Vital Signs Monitoring with Face-Scanning Technology

Anna Drohomirecka (Narodowy Instytut Kardiologii, Warszawa)
Remigiusz Kościelny, CEO MX Labs, Wroclaw
Przemysław Jaworski, CTO MX Labs, Wroclaw
Leszek Pstraś, Tymoteusz Okupnik – research team

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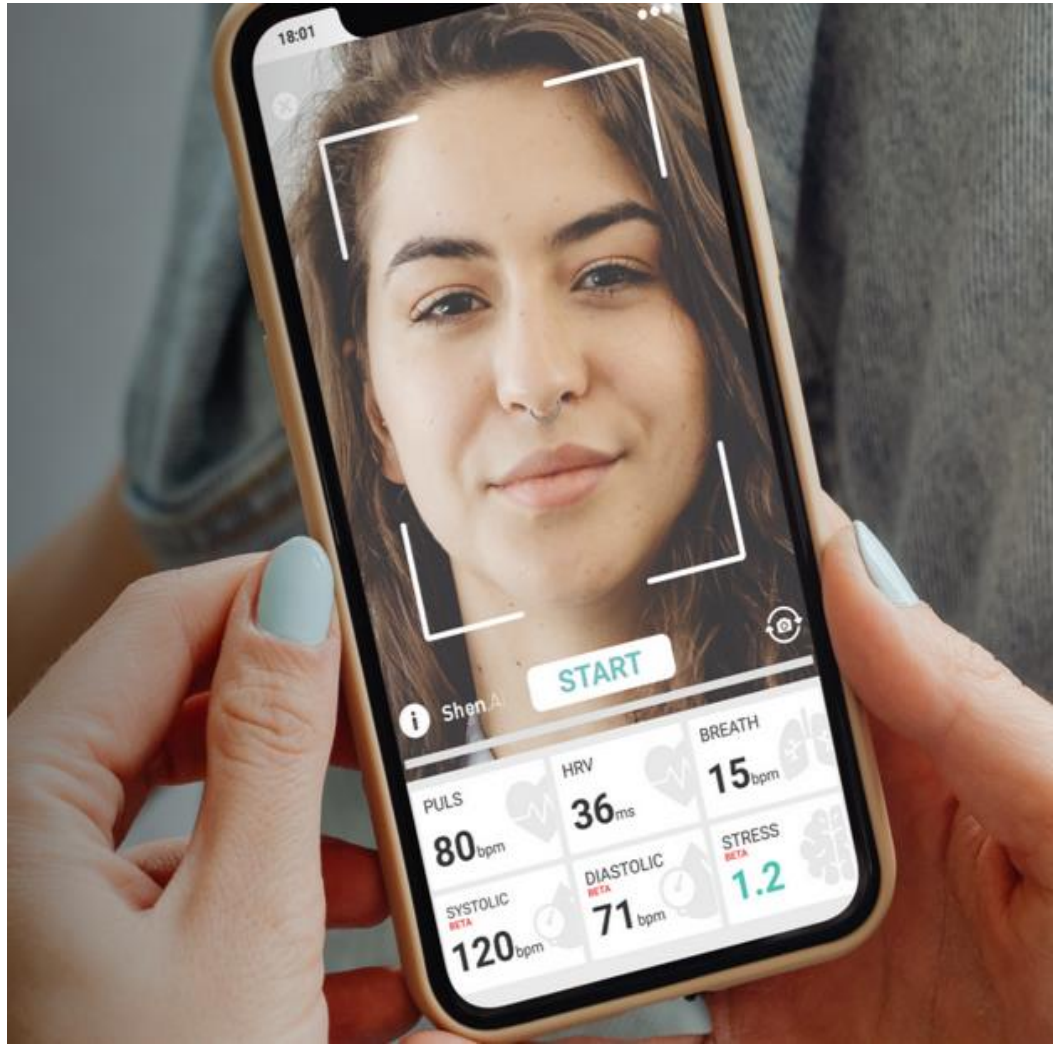
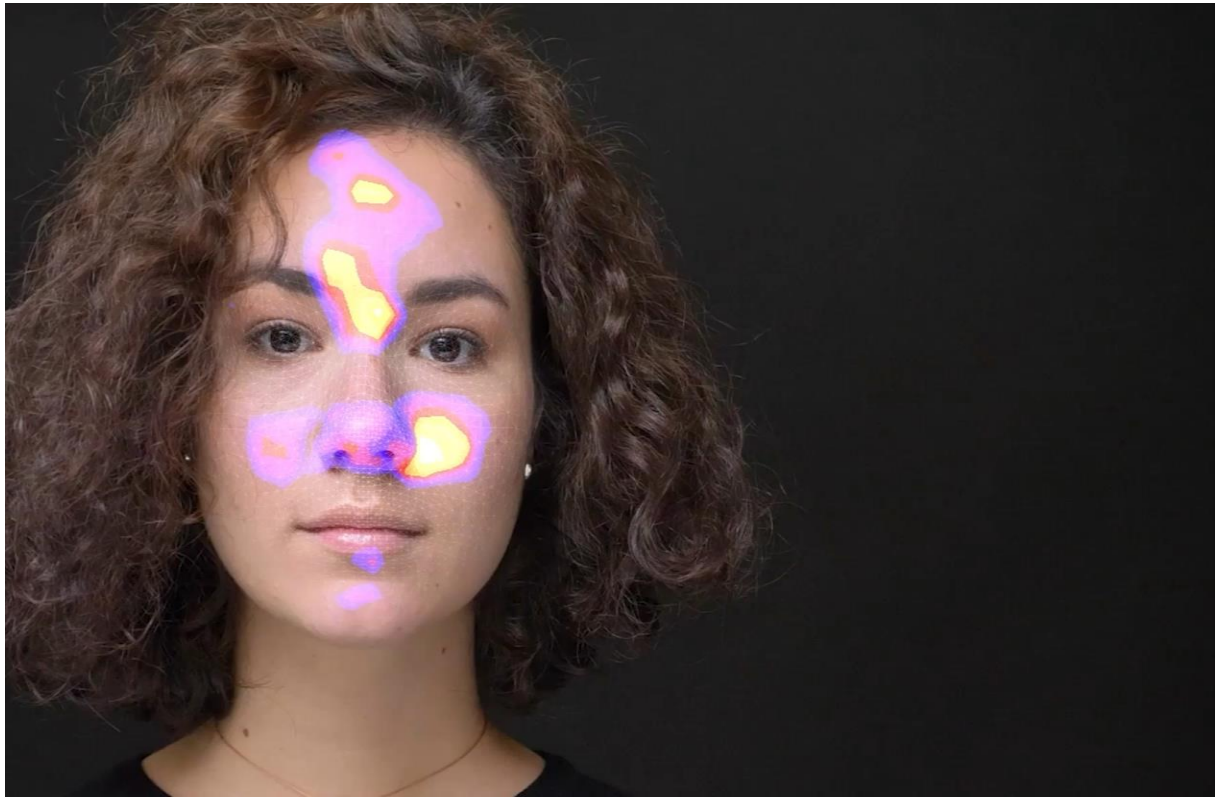


