_time->min, curr_time->sec);
                usleep(50000);
                system("clear");
                printf("    -%02d-%02dWn%02d:%02d %02dWn", curr_time-
>month, curr_time->date,
                        curr_time->hour, curr_time->min, curr_time->sec);
                usleep(50000);
                break;

                break;
        }

    }
}
```

```
                case 4: //flicker month
                    system("clear");
                    printf("%04d-%02d-%02dWn%02d:%02d %02dWn",
curr_time->year, curr_time->month, curr_time->date,
                            curr_time->hour, curr_time->min, curr_time-
>sec);
                    usleep(50000);
                    system("clear");
                    printf("%04d-  -%02dWn%02d:%02d %02dWn", curr_time-
>year, curr_time->date,
                            curr_time->hour, curr_time->min, curr_time-
>sec);
                    usleep(50000);
                    break;
                case 5: //flicker date
                    system("clear");
                    printf("%04d-%02d-%02dWn%02d:%02d %02dWn",
curr_time->year, curr_time->month, curr_time->date,
                            curr_time->hour, curr_time->min, curr_time-
>sec);
                    usleep(50000);
                    system("clear");
                    printf("%04d-%02d-  Wn%02d:%02d %02dWn", curr_time-
>year, curr_time->month,
                            curr_time->hour, curr_time->min, curr_time-
>sec);
                    usleep(50000);
                    break;
            }

        }
}
```

Increase Time

```
void increase_time(modedata_t *modedata, timedata_t *set_time) {
    int cursor = modedata->time_pointer;
    int month = set_time->month;
    int year = set_time->year;

    switch(cursor) {
        case 0:
            set_time->sec = ((set_time->sec + 1)%60);
            break;
        case 2:
            set_time->min = ((set_time->min + 1)%60);
            break;
        case 1:
            set_time->hour = ((set_time->hour +1)%24);
            break;
```

```
        case 5:
                if (month==2) {
                    if (leap_year(year)){
                        set_time->date = ((set_time->date)%29 + 1);
                    }else{
                        set_time->date = ((set_time->date)%28 + 1);
                    }
                }
                else if
(month==1||month==3||month==5||month==7||month==8||month==10||month==12) {
                    set_time->date = ((set_time->date)%31 +1);
                }
                else {
                    set_time->date = ((set_time->date)%30 + 1);
                }
                break;
            case 4:
                set_time->month = ((set_time->month)%12 + 1);
                if(set_time->month == 2 && set_time->date > 28
&& !(leap_year(year))) { //윤년아닐 때
                    set_time->date = 28;
                }
                else if(set_time->month == 2 && set_time->date > 29 &&
leap_year(year)){ //윤년일 때
                    set_time->date = 29;
                }else if(set_time->date > 30 && (set_time->month != 8 ||
set_time->month != 1)){
                    set_time->date = 30;
                }
                break;
            case 3:
                set_time->year = ((((set_time->year+1)-2019)%81)+2019);
        }
}
```

Alarm Mode

```
int alarm_mode(modedata_t *modedata, alarmdata_t *alarmdata, timedata_t *timedata) {
    char button;
    while (1) {
        backlight_curr_sec = timedata->sec;
        if (backlight_curr_sec == backlight_finish_sec) {
            printf("₩033[0m"); //reset
        }
        if(!(modedata->buzzing)&&((button = determine_pushed_button()) > 0)) {
            if (button == 'A') {
                modedata->s_m_data = 2;
                alarm_setting_mode(modedata, alarmdata, timedata);
            } //change to alarm setting mode
            else if (button == 'B') {
                if (modedata->alarm_indicator_data)
                    modedata->alarm_indicator_data = false;
                else
                    modedata->alarm_indicator_data = true;
            } //toggle alarm
            else if (button == 'C') {
                modedata->mode = 2;
                return 0;
            } //change to stopwatch mode
            else if (button == 'D') {
                if (backlight_curr_sec == 58 || backlight_curr_sec ==
59)
                    backlight_finish_sec = (backlight_curr_sec + 2 )-
60;
                else {
                    backlight_finish_sec = backlight_curr_sec + 2;
                }
                printf("₩033[1;33m"); //yellow
            }
        }
        if (modedata->alarm_indicator_data == 0) {
            system("clear");
            printf("   %02d-%02d₩n%02d:%02d₩n", timedata->month,
timedata->date,
                    alarmdata->al_hour, alarmdata->al_minute);
            usleep(100000);
        }
        else {
            system("clear");
            printf("AL %02d-%02d₩n%02d:%02d₩n", timedata->month,
timedata->date,
                    alarmdata->al_hour, alarmdata->al_minute);
            usleep(100000);
        }
    }

}
```

Alarm Checking /Buzz / Buzz handle

```
void alarm_checking(alarmdata_t *alarmdata, modedata_t *modedata, timedata_t *curr_time) {
    if (modedata->alarm_indicator_data&&alarmdata->al_hour == curr_time->hour && alarmdata->al_minute == curr_time->min && curr_time->sec == 0){
        modedata->buzzing = true;
        raise(SIGUSR1);
    }
}
```

