DROWSINESS DETECTOR

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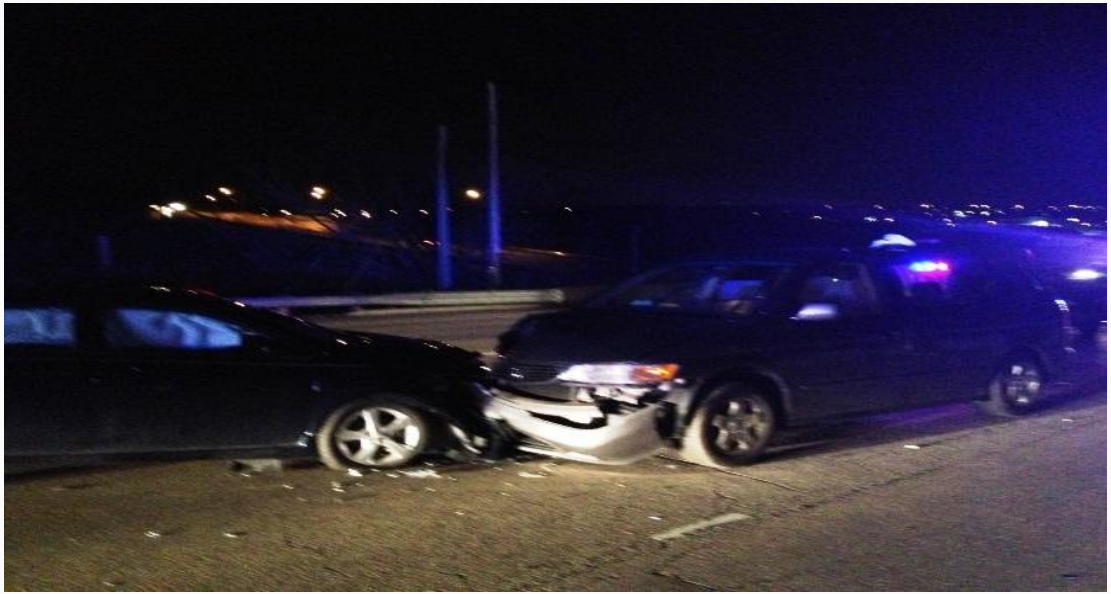
PROBLEM

Sleep deprivation affects driving as much as (and sometimes more than) alcohol.

It has been estimated that approximately 20% of vehicle accidents have sleep deprivation as a cause.



PROBLEM

According to the National Sleep Foundation's 2005 poll (in an year in America)-
- People who felt drowsy - **64%** - 168 million drivers
- People who actually fell asleep - **37%** - 103 million drivers
- People who had an accident or near accident - **4%** - 11 million drivers

Approximated Loss (from 100,000 police-reported crashes)

DEATH - **1550** INJURY **- 71,000** LOSS - **$12.5 Billion**

src : http://drowsydriving.org/about/facts-and-stats/

PROJECT IDEA

We will use following two sensors attached near driver's seat to sense if the driver is feeling drowsy.

- ❏ Pulse Rate Sensor
- ❏ Eye Blink Rate Sensor

- ➔ Connect the output of sensors to microcontroller.
- ➔ Alarm when sensors show value less than a threshold.

PROJECT IDEA

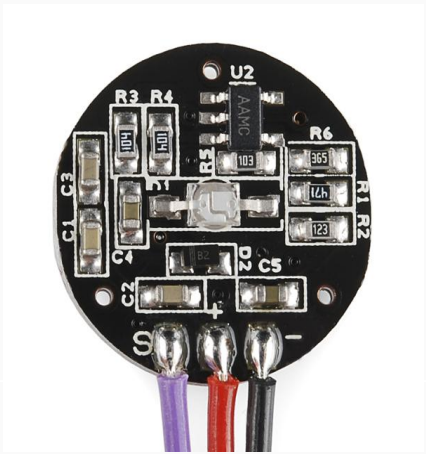
Factors which is considered to build this system are

1. **HEART RATE** - Normal heart rate while resting for average human is (60-80 bpm) for adults. It is known to fall during drowsiness to about (40-50 bpm).
2. **EYE BLINK DURATION** - Normal blink rate for human eye is 100-400ms . Closure to 1000 ms will be taken as drowsiness.

➔ Upon detection of drowsiness , the driver will be alarmed that it’s unsafe to drive. At extreme levels of drowsiness alert will be sent automatically to the emergency contacts

PULSE RATE SENSOR

- ➔ Pulse Rate of a subject is measured via PPG, a volumetric measurement of an organ. The change in volume caused by pressure pulse is detected which gives us the value of pulse rate.
- ➔ All this happens inside the sensor. We will use this sensor directly.



EYE BLINK SENSOR

- ➔ Reflector optical sensor with transistor output. Includes an IR emitter and phototransistor in a leaded package that blocks visible light.
- ➔ Your eyeball and eyelid will reflect IR light differently so blinking will trigger a quick reading change, which will detect eye-blinks.
- ➔ There are open-source signal filtering libraries and templated class for making statistics of data set.

