

## **Paper Review in the field – State of the art**

### **Iphys: Open source toolbox- Matlab**

- Introduction
- Impact of video Parameters:
  - video compression (x.264, x265) has the majority impact. Frame rate and resolution has lower impact – Solution Super resolution
  - Multi Image performance is better
  - Distance depends on the camera sensor type
  - Light wavelength – Green most effective
- Covered methods: Using ROI
  - Green Channel: Filter based approach for green channel
  - ICA: DeTrended, z-transform, Normalized, ICA, FFT
  - CHROM: Combination of chrominance, Spacial average
  - POS: Plane orthogonal to the skin tone
  - BCG: Filter, PCAvi

### **Fusing Partial Camera Signals Pulse rate**

- Face Detection and Segmentation
- Camera Signal Processing!!
- Signal Separation
- Filter
- Auto Regressive

### **Deep Super resolution to recover Physiological information from videos**

- Preprocess video frame by super resolution techniques
  - Bilinear & Bicubic
  - Deep recurrent convolutional network (this paper applied)
- Extract HR from the frames
- Dataset: Recovering pulse rate with a multi-imager array Estepp et. al. 2014

### **DeepPhys: Convolutional Attention Networks (CAN)**

- Outperforms all methods in RGB and infrared video dataset
- Visualization via attention mechanism
- DRM: Model for skin and image
  - $C_t = I(t) \cdot (v_s(t) + v_d(t) + v_n(t))$
  - Non linearity between  $p(t)$  and  $C_t$
- Approach
  - Model Representation input:  $\frac{c_l(t+\Delta t) - c_l(t)}{c_l(t+\Delta t) + c_l(t)}$
  - CNN
- Datasets:
  - Estepp et al. Recovering PR during motion Artifact with multi imager array for non-contact IPPG, 2014
  - Chen et al. Eliminate info from video
  - MAHNOB-HCI <https://mahnob-db.eu/hci-tagging/pages/supplementary/> (Request)
  - Chen et al. Non contact physio. From neck NIR video

### **Spectral Estimation Methods for iPPG**

- Dataset: Estepp et. Al 2014

### **InPhysible: Camouflage against VB Physiological Measurement**

- Proposed a glass based system to disrupt the Heart rate measurement.

### **Cardiolens: Physiological monitoring in mixed environment**

- System to measure PPG using glass

### **DeepMag: Source specific Motion Magnification using GD**

### **Supervised Learning approach to remote HR estimation from Facial Videos**

- Datasets: Own data collection (Rana et al.)
- Method
  - Feature extraction
  - Signal sync: Red and green channel
  - Feature Representation
  - SVM

### **SparsePPG: Drivers monitoring using NIR**

- Dataset: RGB and NIR (collected own)
- Method
  - Signal Modeling - Sparse PPG
  - RPCA denoise
  - Spectral estimation
  - Fusion of time window
  - Facial tracking

### **HR extraction based on NIR: Driver state monitoring**

- Dataset: Own collected
- Method
  - Face tracking KLT
  - EMD and FFT
- Multiple people option

### **Infrared based video HR**

- Dataset: Own collected
- Method:
  - Feature Extration KTL
  - Channel separation, normalization, Detrending
  - EMD, FFT

### **NonContact Monitoring of RR in Newborn using IR**

- Dataset: 12 subject and study of infant
- Method
  - ROI channel
  - Filtering
  - SQI
  - Information Fusion

### **Waveform analysis for camera based PPG**

- Own dataset collection
- processing
- Information about the PPG data

### **Monitoring cardiorespiratory signals using Thermal imaging: Pilot study**

- Data: Frontal view and side view, own collected dataset, 20 subjects
- Vertical head movement to measure RR
  - Cold air from nose in and hot air out.
- HR estimation
  - Image preprocess, region selection, Shi-Tomasi corner detection, Temporal filter, PCA

### **Local Group invariance for HR estimation from Face video in wild**

- **Public data** available: (<https://github.com/partofthestars/LGI-PPGI-DB>) Heusch et. al. And Bobbia et. al.
- Feature invariance under motion
- Mathematical modeling
- Methodology

### **Non-Contact Remote measurement of the HRV using NIR**

- Multiple camera sensors

### **Diffusion Process for HR estimation from face videos under realistic Conditions**

- Problem formulation
- Feature representation under varying pixel intensity

### **Estimation of RR from thermal videos of preterm infants**

- Methodology
  - Region tracking
  - Signal Processing
    - Mean temporal value
    - Adaptive window autocorrelation
    - Adaptive window avg magnitude diff func
    - Adaptive maximum amplitudes pairs