Shen.AI is a novel computer vision and AI-powered platform designed for the acquisition, analysis, and interpretation of vital physiological signs.

This technology utilizes remote photoplethysmography (rPPG), a non-contact optical method for detecting blood volume changes in the skin, which reflect the physiological condition of the subject.

It analyzes facial skin texture and extracts vital signs in real-time from the variations in light absorption, captured within the RGB pixel values of camera frames.



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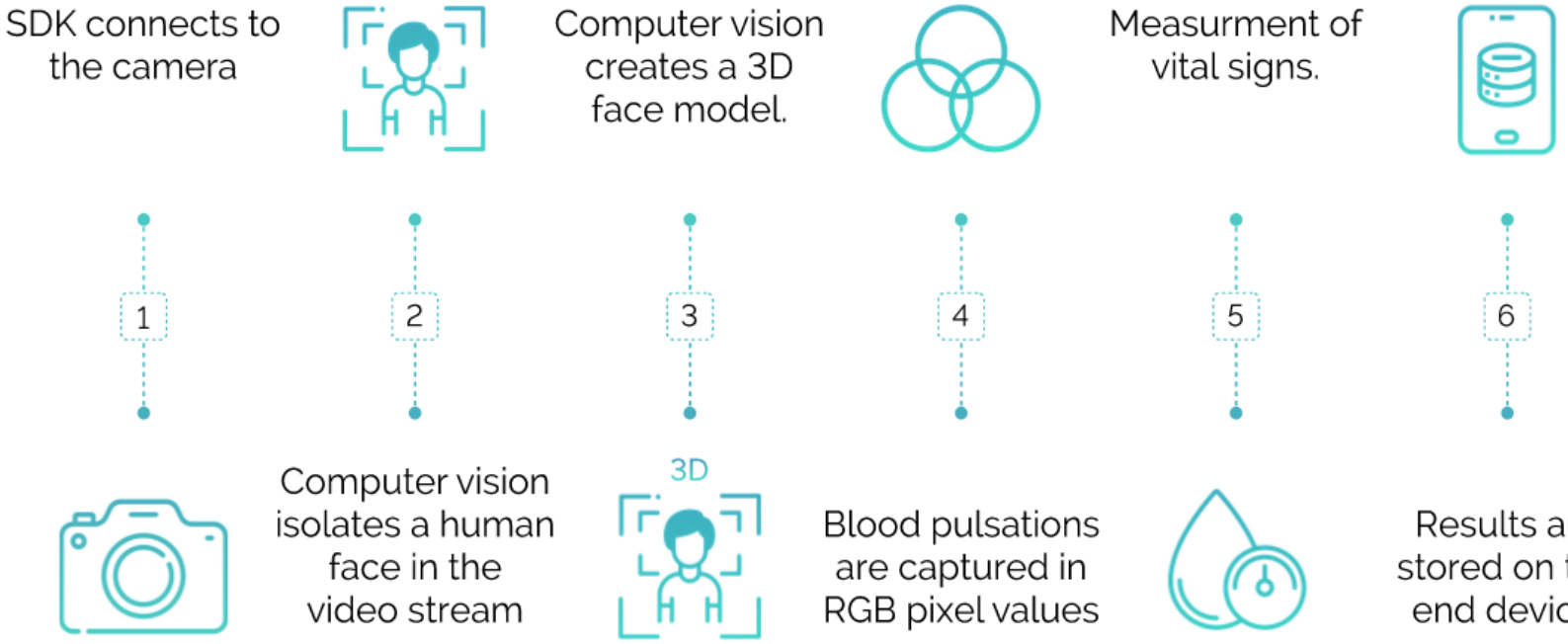
Current version:

- computer vision & AI
- measures vital signs
- camera based
- real time on the smartphone