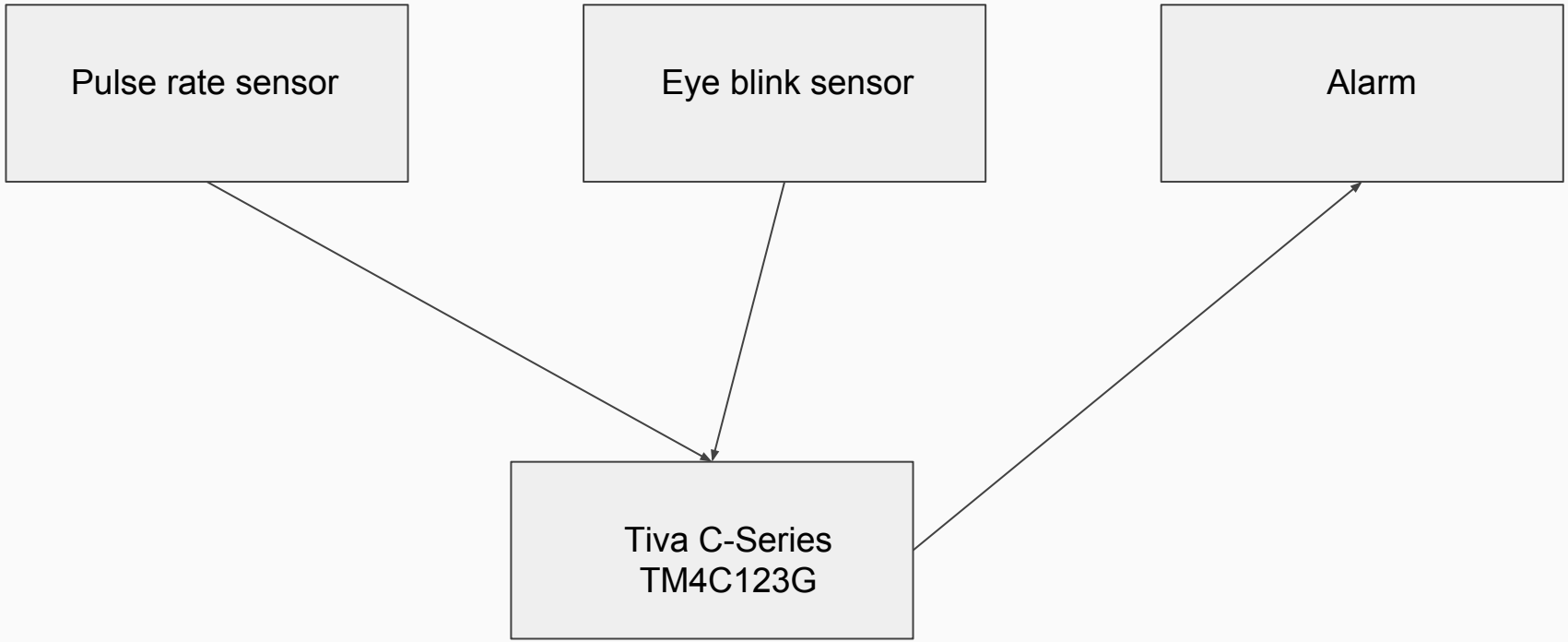
PROJECT PLAN (Execution)

- We bought both the sensors
  - IR sensor (TCRT5000)
  - Pulse rate sensor (M212 Heart Rate Pulse Sensor)
- Took the raw readings of both sensors after connecting them to the TIVA board.
- Read up what raw readings represent, and how to process those to get the final eye blink rate and pulse rate.
- Coded the algorithm we read, made some empirical changes to the parameters in algorithms and got the correct values of eye blink rate and pulse rate.
- Connected the buzzer to TIVA, and calculated a function value using eye blink rate and heart rate. On low values, raised an alarm.

PROJECT PLAN

- We four people, sat together whenever we used to work for this project and cannot really point out individual work. It used to be one person googling, one person coding, one person keeping his hand on the system, and one person managing other issues.
- During our first demo, we had our system connected and we could read the raw values from the sensor.
- By the final presentation, we completed the project. We processed the values from sensors to calculate exact eye blink rate and pulse rate. Also, alarm was buzzed if these values came out to be low.

Block Diagram



CHALLENGES that we expected

- **Positioning of sensors**
  Ensuring that it does not affect the personal customization of vehicle.

- **Writing an efficient code**
  For detecting eye blink, we need to do signal filtering and statistical analysis

- **Accuracy of the result**
  Since we are taking body measurement, it can give wrong result at times. We may need to apply some learning algorithm for this to adapt to a person.

