The Andrew and Erna Viterbi Faculty of ELECTRICAL & COMPUTER ENGINEERING

SIPL
Signal and Image Processing Lab

TECHNION Israel Institute of Technology

Blood Pressure Estimation Using a Smartphone Camera

Students: Dan Ben David & Topaz Aharon
Supervisor: Yair Moshe

Blood Pressure

- The pressure exerted upon the walls of blood vessels
- Expressed using systolic / diastolic pressure
- High blood pressure – “the silent killer”
- Low blood pressure has also its negative effects
- Continuous monitoring of blood pressure is important in many medical conditions

Goal

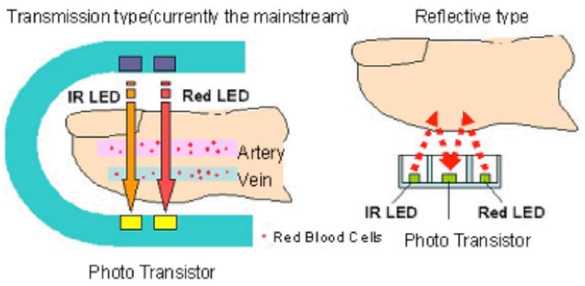
- Estimate blood pressure using a smartphone camera

Challenges

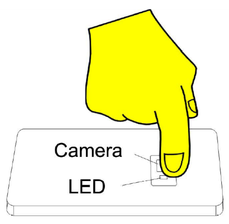
- Very noisy signals
- Lack of tagged data
- Should meet measurement accuracy standards

PPG Signal

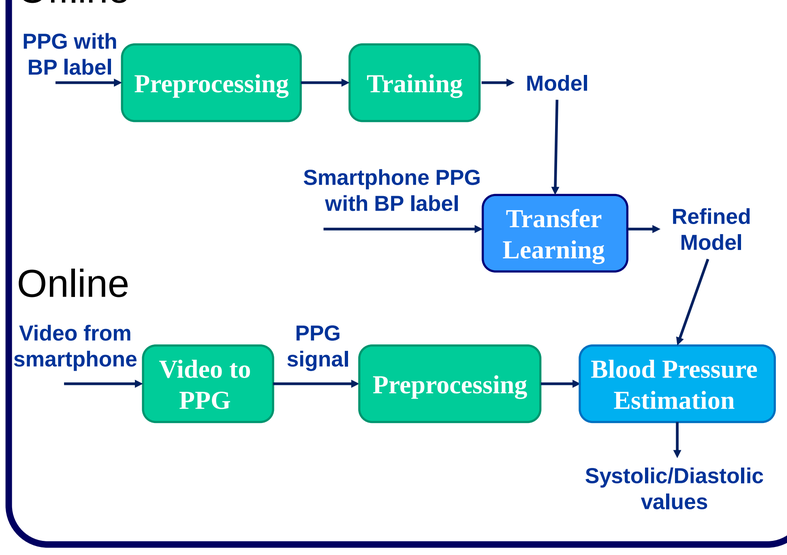
- Obtained by illuminating the skin and measuring absorption
- Oximeter – infrared light and red light, transmission