Commercially available, serving 50k scans/monthly



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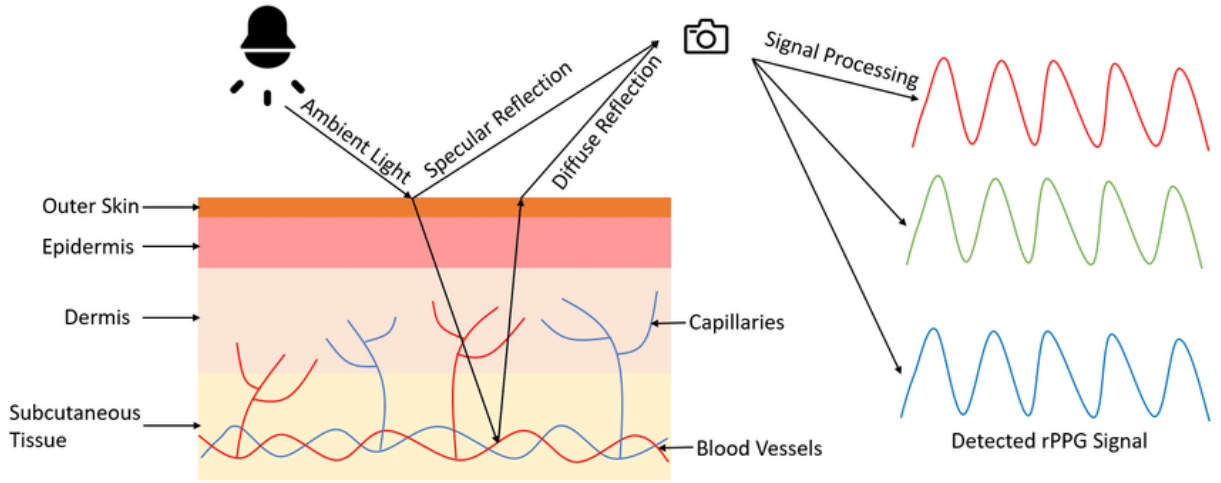
- The Shen.AI Vitals technology is based on remote photoplethysmography (rPPG) - a contactless optical technique of recording blood pulsations in the skin vasculature using a digital camera (e.g. in a smartphone, tablet, or laptop)
- The rPPG signals are extracted from the facial skin using advanced face tracking algorithms.
- Various signal processing algorithms are then employed to filter the signals and combine the information from the red, green and blue channels of the recorded video images. The processed signals are then fed into an artificial intelligence (AI) model to estimate the systolic (SBP), diastolic blood pressure (DBP), heart rate, heart rate variability,breathing rate.
- The technology is designed to operate locally on the user's end-device, ensuring that all computations and the resulting data are immediately available on-device after the measurement. This offline functionality is critical for real-time application and enhances user privacy.

Remote Photoplethysmography

- works on multiple wavelengths
- can use both IR and visible spectrum
- can use ambient and artificial light



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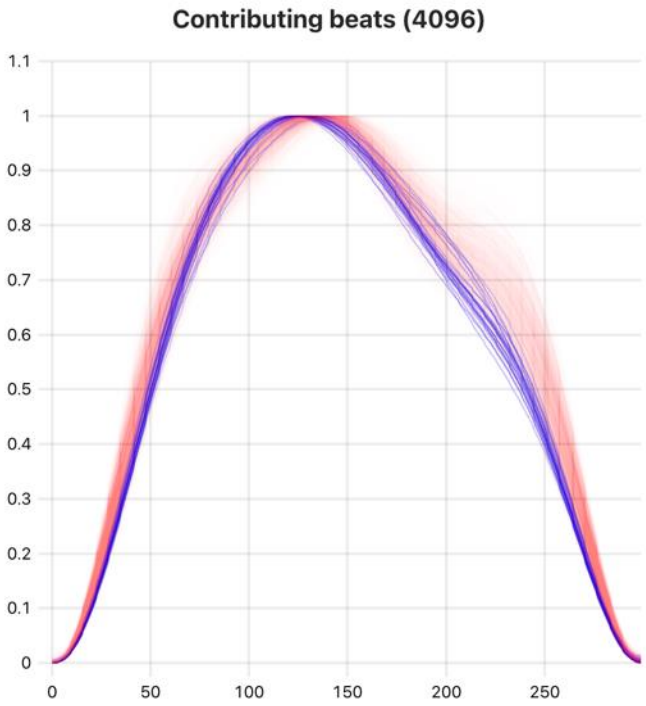

