Roosterband

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Introduction

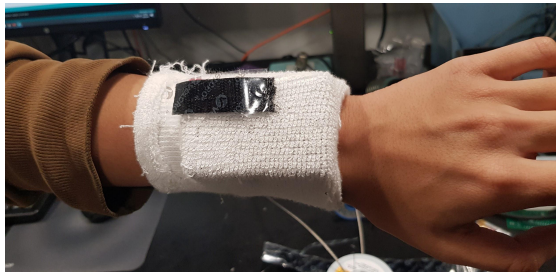
- A simple way to stay awake during classes
- Help people stay awake during work
- This could help prevent car accidents that are due to drowsy drivers and help truck drivers during long routes

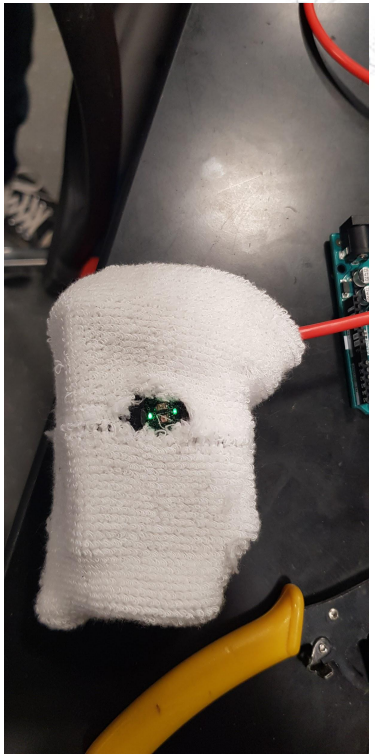
Objective

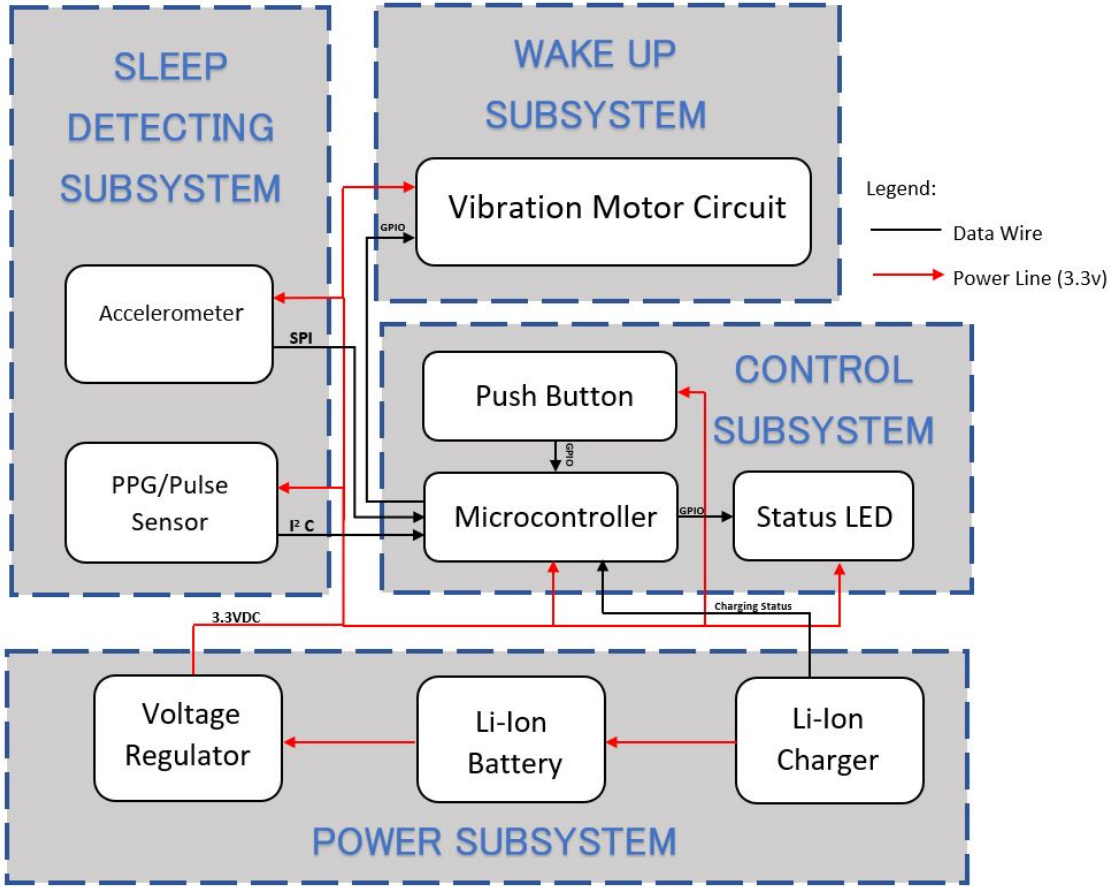
Help people who have had a poor quality of sleep get through their activities and stay awake during their work day.

