J. Younes, L. O. Darashkevich

PORTABLE HEART DISEASE DIAGNOSTIC SYSTEME "PULSE"

Tutor: Associate Professor, Ph.D. S. A. Zhadan
Department of Pathological physiology,
Belarusian State Medical University, Minsk

Resume. *After developing and building a personal ECG device that anyone can use for diagnosing heart diseases, software was developed and used to analyze the ECG signal from students from BSMU. We compared readings from our ECG and a medical ECG, we concluded that our device was as accurate as the medical device and can be used for medical analysis. Noting the advantage that our device can take accurate readings even when the patient is physical active unlike the standard ECG device.*

Keywords: *ECG, personal medical device, diagnostic device, heart and cardiovascular disease, early diagnosis.*

Резюме. Разработано и создано персональное ЭКГ устройство для диагностики сердечных заболеваний. Разработано программное обеспечение для анализа сигнала ЭКГ полученного в ходе исследований у студентов БГМУ. Произведено сравнение показаний полученных с прибора и стандартной медицинской ЭКГ. Устройство может быть использовано в медицинских целях, отмечая точность показания, даже в условиях физической деятельности, в отличие от стандартного ЭКГ устройства.

Ключевые слова: ЭКГ, перосональное медицинское устройство, устройство для диагностики, сердечно-сосудистые заболевания.

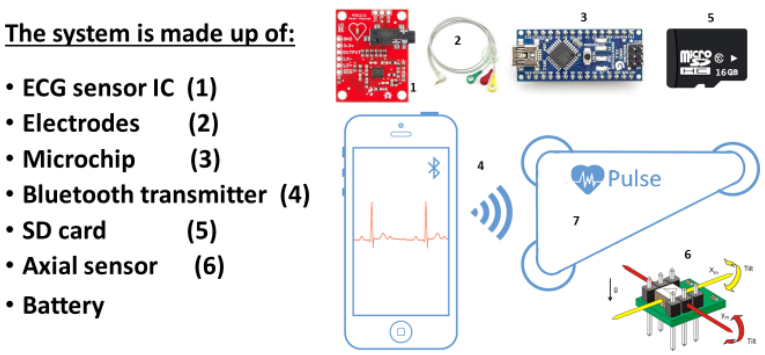
Relevance. Heart and cardiovascular disease are the number one cause of death worldwide [1]. In order to increase life expectancy for these patients it is essential to perform early diagnosis and prophylaxis [2]. But performing such a large-scale analysis is too time consuming, labor intensive, expensive and almost unrealistic compared to the technologies and methods currently deployed. In order to confront this problem, we must find a solution to each of the challenges presented above which are cost, time for analysis, availability and ease of use.

Goal: To create a personal device ECG "Pulse".

Tasks:

1. To develop software that analyzes the ECG signal.
2. To compare the readings from "Pulse" with standard medical ECG.
3. To test our devices on different patients and comparing the obtain results.

Material and Methods. This research was made using a device which was developed by students from the 2nd and 4th course from BSMU, for diagnosing heart diseases. The system is made up of an ECG device containing the electrodes, microchip, Bluetooth transmitter, SD card, axial sensor and battery (picture 1).



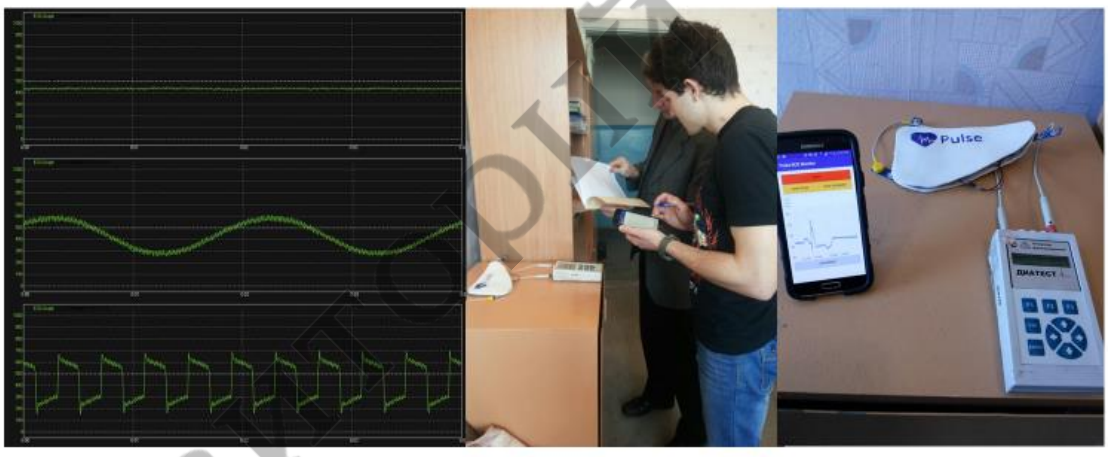
Picture 1- Materials used for constructing the ECG device "Pulse"

For applying of the device the patient clips on new disposable conductive pads and sticks the device onto his torso in such a way that the top of the device is at the border between his stomach and chest. Then he turns it on an it starts recording to an SD card. He can use his phone to check the data. The patient can wear it for up to 24 hours. The application connects also to the device via Bluetooth & to the doctor via the internet. The doctor can use a special software to analyze the signal.