### **Multisensor data fusion for enhanced RR estimation in thermal videos**

- Methodology
  - ROI detection
  - Tracking
  - Breathing waveform
  - SQI
  - Signal fusion

### **A ppg Smartphone based Method for HRV assessment: Device model and breathing influences**

- SPPG: 23 persons : No more description

### **Non-Contact IR camera based respiratory rhythm measurement while driving**

- Infrared frame
- Depth point-cloud
- normalization
- opportunistic piece selection

### **Comparison of video based methods for respiratory rhythm measurement**

- 21 subjects
- RGB videos
- Depth point cloud
- thermal video
- Signal processing

### **VitaMon: Measuring HRV using smartphone front camera**

- Dataset: 30 participants
- Low resolution
  - Multiple ppg reading from different face portion to overcome low resolution
- Methodology
  - CNN to learn correlation between ECG and reconstruct
  - Multiple facial region
  - Two-phase ML

### **Single-Element Remote-PPG**

- SoftSig (soft signature based extraction)

- Methodology
  - Projection
  - Selection Step
  - Dataset: own dataset

#### **Analysis of CNN-based remote-PPG to understand limitation and sensitivities.**

- HNU and PURE pulse rate detection dataset.
- PPG extraction
  - Input preprocessing normalization difference
  - CNN network
  - Post processing

#### **Attacks on Heartbeat-Based security using Remote photoplethysmography**

- Heartbeat based security

#### **Illumination Robust HR extraction from single-wavelength IR camera using spatial channel expansion.**

- Dataset: Own collected
- Methodology
  - Sub-window
  - Decomposition
  - Component selection

#### **IR thermography-based monitoring of respiratory phase without image segmentation.**

- Pixel time series to avoid nose tracking

#### **Discriminative signature for remote-PPG**

- PPG strength lower in NIR spectrum
- Discriminative signature based extraction (DIS) in NIR

#### **NN based luminance variation resistant remote PPG for driver HR monitoring**

- Facial motion and luminance concerns
- Personalized ANN
- HCI driver dataset

#### **Remote PPG enhancement with ML methods**

- Convolutional auto encoder and Multi-channel CAE
- PCA-SS

#### **Motion resistant IPPG based on Spectral peak tracking algorithm**

- MRSPT
- Multi-channel spectral matrix decomposition
- Dominant Motion Signal
- Kalman filter and verification

#### **Remote PPG with constrained ICA using periodicity and Chrominance Constraints**

- cICA<sub>t</sub>
- Dataset:
  - UBFC-RPPG (This Paper) <https://sites.google.com/view/ybenezeth/ubfcrppg>
  - MMSE-HR (Public database) [http://www.cs.binghamton.edu/~lijun/Research/3DFE/3DFE\\_Analysis.html](http://www.cs.binghamton.edu/~lijun/Research/3DFE/3DFE_Analysis.html)

#### **VIPL-HR: A multi-modal database for pulse estimation from less-constrained face video**

- Database: <http://vipl.ict.ac.cn/database.php>
  - MAHNOB
  - MMSE-HR
  - PURE (<https://www.tu-ilmenau.de/en/neurob/data-sets-code/pulse/>) - request
  - PFF
  - OBF

## **Self-adaptive matrix completion for HR Estimation from face videos under realistic conditions**

- Dynamically select face regions
- Chrominance Features
  - $C = X_f - \alpha Y_f$
  - $\alpha = SD(X_f)/SD(Y_f)$
  - $X_f$  and  $Y_f$  are filtered signal of  $X$  and  $Y$
  - $X = 3R_n - 2G_n$ ,  $Y = 1.5R_n + G_n - 1.5B_n$ ; (normalized version of  $R, G, B$ )
- Self-adaptive Matrix Completion

## **New insights into the origin of rPPG signals in visible light and infrared**

- mathematical modeling

## **Noldus information technology Research**

- Skin Reflection model – Wang et al. Algo. Principle of remote PPG
- Facereader

## **Remote Detection of PPG systolic and diastolic Peaks using a Digital camera**

- Face ROI
- Color channel
- ICA
- Source signal separated and rescaled

## **HR estimation using remote PPG with multi-objective optimization**

- Semi blind source extraction method – Optimizing method
- Face ROI and Spatial avg
- Pulse and feature extraction
- MAICA (Multi-objective Opt. With Autocorrelation as a periodicity measurement and ICA)

## **Exploring the usage of time-of-flight cameras for contact and remote PPG**

- ToF camera type – Pico Flexx ToF
- Own Data!!