Our Solution:

- Wearable Wristband
- Detects Sleep with Sensors
- Wakes user up with vibration
- Chargeable

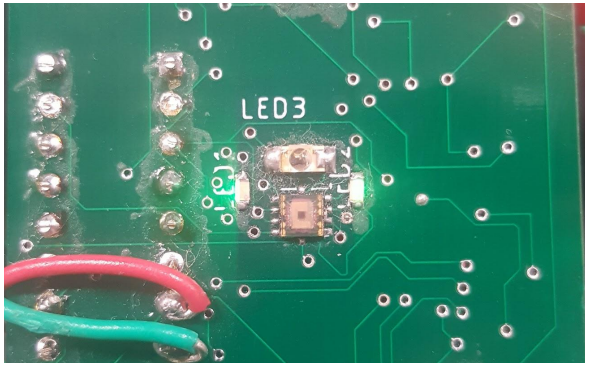


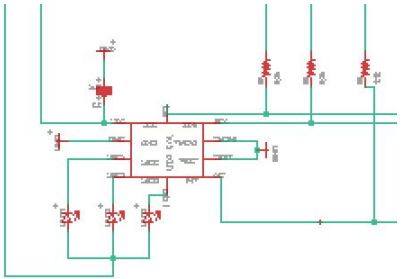


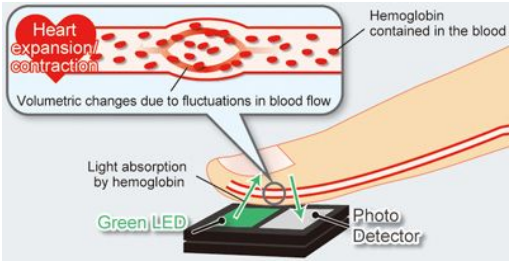

SLEEP DETECTING SUBSYSTEM
WAKE UP SUBSYSTEM
Vibration Motor Circuit
GPIO
Accelerometer
SPI
PPG/Pulse Sensor
I² C
CONTROL SUBSYSTEM
Push Button
GPIO
Microcontroller
GPIO
Status LED
Charging Status
3.3VDC
Voltage Regulator
Li-Ion Battery
Li-Ion Charger
POWER SUBSYSTEM
Legend:
Data Wire
Power Line (3.3v)

Design : Pulse Sensor

- Reads blood cell Count (Pulse Oximetry)
- 2.5-3.6V
- 2 Green LED (530nm)
- 1 IR LED (770nm)
- I2C







Design : Pulse Sensor : BPM Algorithm:

Sensor Data -> Pulse Wave: Moving Average + IIR Filter ->

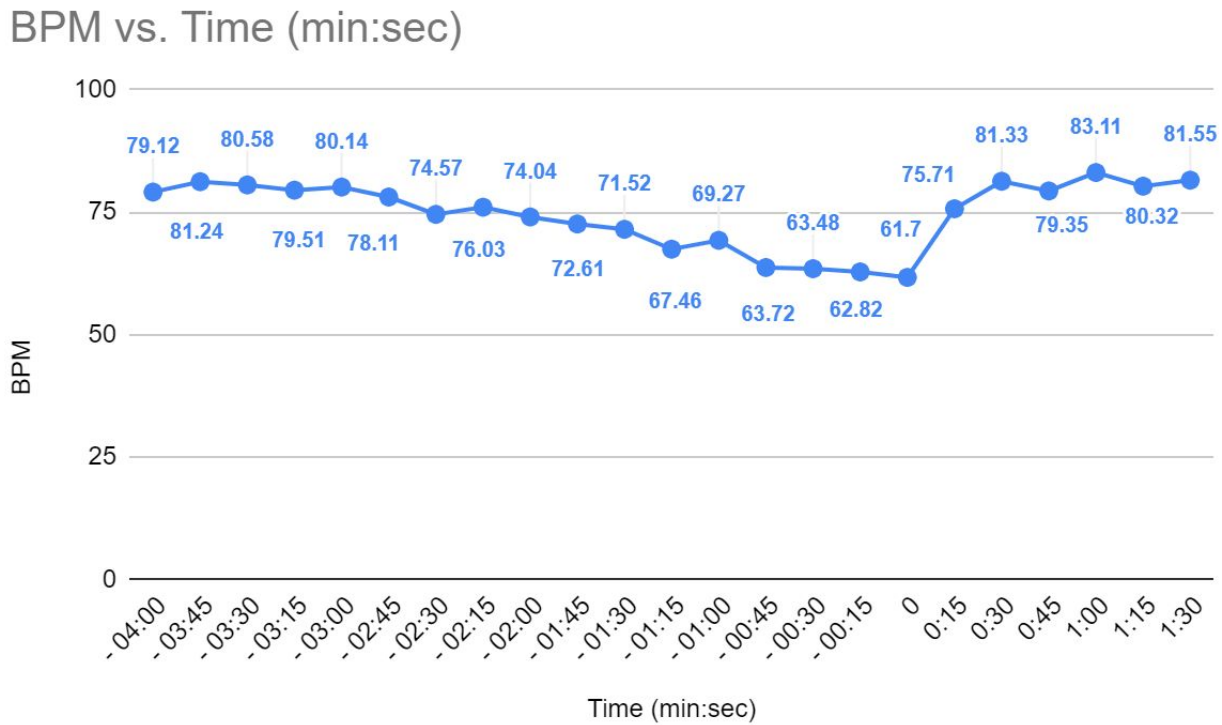
Hold:

```
//==============================
//  Type Definition
//==============================
typedef struct {
    uint8_t      bpm;
    int32_t      cnt;
    int32_t      cnt_diff2;
    int32_t      cnt_pkDet;
    float32_t    last1;
    float32_t    last2;
} hrParam;
```

BPM =

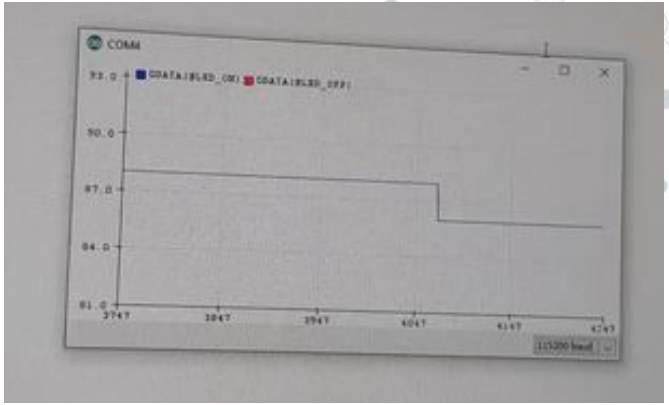
60/[Sampling Period*(PeakCount - CurrentCount)]

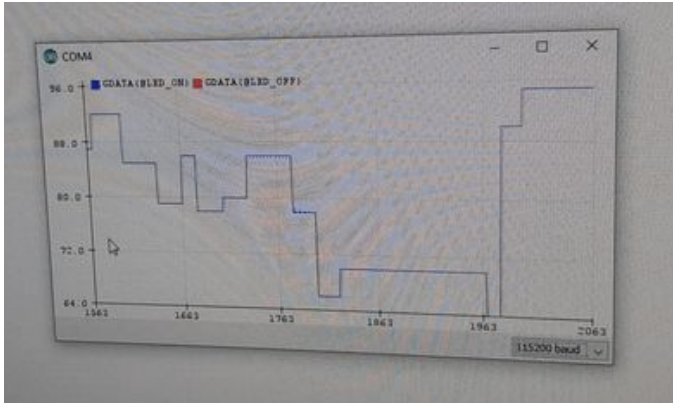
Design : Pulse Sensor : Sleep Data



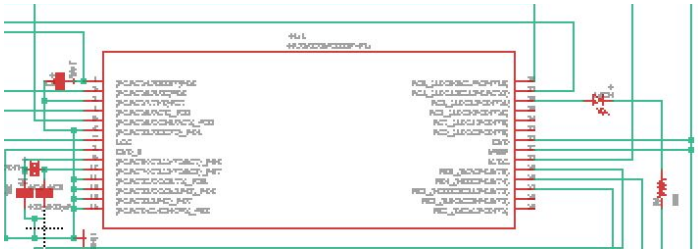
Pulse Sensor: R&V

Wake detection **1.** Detect within 2 min whether the user is in sleep or not **2.** System does not incorrectly declare state as "sleeping" when sensor readings get unstable	**1.** (a)Track user with video while in a boring sedentary activity while wearing wristband. (preferably the user is already tired) (b) check if algorithm correctly marks state as sleep when the video shows the user is sleeping **2.** (a) User wears the wristband (b) Try rapid rotational motion of the wrist for 1 min, rotational motion of the whole arm in both directions for 1 min. (c) Ensure the system does not incorrectly categorize state as sleep.