A medical ECG device (Кардиан-ПМ) was used as a control device for making a standard ECG. The record of signal was made by standart methods.

The object of our investigation was 10 students (5 male and 5 females) under different stimuli: directly after consumption caffine and during physical excersise (running for 15 min at a speed of 8km/h).

Results and discussions. On the first step of our researching the testing and calibrating of the device was made using an ECG signal generator, from the research and development lab in "Luch watch factory" (Minsk, Belarus) (picture 2). The signal generator tested our device's minimum and maximum capabilities, which were as follows: minimum frequency 0.5Hz maximum 600Hz, maximum heart rate 200 bpm, min aptitude ±0.1mv max ±300mv. In addition to testing different signal shapes and heart beat simulations.



Picture 2 - Testing at "Luch watch factory"

The second step was comparing our device with a standard medical ECG (Кардиан-ПМ) from the Department of normal physiology of BSMU, by connecting both devices to a patient at the same time, in order to compare the signals of both devices simultaneously (picture 3).

As a result, we concluded that the signals were very similar. It was noted that the signal generated by our device was clearer for 2 reasons: the first, it's electrodes are place closer to the heart, second our device collects data at a much higher rate which is 200Hz compares to the 50mm/s (approximately 50Hz) from the standard medical ECG

Picture 3 - Comparing the ECG signals from both devices

The third step was testing the device on 10 students (5 male and 5 females), comparing their ECG signal in normal state and under physical stress (picture 4) or after consuming caffeine (picture 5), to prove the device's capability to work and record a clear signal under different circumstance (active or resting) or under stimuli.

Picture 4 - Comparison of ECG signal before and during physical activity for patient wearing "Pulse"

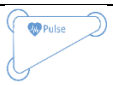
Picture 5 - Comparison of ECG signal before and after drinking coffee for patient wearing "Pulse"

The results showed that this device can registrate the changing of the signal under the different factors (physical activity and taking coffee).

Many ECG devices already exist in the market but most of them have limited capabilities, high prices and are only targeted towards doctors and medical centers, unlike our

device which has a low cost and is targeted for the patients and athletes. “Pulse” also contains more sensors such as accelerometers and temp and can connect to more biomedical sensors such as BP sensor and Oximeter. In addition, we have designed a 12-lead model targeted specifically for medical use, and we have compared the specifications of our devices to the cheapest available devices to prove this point (table 1).

Table 1. A comparison between our current device “Pulse” and a future design “Pulse Medx” and the cheapest Available ECG’s currently available on the market

Devices / **Parameters**	**Pulse**	**Pulse Mec**	Contec 1200G	Contec 90A portab rocardiogra	Heal For 0B	**MySignals** (eHeal cal Developme orm)
						
Price	Starting	300-400$ ead)	600$	360$	100$	2000$
Frequency	200Hz	2000Hz	1000Hz	150Hz	-	200HZ
Leads	3	12	12	12	3	3
Data sa Recording mode	Yes/ Digital & printed		NO / The paper	Yes mal paper	Yes/ Digital	Yes/ Digital
Live graph	Yes		Yes	Yes	Yes	NO
Data analysis	Algorithmic or Artif ntelligence		Algorithm	NO	NO	Graphical
Measurement	Continuous (> 2 s)		Short (fe	Short (fe	Short (fe	Short (few min)
Open source	Yes		NO	NO	NO	Yes
Polarization ge	± 300mV		± 500mV	± 300mV	± 300mV	± 300mV
IOT device	Yes (data can be sav shared online)		NO	NO	NO	Yes (data can be sav shared online)
How is it use	Wearable or Handhelc		Handheld	Handhelc	Handheld	Hand held

Comparing analysis the different devices showed that the ‘Pulse’ has a number of advantages. First of all data is saved on a Micro SD card and be saved online where they can be easily shared with a doctor. Our device is open source allowing more doctors, developers, scientists, students and engineers to take part in the development and improvement of the device. It’s low cost and easy to use means more people can buy it and use it. Our system is expandable allowing for the use of as many leads as needed for the application. In addition, it is compatible with many sensors such and temperature sensors, Oximeter, Blood pressure sensor, all this data gives doctor clearer view of the patient’s state, allowing for a better diagnosis and treatment. The ergonomic construction of the device allows it to be worn comfortably and does not obstruct the daily activity of the patient. The fact that we have developed a complete system, such that the data can be shared directly between doctors and patients gives a great advantage over conventional devices. In addition, Pulse can take continuous recording even in heavy physical activity and can even take notes from patient by highlighting periods when the patient feels some sort of discomfort.

Conclusion:

1 The ‘Pulse” was tested and it complies with the standards of devices for ECG recording.

2 The device can registrate the changing of the heart's work under the different factors.

3 The device is suitable for wide circus of users.

А. Ж. Юнес, Л. О. Дарашкевич

ПОРТАТИВНАЯ СИСТЕМА ДИАГНОСТИКИ СЕРДЕЧНЫХ ЗАБОЛЕВАНИЙ "PULSE"

Научный руководитель: канд. биол. наук, доц. С. А. Жадан

Кафедра патологической физиологии

Белорусский государственный медицинский университет, г. Минск

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