RespiTrack

version 1.0

Respiratory patterns tracking and analysis

TOC

Overview

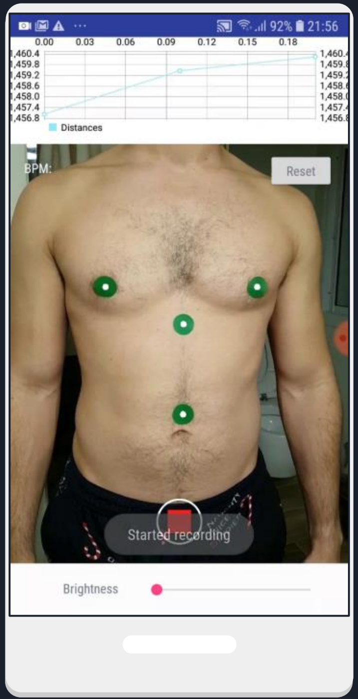
A person’s breathing pattern abnormalities are serving a major role in detecting many human diseases like asthma, acute respiratory failure, heart failure and more.

The detection of such abnormalities is primarily done by human diagnostic.

As part of a research being done in GIP lab, Technion, we aim to automate the detection and analysis process using tools of image processing.

The project is implemented as an Android app.

Demo



92% 21:56
0.00 0.03 0.06 0.09 0.12 0.15 0.18
Distances
BPM:
Reset
Started recording
Brightness

Understanding the problems

01 **Invasiveness -** the examination of a patient's breathing is done by a medical staff member and requires the patient to physically be present during the entire process.

02 **Human Error** - since the examination is done by humans it is prone to human error. It can either be misread of data or a bad decision by the medical staff.

03 **Time consuming** - The amount of patients to be examined in the current process is slow due to physical limitations and therefore collecting large data from patients is limited.

Project objective

RespiTrack objective is to provide automated recording of breathing patterns and presenting the breathing rate and patterns in an easy to use method for comparing with abnormal patterns which are typical to some diseases.

We aim to solve the problems described:

- No physical attendance required - simple use of an Android App.
- Reduce human error with advanced algorithms and method.
- No time wasted - send results any time.

Application flow

User Configuration

Customize stickers amount and color

Recognition

Filtering noises to detect stickers

Tracking

Recording samples taken from stickers positions through time

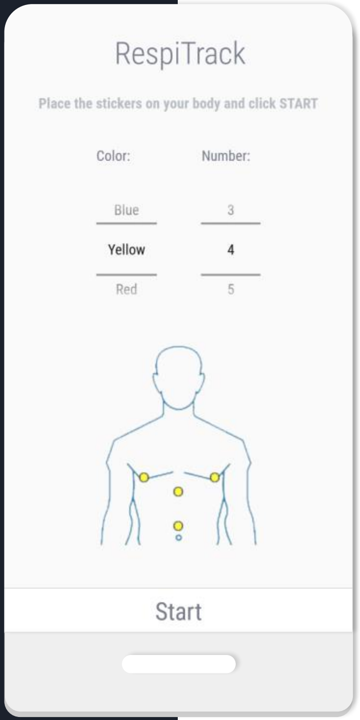
Results

Generate results graph

BPM

Calculate breaths per minute (BPM) and save results

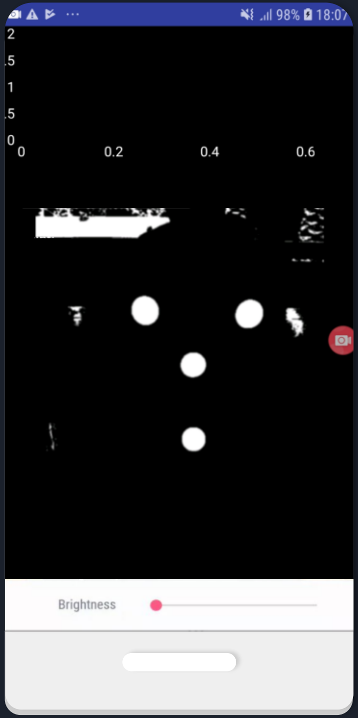
User Configuration



To track movement of the chest during breathing we use same color stickers placed on points of interest on the body.

The homepage screen allows the user to choose the color of stickers as well as the number of stickers to perform the examination.

Recognition



We use OpenCV methods to extract the stickers' color specific range from an image taken by the phone's camera.