- Smartphone – white light, reflective

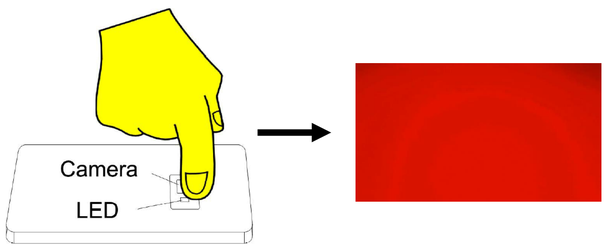


System Scheme

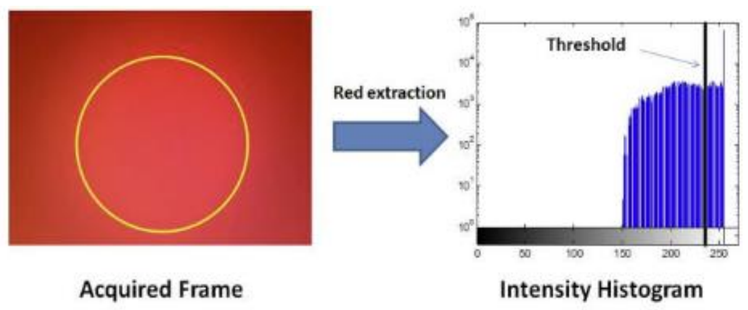


PPG from Smartphone

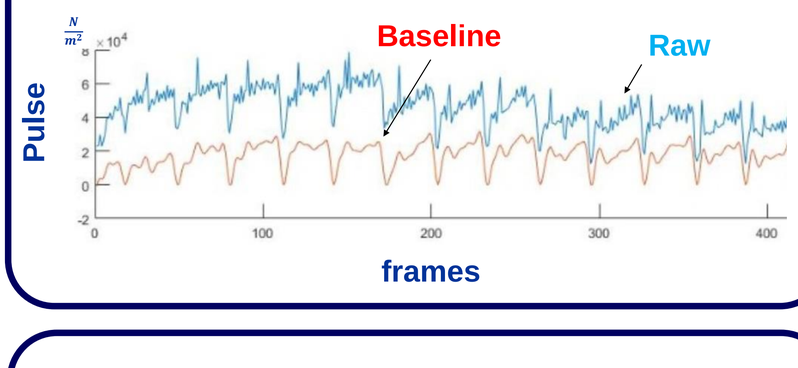
- Mimic an oximeter using the camera and the flash light of the smartphone



1. Extract relevant frequencies from the acquired video
2. Find threshold value for the red channel
3. Remove noisy frames
4. Create a PPG signal

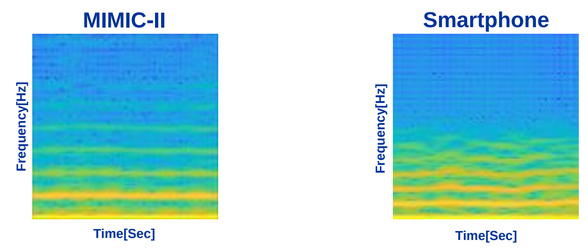


- **For every frame:** $R[i]$
- **If:** $(0.25N\_i<R[i]<N\_i)$
  $PPG[i] = (Max\ (R)-R[i])\ /\ (Max(R)-Min(R))$
- **Else**
  remove frame
- **Remove baseline**

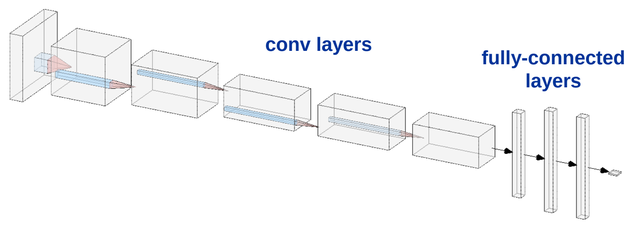


Transfer Learning

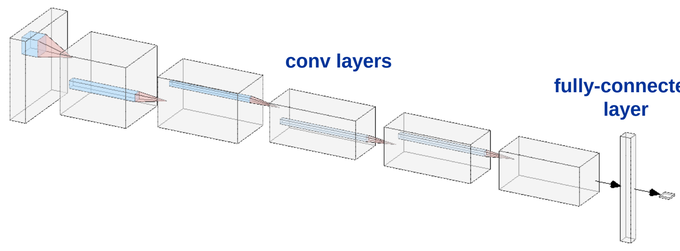
- MIMIC-II is a database with physiologic signals from tens of thousands of Intensive Care Unit (ICU) patients
- For over 1500 patients, the database contains PPG signals with corresponding BP values



- Previous project created a BP estimation network using MIMIC-II
  - Inspired by AlexNet architecture
- We used transfer learning on this network to train the model on our dataset



- Due to our small dataset, we also tried to perform transfer learning with only one fully-connected laver



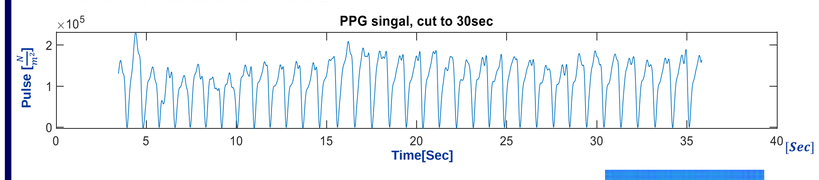
- 60% training 20% validation, 20% test

Data Collection

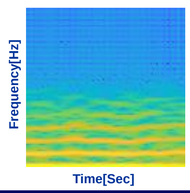
- Parallel sampling using a blood pressure monitor and a smartphone camera
- Each sample is approximately 40sec
- 15 different people, 200 samples in total

Preprocessing

- Convert video to PPG
- Upsample from 30Hz to 125Hz
- Cut middle 30 sec



- Transform to a spectrogram



Results

- Accuracy was measured as a success if the loss between the prediction and the true BP was less then 5 mmHg
- Comparison to naive algorithm (average BP as an estimator)

Transfer learning	Naive
accuracy: 45.0	accuracy: 0.0
loss: 9.66	loss: 18.84

- We have achieved better results than the naive way
- To meet medical standards, we should obtain
  - Accuracy over 95%
  - Loss < 5 mmHg
- We believe that acquiring a larger labeled database from smartphones will significantly improve results