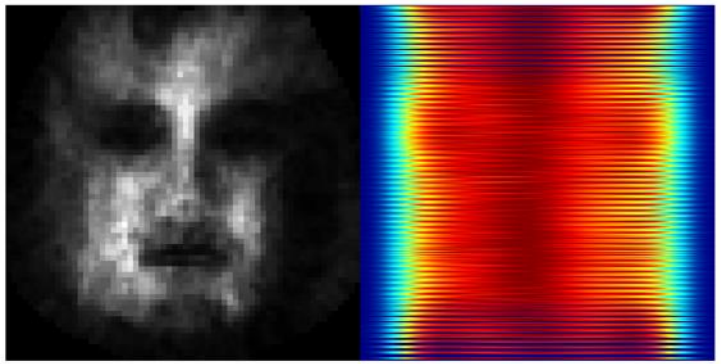

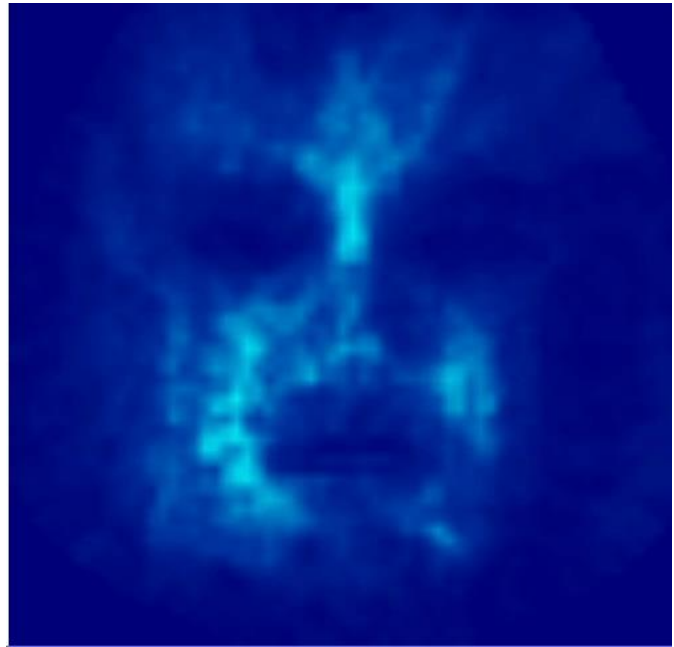

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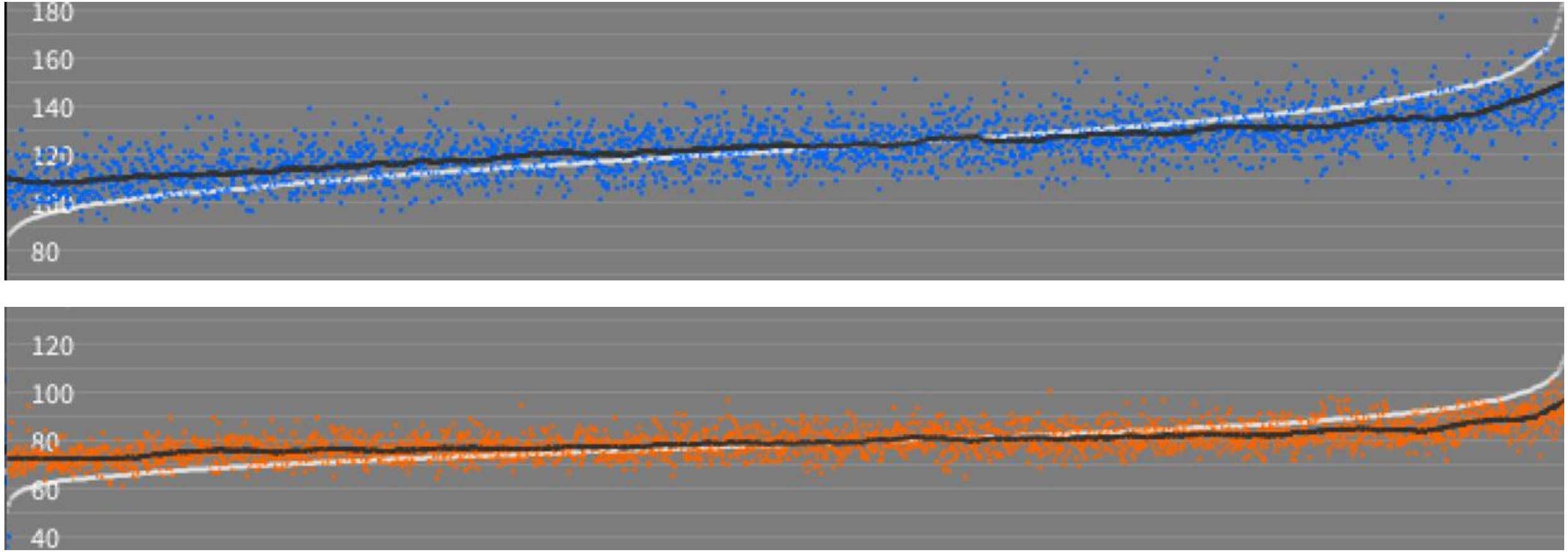
AI tools

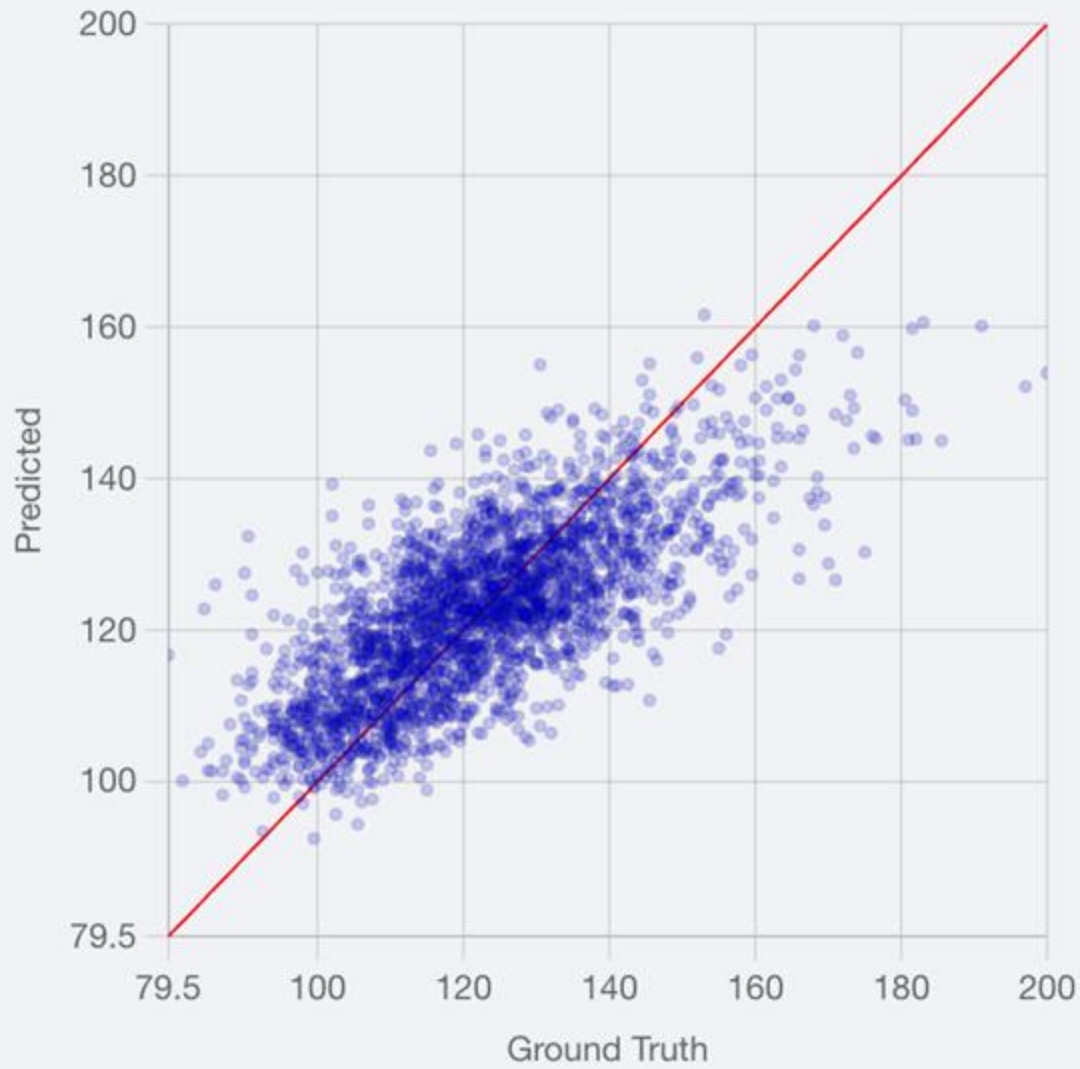
- Computer Vision methods (facial landmarks, 3d reconstruction, motion tracking, live texture extraction)
- Deep Neural Networks (rPPG signal processing)
- Supervised and unsupervised learning techniques used
- Trained on high quality ground truth data

Accuracy of blood pressure estimation



2600 samples, measured [white] vs predicted [blue and orange]

SubjectAverageSystolicPressure



N	MAE	MAPE	maxAPE	SD	Mean bias	Correlation
2,595	8.57	7.05 %	46.85 %	11.03	-0.02	0.73

SubjectAverageDiastolicPressure

N	MAE	MAPE	maxAPE	SD	Mean bias	Correlation
2,595	5.78	7.48 %	59.01 %	7.46	0.05	0.64

Accuracy and precision of systolic and diastolic blood pressure measurements using Shen.AI Vitals technology compared to reference measurements (in mmHg).