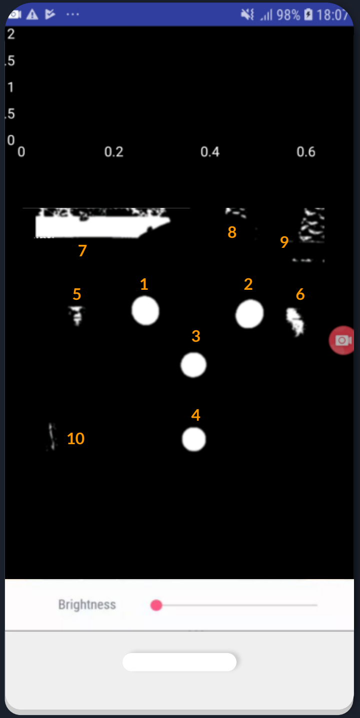
We then use the connected components algorithm to label the connected areas which suppose to represent the stickers.

Finally, we filter out noise with our own algorithm that considers area size and shape to determine a sticker.

User Configuration
Recognition
Tracking
Results
BPM

Recognition

CCL Labeling



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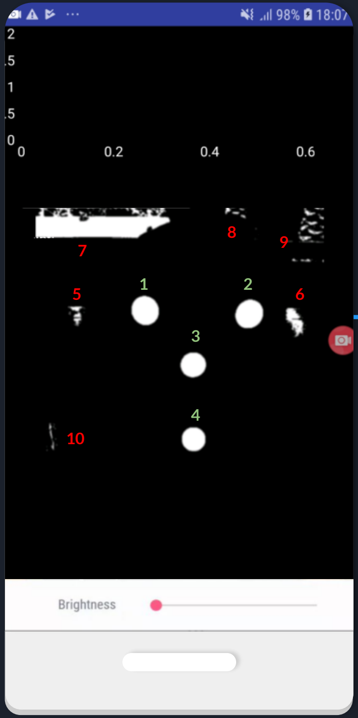
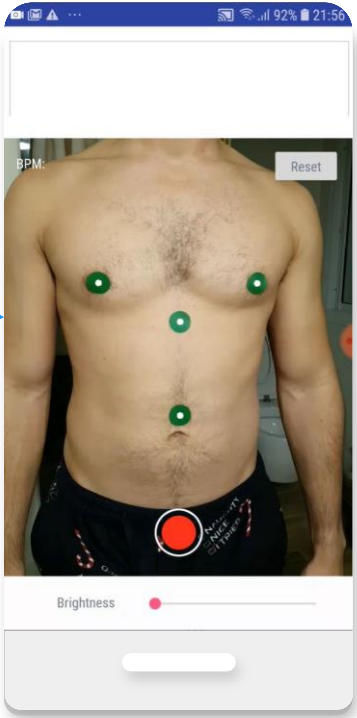
Recognition

- Stickers
- Noise





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User Configuration | Recognition | Tracking | Results | BPM

Tracking

Following the method (developed in the GIP lab) we take the sum of the distances between each 2 points on each frame.

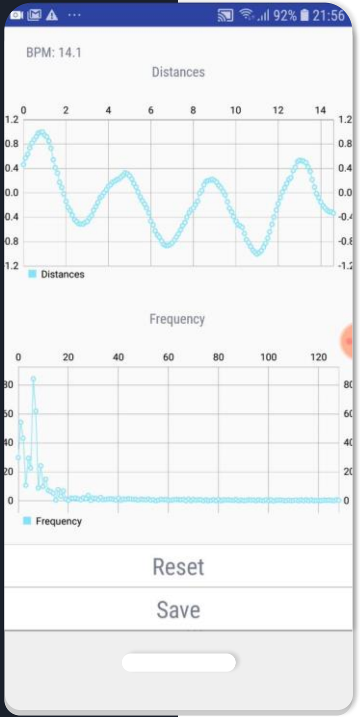
We plot the sum of every sample on a graph to provide the user a nice interface to see what the breathing looks like through time.

Normal breathing rate will be presented as a smooth sine-like wave.

Results

When the user hits the stop button, we take the recorded samples and present 2 graphs:

- **Normalized sums graph**
- Fourier graph



Normalized sums

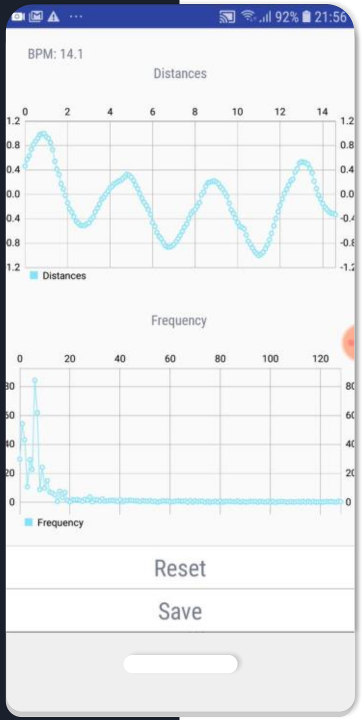
We perform a normalization of the samples recorded to present how the chest expands and contracts during the breathing.