Design: Microprocessor: ATmega328p



Atmega168 Pin Mapping

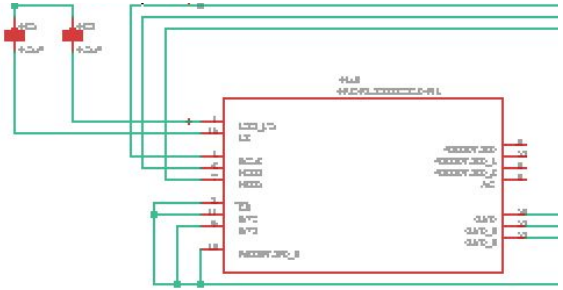
Arduino function				Arduino function
reset	(PCINT14/RESET) PC6	1	28 PC5 (ADC5/SCL/PCINT13)	analog input 5
digital pin 0 (RX)	(PCINT16/RXD) PD0	2	27 PC4 (ADC4/SDA/PCINT12)	analog input 4
digital pin 1 (TX)	(PCINT17/TXD) PD1	3	26 PC3 (ADC3/PCINT11)	analog input 3
digital pin 2	(PCINT18/INT0) PD2	4	25 PC2 (ADC2/PCINT10)	analog input 2
digital pin 3 (PWM)	(PCINT19/OC2B/INT1) PD3	5	24 PC1 (ADC1/PCINT9)	analog input 1
digital pin 4	(PCINT20/XCK/T0) PD4	6	23 PC0 (ADC0/PCINT8)	analog input 0
VCC	VCC	7	22 GND	GND
GND	GND	8	21 AREF	analog reference
crystal	(PCINT6/XTAL1/TOSC1) PB6	9	20 AVCC	VCC
crystal	(PCINT7/XTAL2/TOSC2) PB7	10	19 PB5 (SCK/PCINT5)	digital pin 13
digital pin 5 (PWM)	(PCINT21/OC0B/T1) PD5	11	18 PB4 (MISO/PCINT4)	digital pin 12
digital pin 6 (PWM)	(PCINT22/OC0A/AIN0) PD6	12	17 PB3 (MOSI/OC2A/PCINT3)	digital pin 11(PWM)
digital pin 7	(PCINT23/AIN1) PD7	13	16 PB2 (SS/OC1B/PCINT2)	digital pin 10 (PWM)
digital pin 8	(PCINT0/CLKO/ICP1) PB0	14	15 PB1 (OC1A/PCINT1)	digital pin 9 (PWM)

Digital Pins 11,12 & 13 are used by the ICSP header for MOSI, MISO, SCK connections (Atmega168 pins 17,18 & 19). Avoid low-impedance loads on these pins when using the ICSP header.

- 3.3V
- 1 I2C
- Multiple SPI
- Arduino

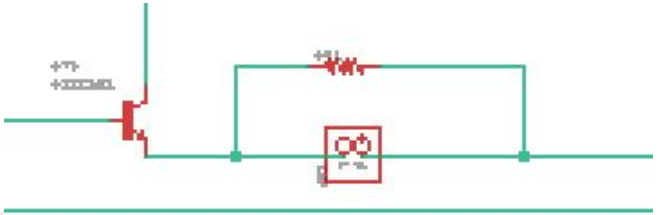
Design: Accelerometer

- Threshold in change of acceleration
- Being still for a long time = high chance of being asleep
- Temperature function redundant



Vibration motor

- Powered from battery
- Controlled via transistor
- 12000 RPM
- 100mA



Design: Power

Power Subsystem **1.** Run without charge in silent for 6 hrs. **2.** Run without charge with vibration motor on for 30 mins. **3.** Lithium battery recharges when 3.7V- 4.2V is constantly provided	**1.** (a) Calculate the power drain of circuit then construct a mock circuit with same power drain when the vibration motor is not active. (b) power the circuit with the battery and check if device still runs after 6 hrs. **2.** (a) Modify circuit to match power drain when vibration motor is running. (b) turn device on and check if device still runs after 30 mins. **3.** (a) Drain battery (b) Set up the recharging circuit

