



SNS COLLEGE OF TECHNOLOGY

(AN AUTONOMOUS INSTITUTION)

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Department of Biomedical Engineering

Course Name: 19BM0302 & WEARABLE TECHNOLOGIES

Topic : Cardiac Activity

Semester :6

19BM0302/Wearable Technology /Cardiac Activity/Mr.S.Prince Samuel /AP/BME



NEED FOR WEARABLE TECHNOLOGY



Existing approaches with a Smartphone:

Adding specialized sensors

-- *Not accessible to a wide range of users*

Using built-in sensors:

Ordinary camera as a PPG sensor

IMU with phone on the chest or the navel

-- *Require active user participation*

Vision Tit 2

Sensing
Vision Tit 3

+

Processing power

Always with us



HEART RATE MONITORING



Heart Rate Monitoring without active user participation

HandRate revisits Ballistocardiography (BCG)

- *Measurement of the body movement during cardiac cycle*
- *Caused by recoil forces (especially during the systole)*

Vision Tilt 2

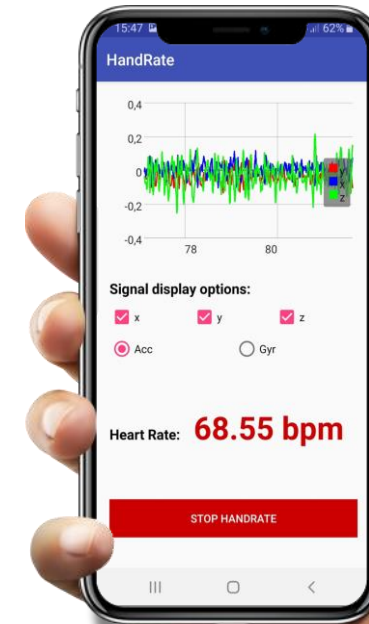
Slide 3

Two important questions :

Is it possible to acquire BCG in hand with a commodity mobile phone ?

Far away from the heart and subject to motion artifacts

If yes, which system to extract Heart Rate from it ?





Hand-BCG: is it possible?



The theoretical answer

- Smartphones' accelerometers are able to sense very weak motions
 - Typical sensitivity value: $2 \times 10^{-3} \text{ m.s}^{-2}$ Vision Tit 2
- Peaks' average in our dataset: **$9 \times 10^{-2} \text{ m.s}^{-2}$** Vision Title 3
 - *barely an order of magnitude greater than the accelerometers' noise level ($\sim 2 \times 10^{-2} \text{ m.s}^{-2}$)*



DOMAIN ANALYSIS

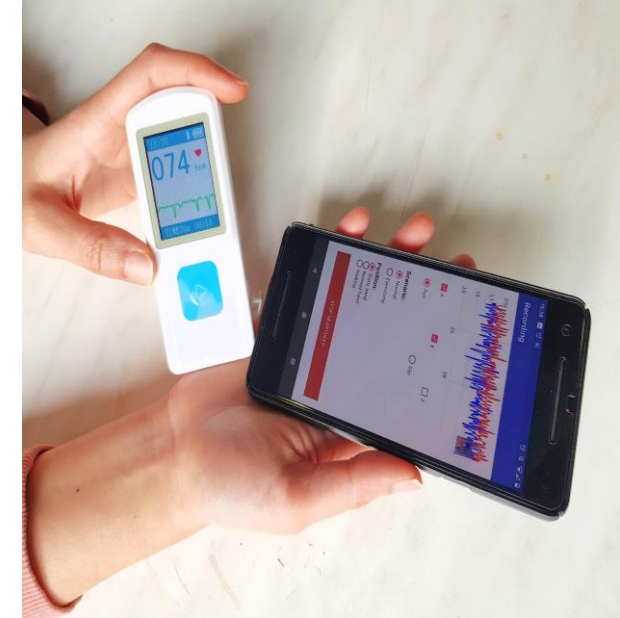
Experimental study

- Collection of multiple signals: 30s per session
- Hand vs Navel (reference)
- **Frequency** Computation of signal quality : Q_{kurt} [1]

Vision Tit 2

BCG signal can be sensed from hand using a smartphone' accelerometer

But this signal can be of poor quality, making Heart Rate computation challenging





BLOCK DIAGRAM OF PROCESSING

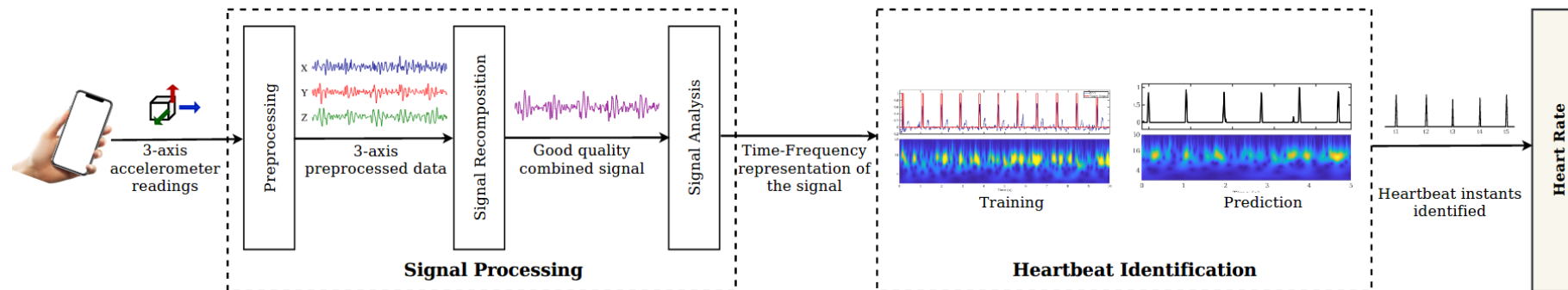


Heart Rate Monitoring system with phone in hand

Just takes as input the accelerometer readings to compute the Heart Rate

Vision Tit 2

Vision Title 3





PREPROCESSING

Filtering out too weak or too strong signals

--> in the range [-1, 1]

Vision Tit 2

Vision Title 3



--> $F_s = 100\text{Hz}$

Reduce noise

ANALYSIS



Heart rate monitoring system with a phone in hand

Feasibility study

Design of a system to perform this task

Performance evaluation - *Error comparable to other techniques and performs well under different experimental conditions*

Future work

More diverse data collection and evaluation (large period of time in daily life, phone models, non-healthy subjects)





USES OF WEARABLE TECHNOLOGY



Vision Tit 2

Vision Title 3

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A top-down photograph of a white card with the words "Thank you" written in purple cursive. The card is placed on a light-colored marble surface. To the left of the card is a bouquet of small purple flowers with green leaves. To the right of the card is a black pen with a white polka-dot grip. Further to the right is a small gift wrapped in white paper with a grey polka-dot pattern, tied with a red and white striped string. A spool of the same string is visible in the top right corner.

Thank
you