CHALLENGES faced

➔ Understanding the raw values of sensor

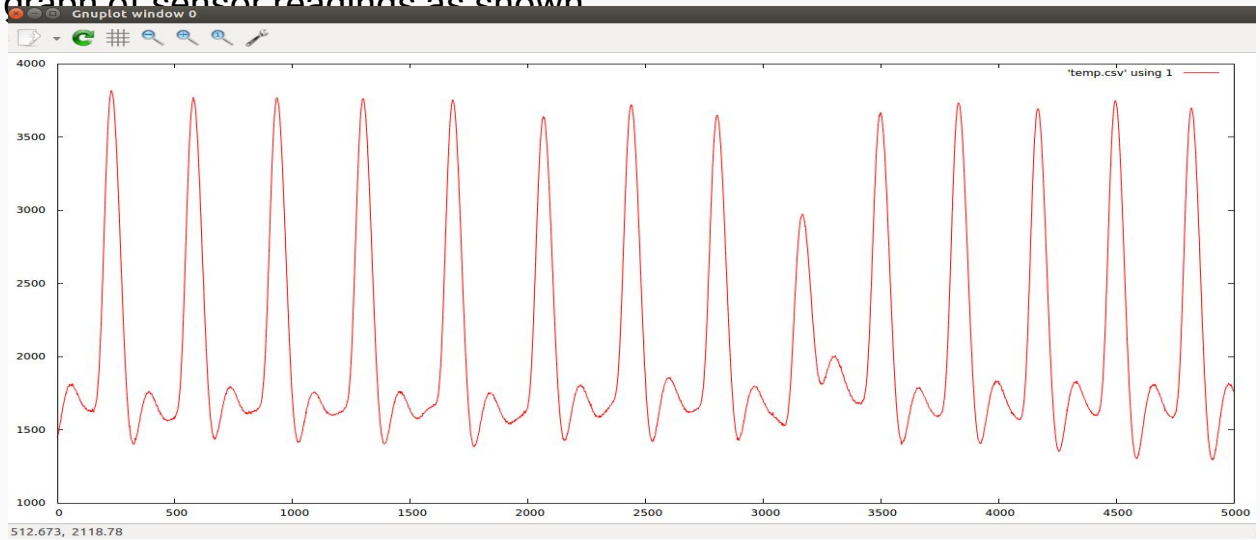
The raw readings of pulse rate sensor was something we couldn't comprehend. It showed values in the range 5-15 for few seconds and then it shot up to over 2000.

➔ Getting the correct raw values

To get the correct readings from pulse rate sensor, we had to make little set-up. A valcro tape over the sensor and the tightening belt of laptop charger used to have the tip of finger stable.

TASKS COMPLETED

- Calculated the Pulse rate
  - Problems faced: The graph of sensor readings should be as shown. But it was coming out to be very noisy.
  - Solution: First insulated the pulse rate sensor with hot glue. Then used a valcro tape on both sides of the sensor and tied the finger tip with the sensor to get stable readings. Then we got the graph of sensor readings as shown



TASKS COMPLETED

- Calculated the Eye blink rate
  - Problems faced: Positioning the sensor at same place for all the users so that we could use the hard-coded thresholds was a problem.
  - Solution: Added **Calibration** process at the beginning of use to get the thresholds
    - Close the eyes and then press switch 1
    - After 2 seconds, open the eye and release switch 1
- Calculated a function value based on eye blink rate and heart rate.
  - Problems faced: There can be cases when one out of two sensors doesn't work or gives opposite values
  - Solution: Created a function with 0.3 weight to pulse rate and 0.7 weight to eye blink duration. Then on the basis of that fire the alarm.

TEST CASES

All the following tests were performed after connecting pulse rate sensor with the fingertip and attaching eye blink sensor to the spectacles.

- Test 1 : Eyes blinking slowly, pretending to be asleep
  - Eye blink rate falls down, and if pulse rate is normal alarm is raised
- Test 2 : Eyes blinking rapidly after alarm is sounded
  - Alarm stops buzzing
- Test 3 : Doing exercise and then measuring pulse rate
  - Pulse rate goes up, now if pretends to be asleep, no alarm is raised
- Test 4 : Slow breathing and measuring pulse rate
  - Pulse rate goes down by maximum 5 to 6 pulses per minute

Performance metrics

- Pulse rate displayed was the pulse rate averaged over past few milliseconds, hence it was without any delay.
- Eye blink rate displayed was with a delay of 1 or 2 seconds sometime. We checked this by closing the eyes suddenly, and alarm was sounded after 1 or 2 seconds rather than instantaneously.

RE-USABILITY FEATURES

- Configurable values are kept as global variables. These can be directly changed.
- Functions are generously used in the code. calcBPM, calcEyeBlink, setup functions keeps the code modular and in different parts.
- Comments are written for each variable and function about their usability

FUTURE ENHANCEMENTS

- Making a complete car safety system
  - Sense the level of Vibration
    - Detect whether the car is driving smoothly
  - Parking sensor
    - While driving in reverse gear, sense the proximity of any obstacle
- Reduce the size of the eye blink rate sensor such that it can be easily put on the spectacle and can also be worn by driver

Stay Awake Stay Alive

THANKS