	SBP	DBP
mean error (ME)	1.3	-0.1
standard deviation of errors (SD)	9.0	4.8
mean absolute error (MAE)	7.0	3.8
root-mean-square error (RMSE)	9.0	4.7

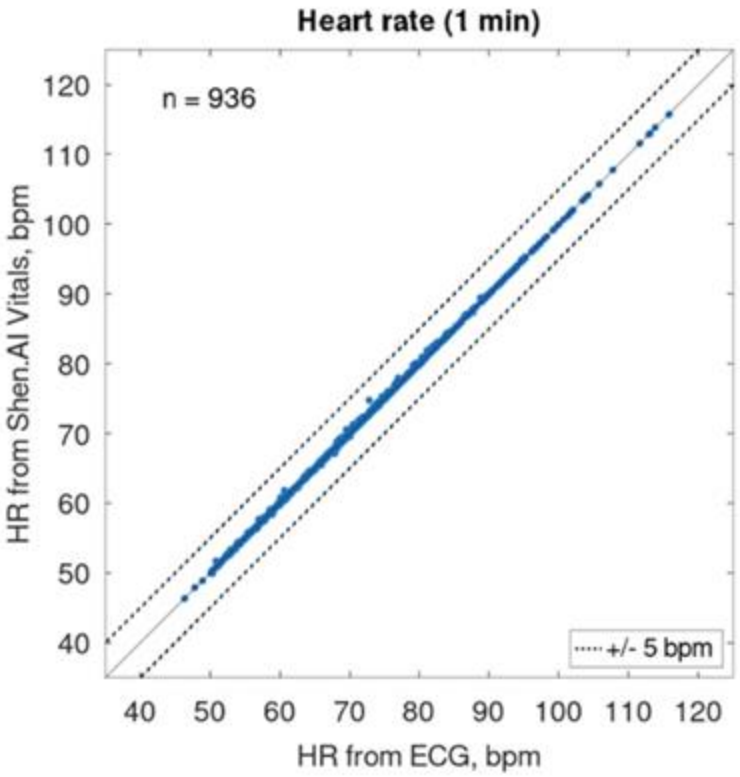
38 healthy, white, adult volunteers (aged 20 to 43 years, mean 25 years, 20 females)
The reference blood pressure (BP) measurements were performed using a validated automatic upper arm blood pressure monitor (Omron M4 Intelli IT).

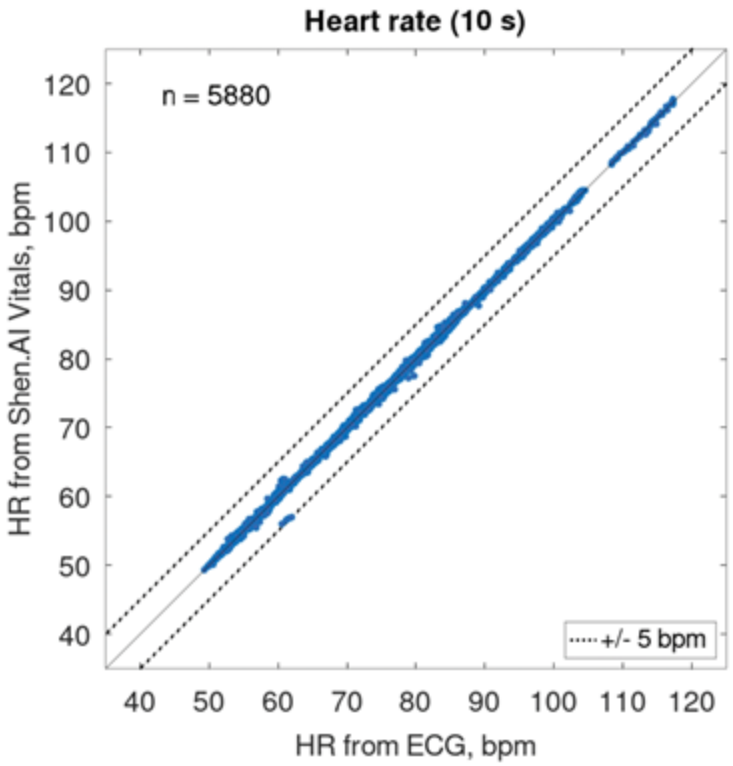
Accuracy and precision of heart rate, heart rate variability, and breathing rate measurements performed with Shen.AI Vitals technology as compared with reference measurements.