This graph varies between breathing rates, the cycles become shorter when breathing rapidly and longer when breathing slowly which is represented in the graph by the distance between peaks.

Results

When the user hits the stop button, we take the recorded samples and present 2 graphs:

- Normalized sums graph
- **Fourier graph**



Fourier graph

We use the Cooley-Tukey algorithm (radix-2 form) to perform Fast Fourier Transform on the normalized samples.

The FFT transfers the data collected from the time domain to the frequency domain.

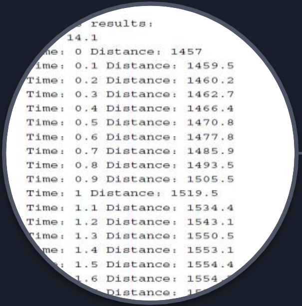
A “normal” breathing is has a single dominant magnitude as shown in the example.

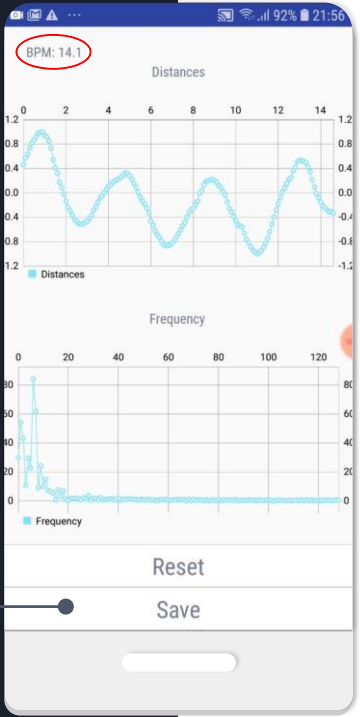
The dominant frequency (x-axis) will be greater for faster breathing.

User Configuration | Recognition | Tracking | Results | BPM

BPM

(Breaths Per Minute)





BPM

By multiplying the dominant frequency by 60 we get the BPM.

Reset to start over the process

Save a pdf file conaitning the data recorded (can be used for offline analysis)

User Configuration

Recognition

Tracking

Results

BPM

Recap

By examining the resulting graphs and comparing them to the ones we receive from disease carrying persons we can advance in these diseases' detection using this simple method.

Using the app is simple and require no invasive procedures or special tools.

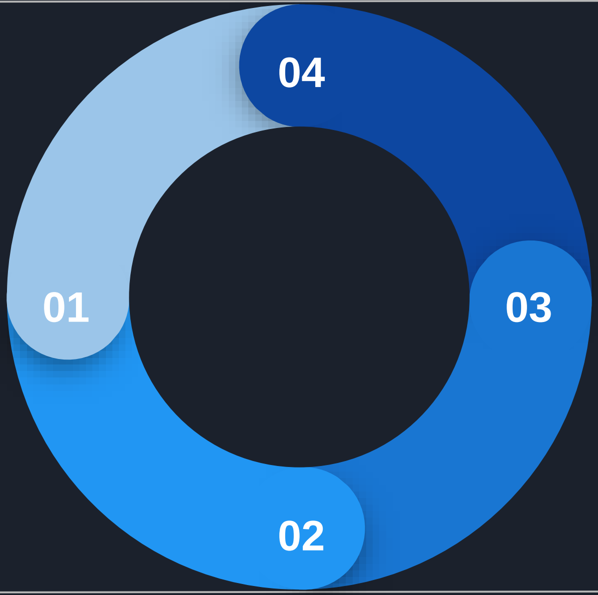
Project milestones

Environment

Setup Android Studio IDE and OpenCV image processing library

Research

Understanding the purpose and designing workflow to suit the methodology and solutions



Data and UI

Collecting and presenting data in a fast way with minimum loss and crafting easy to use and understand UI

Stickers tracking

Using OpenCV algorithms to detect specific colors and shapes from a camera frame

What's next?

- Recording the real-time analysis frames.
- Offline analysis (from a file).
- Machine learning tools to replace the need of stickers.
- Collect big data from the app of sick and not sick users to extend the research.

The Team

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