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HEART RATE RECORDING SYSTEM FOR PARTICIPANTS TO WEIGHT TRAINING IN CLUJ-NAPOCA'S FITNESS GYMS (COMPATIBILITIES BETWEEN ANDROID AND WINDOWS 7)

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ABSTRACT. Measuring the heart rate we can analyse the cardiac profile of a particular sport (Derevenco, 1998) and we can use the heart rate as a guide to plan our exercise intensity because it is in a direct linear relationship with oxygen consumption (American College of Sports Medicine, 2005). Using a heart rate monitor allows us to assess the dynamic changes that occur during physical activity in a heart rate profile (Burke & Polar Electro Inc., 1998). The system we use for our research include one cardiac monitoring belt, Polar brand, one smartphone with Bluetooth reception and specific software for analysis and the interpretation of heart rate data (SportsTracker Pro for Android and SportTracks for Windows 7). There are many systems that record heart rate during physical activity but their importance is given by the mobility that users have in terms of control and recorded data processing. We believe that the main advantages of our system are the high compatibility between system components and the high mobility to use and to transfer data from a software to another.

Key words: *heart rate monitor, Polar, Android, Microsoft Windows 7.*

REZUMAT. ***Sistem de înregistrare a frecvenţei cardiace la practicanţii antrenamentului cu greutăţi în sălile de fitness din Cluj-Napoca (compatibilităţi între platforma Android şi platforma Windows 7).*** Măsurând frecvența cardiacă putem urmări profilul cardiac al unei anumite activităţi sportive (Derevenco, 1998) şi putem folosi FC ca pe un ghid pentru a planifica intensitatea efortului deoarece ea este într-o relaţie liniară directă cu consumul de oxigen (American College of Sports Medicine, 2005). Folosirea unui monitor de frecvență cardiacă ne permite în fiecare moment să evaluăm modificările de dinamică a frecvenţei cardiace care au loc în timpul unei activităţi fizice (Burke & Polar Electro Inc., 1998). Sistemul folosit de noi pentru cercetarea desfăşurată în cadrul studiilor doctorale

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include centură de monitorizare cardiacă, marca Polar, un telefon (smartphone) cu funcţie bluetooth şi softuri specifice de recepţie, analiză şi intrepretare a datelor cu privire la frecvenţa cardiacă (SportsTracker Pro pentru Android şi SportTracks pentru Windows 7). Există multe sisteme care se folosesc pentru a înregistra frecvenţa cardiacă în timpul activităţilor fizice dar importanţa lor este dată de mobilitatea pe care o au utilizatorii în ceea ce priveşte controlul şi extragerea datelor înregistrate. Considerăm că principalele avantaje ale sistemului propus de noi îl reprezintă compatibilitatea ridicată între componentele sistemului şi mobilitatea mare de utilizare şi transferare a datelor în interiorul sistemului de la un program la altul.

Cuvinte cheie: *frecvenţă cardiacă, monitor, Polar, Android, Microsoft Windows 7.*

"Heart rate (HR) is one of the main functional parameters of the heart" (Derevenco, 1998, p. 40). It provides, in a simple manner, the most useful information about the amount of work that the heart does in order to satisfy the demands of a body involved in physical activity (Wilmore & Costill, 1999). Measuring HR we can assess the cardiac profile of a sporting activity (Derevenco, 1998) and we can use it as a guide to plan our exercise intensity because it has a direct linear relationship with oxygen consumption (American College of Sports Medicine, 2005).

Using a heart rate monitor allows us to evaluate changes of HR dynamics that occur during physical activity (Burke & Polar Electro Inc., 1998). We can use the monitor for HR to understand how the dynamics change, anticipating, how it will evolve during exercise, which makes our workouts more effective.

The first portable electrocardiograph, for periods of time up to 24 hours, appeared in 1961, made by Norman Holter (Holter, 1961 cited by Billman, 2011, p. 3). In 1983, Polar Electro invented the first wireless ECG (no cables between electrode belt and receiver): Polar Sport Tester PE 2000 (Parker, 2007). It began, thus, the period of HR portable monitors. They were developed continuously, modifying their performance in a very fast pace.