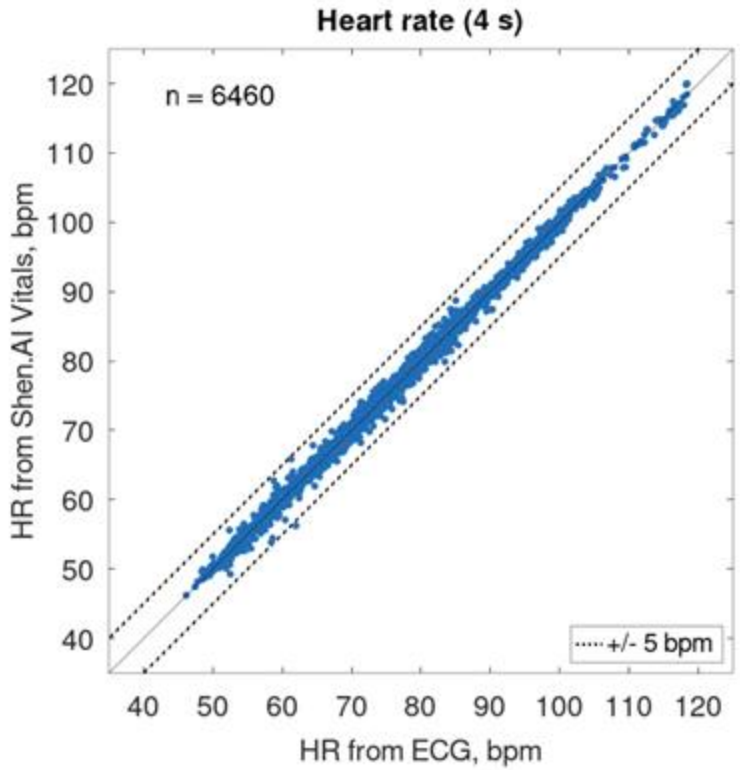
	n	ME	SD	MAE	MdAE	RMSE	
Main parameters							
Heart rate (1 min)	936	0.2	0.3	0.1	0.0	0.3	bpm
Heart rate (10 s)	44447	0.0	0.4	0.2	0.0	0.4	bpm
Heart rate variability (SDNN)	936	1.9	6.0	4.4	3.0	6.3	ms
Breathing rate	598	0.0	2.3	1.3	1.0	2.3	bpm
Modified parameters							
Breathing rate ≥ 10 bpm	584	0.2	1.9	1.2	1.0	1.9	bpm
Additionally tested parameters							
Heart rate (4 s)	48887	0.0	0.8	0.5	0.0	0.8	bpm
Heart rate variability (lnRMSSD)	936	-0.01	0.38	0.29	0.20	0.38	-

- 130 healthy, white, adult volunteers (aged 19 to 80years, median 24 years, 71females)
- The NovaScope software was used to detect QRS complexes in the ECG signals and to calculate the reference heartbeat intervals.
- The reference brething rate values were obtained by impedance signal or manual (visual) counting of the breathing cycles visible in the signal.