```
void *buzz(void *arg) {
    int curr_sec;
    int finish_sec=5;

    char button;
    if(mode_data->s_m_data!=1 && mode_data->s_m_data!=2){
    while (1) {
        if ((button = determine_pushed_button()) > 0) {
          mode_data->buzzing=false;
            return;
        } //if button is pressed, stop buzzing
       curr_sec=time_data->sec;
        if (curr_sec >= finish_sec) {
            mode_data->buzzing=false;
            return;
        }
        printf("Wa");

    }
    }
    mode_data->buzzing=false;
    return;
}
```

```
void buzzer(int signum) {
    if (signum == SIGUSR1) {
        pthread_t buzz_thread;
       pthread_create(&buzz_thread, NULL, buzz, NULL);


    }

}
```

Stopwatch Mode /Laptime

```
int stopwatch_mode(stopwatchdata_t* stopwatch_data, modedata_t*
modedata, timedata_t* timedata) {
    char button;
    pthread_t sttime_pid;


    while (1) {
        backlight_curr_sec = timedata->sec;
        if (backlight_curr_sec == backlight_finish_sec) {
            printf("\033[0m"); //reset
        }
        if(!(modedata->buzzing)&&((button = determine_pushed_button()
) > 0)) {

            if (button == 'C') {
                modedata->mode = 0;
                return 0;
            }  //change to timekeeping mode
            else if (button == 'D') {
                if (backlight_curr_sec == 58 || backlight_curr_sec == 59)
                    backlight_finish_sec = (backlight_curr_sec + 2 )- 60;
                else {
                    backlight_finish_sec = backlight_curr_sec + 2;
                }
                printf("\033[1;33m"); //yellow
            }
```

```
//stopwatch mode
            if (modedata->lap_time_state == 0) {
                if (button == 'B') {
                            modedata->stopwatch_state=(++mode
data->stopwatch_state)%2;
                } // start stopwatch
                else if (button == 'A') {
                    //stopwatch running
                    if (modedata->stopwatch_state == 1) {
                        modedata->lap_time_state = 1;
                        stopwatch_data->lap_centisecond = stopwa
tch_data->centisecond;
                        stopwatch_data->lap_second = stopwatch_
data->second;
                        stopwatch_data->lap_minute = stopwatch_
data->minute;
                    } //save lap time
                    //stopwatch not running
                    else {
                        stopwatch_data->centisecond = 0;
                        stopwatch_data->second = 0;
                        stopwatch_data->minute = 0;
                    } // reset stopwatch
                }
            }
```

Stopwatch Mode /Laptime

```
    //laptime mode
        else {
            if (button == 'B') {
                modedata->lap_time_state = 0;
            } //return to stopwatch mode
            else if (button == 'A') {
                stopwatch_data->lap_centisecond = stopwatch_data->centis
econd;
                stopwatch_data->lap_second = stopwatch_data->second;
                stopwatch_data->lap_minute = stopwatch_data->minute;
            } //save lap time
        }
    }
    if (modedata->lap_time_state == 0) { //stopwatch time display
        system("clear");
        printf("ST %02d:%02d\n%02d\'%02d\"%02d\n", timedata->hou
r, timedata->min,
                stopwatch_data->minute, stopwatch_data->second, stopwat
ch_data->centisecond);
        usleep(10000);
    }
    else { //lap time display
        system("clear");
        printf("ST %02d:%02d\n%02d\'%02d\"%02d\n", timedata->hou
r, timedata->min,
                stopwatch_data->lap_minute, stopwatch_data->lap_second,
stopwatch_data->lap_centisecond);
        usleep(10000);
```

BackLight

```
int backlight_curr_sec = 0;
int backlight_finish_sec = 0;

int time_keeping_mode(modedata_t *modedata, timedata_t *curr_ti
me) {
    char button;
    while (1) {
        backlight_curr_sec = curr_time->sec;
        if (backlight_curr_sec == backlight_finish_sec) {
            printf("\033[0m"); //reset
        }

        if (!(modedata->buzzing)&&((button = determine_pushed_button
()) > 0)) {
            if (button == 'A') { //change to time setting mode
                modedata->s_m_data = 1;
                time_setting_mode(modedata, curr_time);
            }
            else if (button == 'C') { //change to alarm mode
                modedata->mode = 1;
                return 0;
            }
            else if (button == 'D') {
                if (backlight_curr_sec == 58 || backlight_curr_sec == 59)
                    backlight_finish_sec = (backlight_curr_sec + 2 )- 60;
                else {
                    backlight_finish_sec = backlight_curr_sec + 2;
                }
                printf("\033[1;33m"); //yellow

            }
            else {
                continue;
            }
        }

        system("clear");
        printf("%s-%04d-%02d-%02d\n%02d:%02d %02d\n", curr_time-
>day[get_day(curr_time->year, curr_time->month, curr_time->date)],
curr_time->year, curr_time->month, curr_time->date,
                curr_time->hour, curr_time->min, curr_time->sec);
        usleep(100000);
    }
}
```

Main controller

```
void *main_controller(void *arg) {
    //circulate between modes: "timekeeping mode", "alarm mode", "stop
watch mode"
    while (1) {
        time_keeping_mode(mode_data, time_data);
        alarm_mode(mode_data, alarm_data, time_data);
        stopwatch_mode(stopwatch_data, mode_data, time_data);
    }

    return 0;
}
```

개발 도중 어려웠던 점

1. 시간 오차 발생

2. 쓰레드 간 동기화 문제

QnA