Such an apparatus is made by a ring electrode which will be positioned on the chest. These electrodes monitor the electrical activity of the heart and transmit information by radio signal to a receiver that calculates heart rate per minute. This receiver can be a device as the clock attached to the forearm, or can be any type of device (phone, tablet) which has Bluetooth and software specifically designed for decoding signals received. The best apparatus have the signal coded between belt and receiver in order to prevent interference by nearby devices (Parker, 2007). These devices that monitor the HR allow the user to have real-time readings of the device.

The system used in the research carried out for doctoral studies include cardiac monitoring belt, Polar brand, a smartphone with Bluetooth and specific software for reception, analysis and the interpretation of HR data. Specifically, the system consists of:

- Polar WearLink® + transmitter with Bluetooth® (Polar Electro, 2014) (Fig. 1)
- Samsung GalaxyNote 2 N7100 (Samsung Electronics Co. Ltd., 2014) (Fig. 2)
- Software operating on Android (Google Inc., 2014), SportsTracker Pro (SportsTrackLive, 2014) (Fig. 3)
- Software operating on Windows 7 (Microsoft Corporation, 2014), SportTracks (Zone Five Software LLC, 2014) (Fig. 4)

Fig. 1. - Polar WearLink® + transmitter with Bluetooth® (Polar Electro, 2014)

Fig. 2. - Samsung Galaxy Note 2, N7100 (Samsung Electronics Co. Ltd., 2014)

Fig. 3. - SportsTracker Pro (phone screen capture)

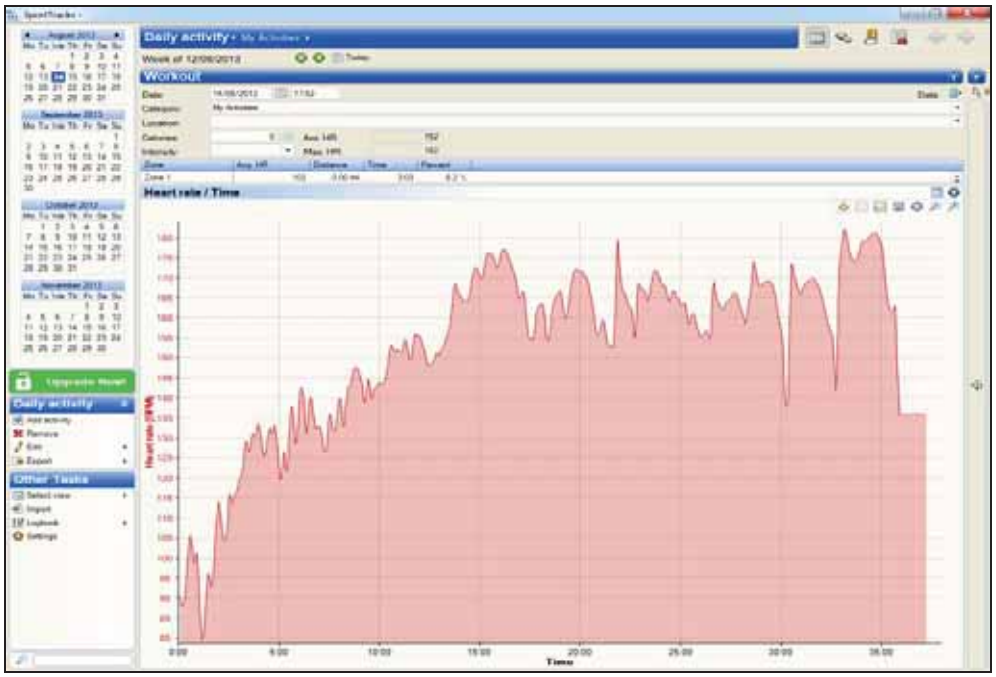


Fig. 4. - SportTracks (PC screenshot)

Polar HR monitor consists of a belt with electrodes which are attached to the chest and a Bluetooth transmitter that fits on the belt in the centre. The HR monitor sends specific parameters to the receiver that was paired with. The synchronization between the two is controlled by Android software and has a key consisting of "0000".