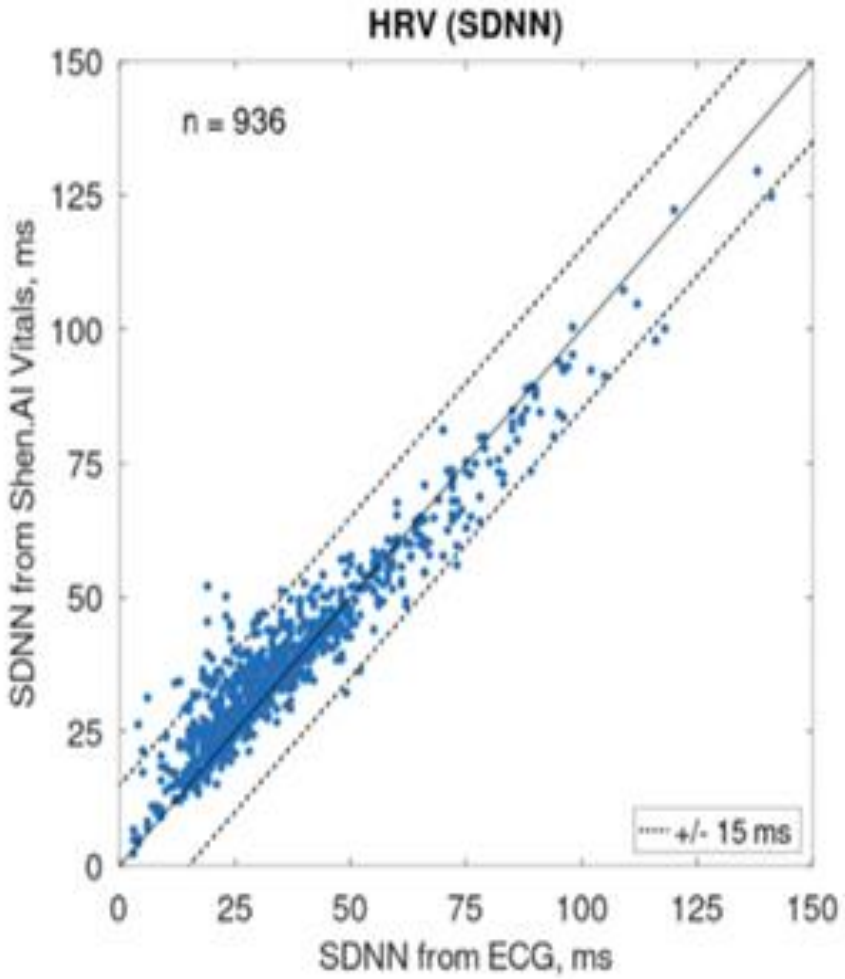
Accuracy of heart rate estimation

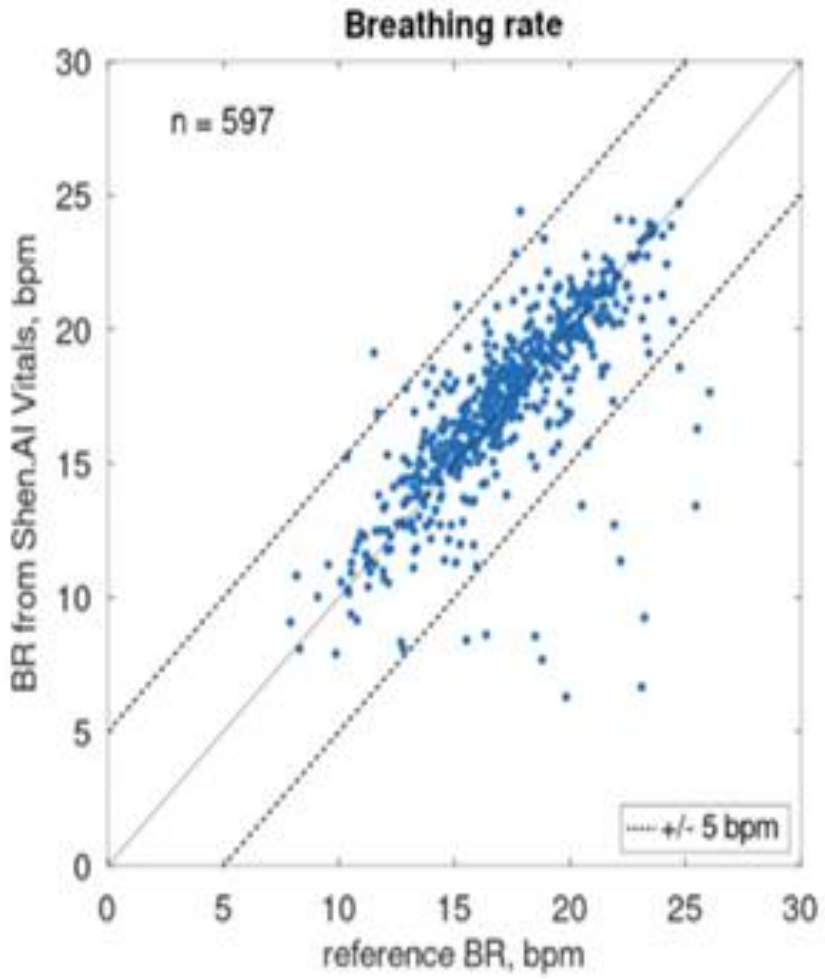






Accuracy of heart rate variability and breathing rate estimation



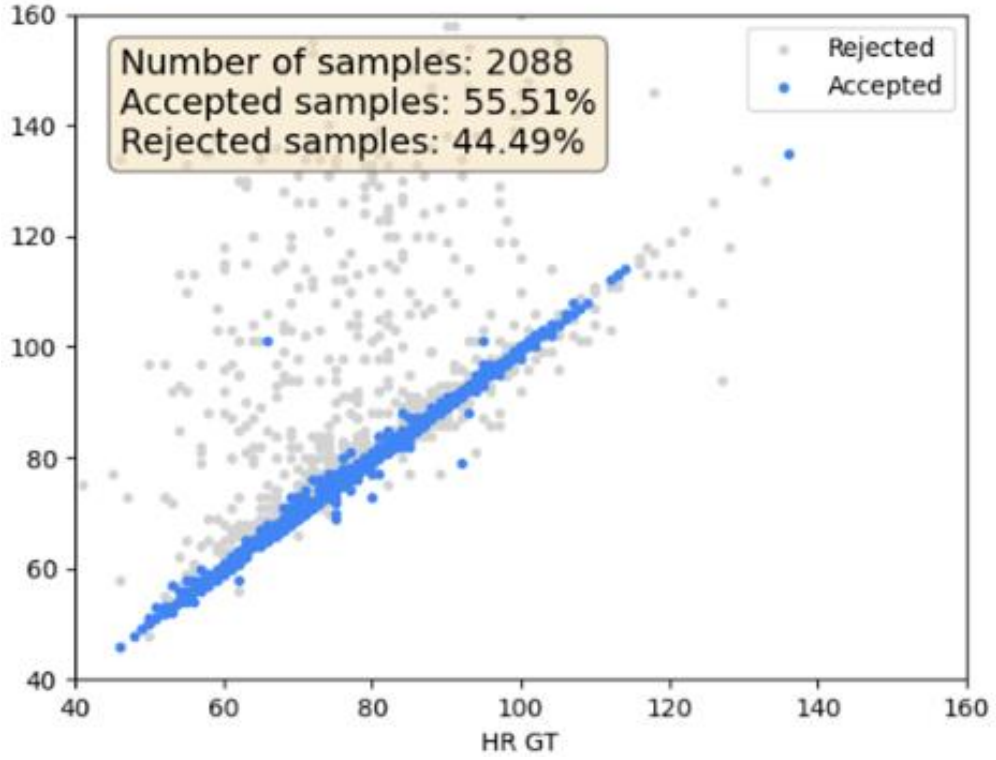


Multi-Tonal Sensing

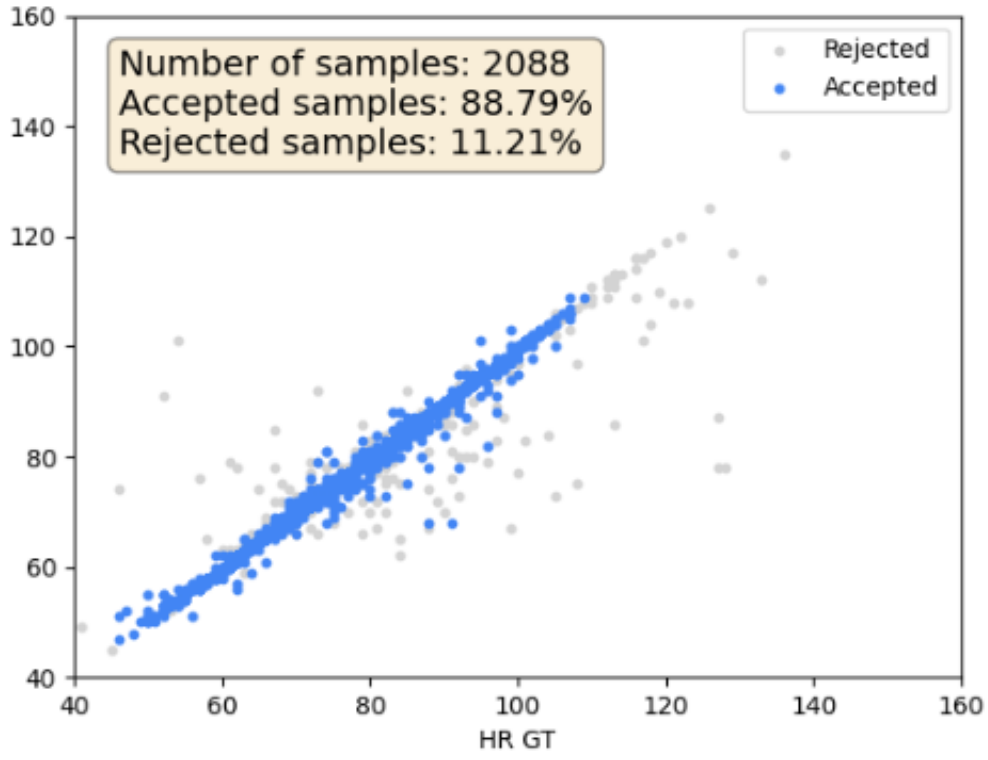
The Multi-Tonal Sensing technology drastically reduces the dependence on lighting conditions, ensuring accurate and reliable readings across a broader spectrum of environments. This advancement is particularly crucial for accurately capturing data from Fitzpatrick skin tones 4-6, enhancing the inclusivity and precision of our health monitoring software.