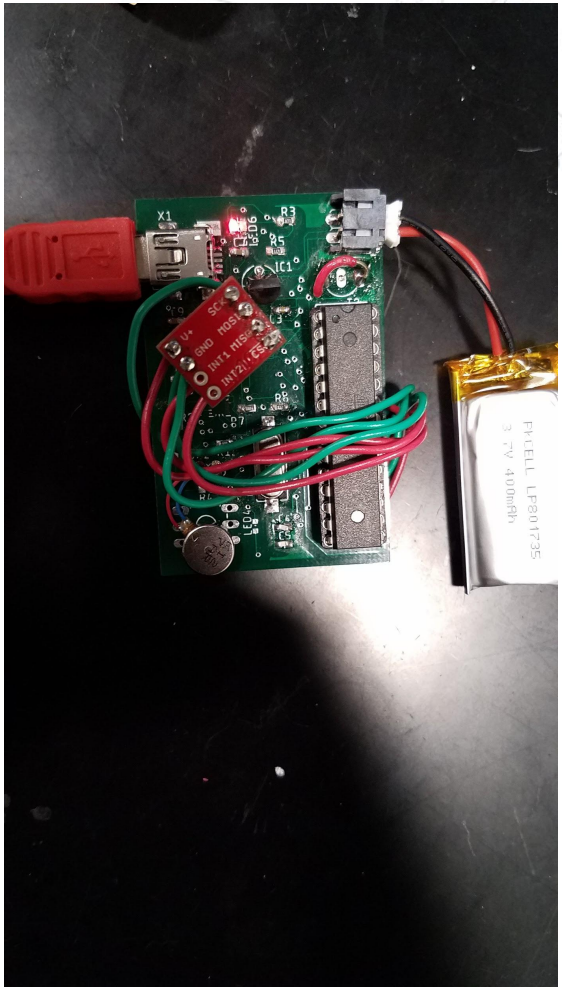
Design: Power

- 3.7v, 400mAh Battery
- Power consumption without motor: 0.0958W
  - 155mAh for 6 hours silent runtime
- Power consumption with motor: 0.39583W
  - 641mAh for 6 hours active runtime
  - 3v, 100mA Vibration motor

30 Minute battery Active runtime

Design: Power

- 3.3v Linear regulator
- Charging capability included
  - 100mA charging current



Challenges

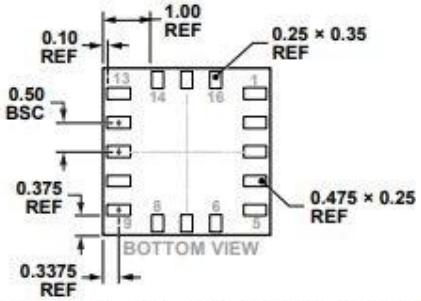
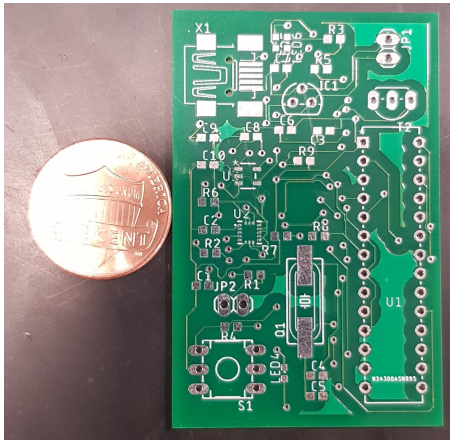


Figure 53. 16-Terminal Land Grid Array [LGA]
(CC-16-4)
Dimensions shown in millimeters

- Solder
- PCB parts integrity
- Eagle file mismatch on voltage regulator
- Ahead planning for sensor value communication

Wrist band **1.** Ensure sensor readings are accurate while moving **2.** Elastic for sizes 6” to 9”	**1.** (a)user puts on the wristband and fitbit (b)user runs at 3km/h for 3 minutes (c) ensure both readings match with error range of 10% **2.** Make sure the diameter of the band while flat can extend from 3” to 4.5”



Conclusions and Further Work

- Pulse Sensor can detect pulse, reacts properly to the bpm drop
- Accelerometer can detect movement, triggers vibration motor reliable
- Communication with the microcontroller tested and verified on PCB

- Fine-tune the pulse sensor program for sleep detection
- Adding more User Interface for debugging and ease of use
  - LED, button, LCD