## **RPPG using nonlinear mode decomposition**

- PURE dataset
- NonLinear Mode Decomposition

## **Non-Contact PPG and Instantaneous HR estimation from infrared face video**

- Principle signal extraction method
- Code: [https://github.com/natalialmg/IR\\_iHR](https://github.com/natalialmg/IR_iHR)

## **3D CNN for remote pulse HR measurement and mapping from facial video**

- COHFACE Dataset: <https://www.idiap.ch/dataset/cohface/download-proc>
- 3D CNN

## **Might check later**

- <https://www.jimmynewland.com/wp/>

## **A novel framework for rPPG pulse extraction on compressed videos**

- Benchmark dataset – own!
- Video compression artifacts
  - Amplitude deterioration
  - High-freq. Noise
  - trace discontinuity
- Methodology
  - Singular spectrum analysis (SSA)
  - Reconstruction component (RC)

## **A comparative Survey of Methods for remote HR detection from frontal face videos**

- MAHNOB-HCI dataset
- Survey paper

### **Algorithmic principles of remote PPG**

- Own dataset of 60 people
- Comparison between existing methods

### **Amplitude selective filtering for remote PPG**

- Own dataset
- R channel AS and band pass filter

### **Remote HR measurement from highly compressed facial videos: An End-to-end Deep learning solution with video enhancement. (<https://arxiv.org/pdf/1907.11921v1.pdf>)**

- Two stage – Enhancement and Attenuation network
- STVEN and rPPGNet

### **RhythmNet: End-to-end HR estimation from face via spatio-temporal representation**

- VIPL-HR databases.

### **Non-contact heart rate monitoring by combining convolutional neural network skin detection and remote photoplethysmography via a low-cost camera**

- CNN to get skin (ROI),
- then rppg methods (ICA or PCA)

### **Vision-Based Heart Rate Estimation Via A Two-Stream CNN**

- COHFACE databaset

### **Real-time rPPG monitoring**

### **A Real-Time Contactless Pulse Rate and Motion Status Monitoring System Based on Complexion Tracking**

- NIR camera on FPGA
- Transfer to mobile for processing
- BPM detection.
- Motion/skin detection

### **Remote heart rate monitoring - Assessment of the Facereader rPPg by Noldus**

- Facereader app
- BPM only

### **Optimizing Remote Photoplethysmography Using Adaptive Skin Segmentation for Real-Time Heart Rate Monitoring**

- Proper ROI selection

### **Remote heart rate measurement using low-cost RGB face video: a technical literature review**

- A review itself.

### **HeartTrack: Convolutional neural network for remote video-based heart rate monitoring**

- Synthetic dataset
- CNN based 3D architecture

### **Github Links: Dataset, Database, Code**

- Dataset: <https://github.com/partofthestars/LGI-PPGI-DB>
- Code: <https://github.com/pi-null-mezon/vpglib>
- <https://github.com/partofthestars/PPGI-Toolbox>
- <https://github.com/ymonno/RemotePPG>
- <https://github.com/habom2310/Heart-rate-measurement-using-camera>
- <https://github.com/danmcduff/iphys-toolbox>
- <https://github.com/vladostan/Dataset-for-video-based-pulse-detection>
- Dataset: [ftp://ftp.merl.com/pub/tmarks/MR\\_NIRP\\_dataset/](ftp://ftp.merl.com/pub/tmarks/MR_NIRP_dataset/)

## **IR Fever Detection:**

[http://www.infrared.avio.co.jp/en/products/ir-thermo/lineup/tvs200is\\_tvs500is/index.html](http://www.infrared.avio.co.jp/en/products/ir-thermo/lineup/tvs200is_tvs500is/index.html)  
[https://www.photonics.com/Articles/Demand\\_for\\_FLIR\\_Temperature\\_Screening\\_Devices/a65632](https://www.photonics.com/Articles/Demand_for_FLIR_Temperature_Screening_Devices/a65632)  
<https://satir.com/application/thermal-imaging-and-fever-detection>  
<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0203302>  
<https://iopscience.iop.org/book/978-0-7503-1143-4/chapter/bk978-0-7503-1143-4ch5>  
 \*<http://www.thermoteknix.com/products/oem-thermal-imaging/fevir-scan-fever-screening-system/>  
<https://www.optotherm.com/ts-advantages.htm>  
<https://www.hikvision.com/en/products/Thermal-Products/Thermography-thermal-cameras/fever-screening-series/>  
<https://athena-security.com/>