This breakthrough at Shen.AI represents more than just a technological advancement;
it embodies our commitment to making health monitoring more accessible and equitable. By expanding the usability of camera-based health monitoring, we're opening doors to better healthcare opportunities for people globally, regardless of their skin tone.

Accuracy and rejection rate for Heart Rate measurements with Shen.AI SDK
on Fitzpatrick scale IV-VI skin tones



without Multi Tonal Sensing



with Multi Tonal Sensing

Clinical applications:

Individual user (patient):

- Self-monitoring (e.g. in hypertensive patients)
- Screening for hypertension

Institutional user (hospitals, clinics) :

- Face-to-face visits
- Teleconsultantion (video consultation)
- Hospitalization

Advantages

- it increases the chances of more frequent measurements thanks to the mobility of the solution
- non-contact measurement minimises the risk of transmitting pathogens and reduces costs (e.g. for disinfecting equipment)
- non-contact blood pressure measurement based on the analysis of a facial image recorded by a camera can be an alternative solution for patients for whom traditional measurement using an upper arm or wrist cuff is difficult or impossible
- it is engineered for integration across a variety of devices and frameworks, enabling its incorporation into third-party mobile or web applications

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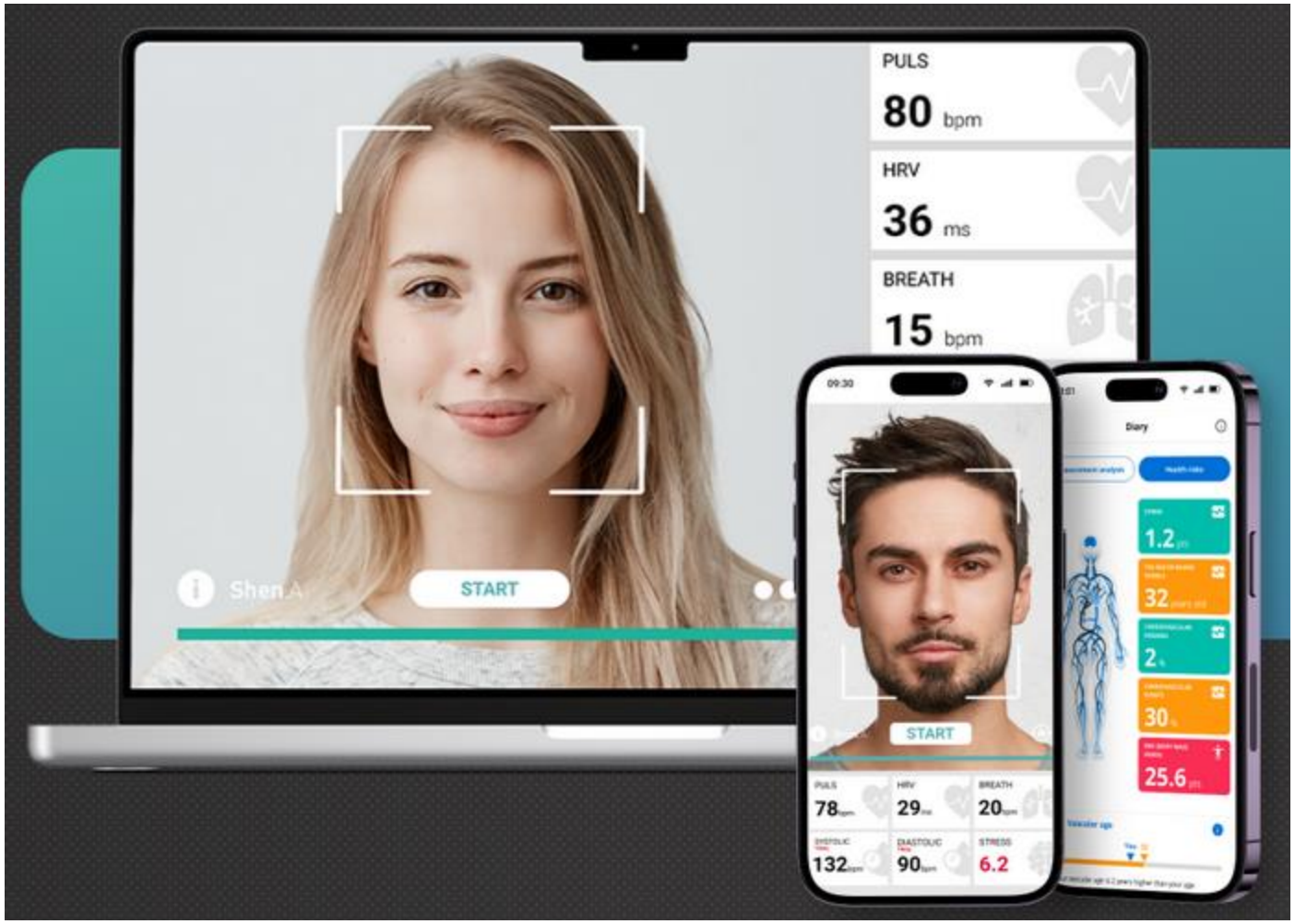
Prospects for the future



Shen.AI®

HQ: Lõõtsa tn 5, 11415 Tallinn, Estonia
R&D: Gwiazdzista 66, 53-413 Wroclaw, Poland

office@shen.ai

MX LABS®