Electrode belt is fastened to the thorax practitioner after tapping the belt with water. It then performs the synchronization between the transmitter and the receiver by choosing the device "Polar iWL" (Fig. 5).

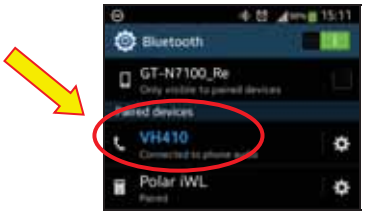


Fig. 5. - Bluetooth pairing

After making the connection between the HR monitor and the smartphone we can enter the personal data of the subject (sex, weight and age). To achieve this we have to access the "Personal" section in "Settings" (see Fig. 6).

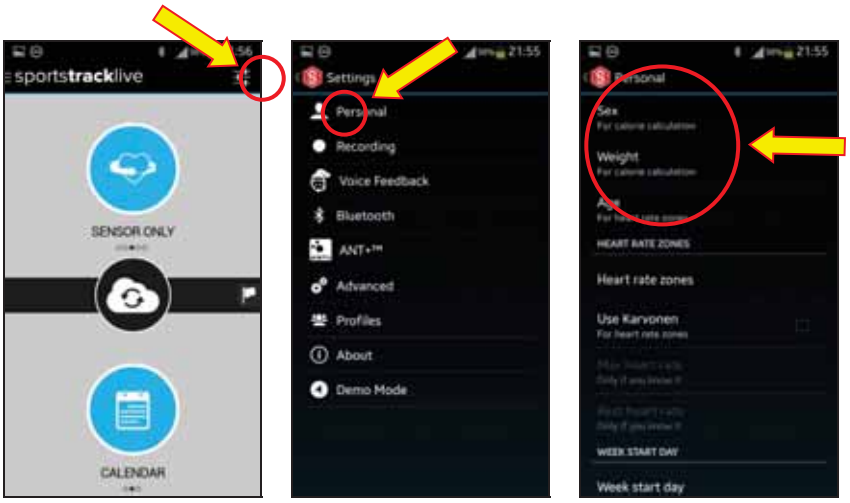


Fig. 6. - Setting personal data in SportsTracker Pro

After achieving coded pairing between the HR monitor and the software that will record the dynamic of HR, we begin monitoring the HR enabling the "Sensor only" feature (see Fig. 7).

Fig. 7. - Enabling the recording

We have to wait for recording confirmation. Stable connection between the two devices is confirmed by the message "Connected" and the emergence of data on the smartphone display (Fig. 8). If we wait for a minute after the recording started the chances of erroneous fluctuations are very low. One minute after the data appeared on the display the researcher can start his/her counter. This allows perfect synchronization between HR recording data and observation notes. This synchronization is very important for further analysis based on the record sheet.

Fig. 8. - Records by SportsTracker Pro

At the end of the training data are stored by the phone software in separate sessions (Fig. 9). These sessions will be uploaded on the internet on the producer's page (Fig. 10).

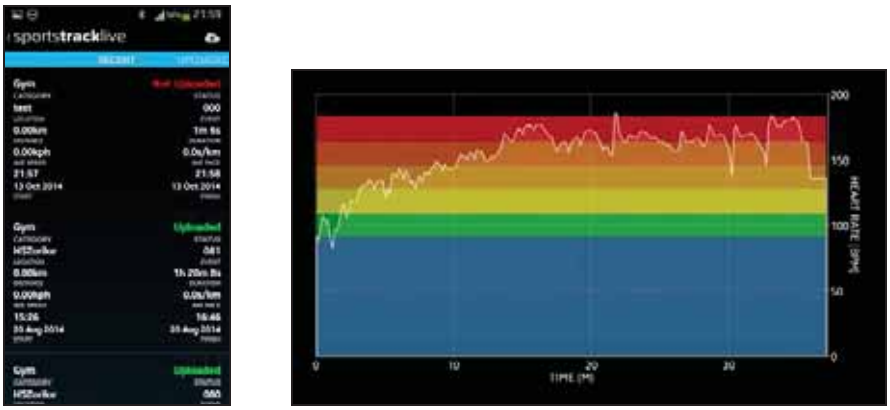


Fig. 9. - Training session recorded with SportsTracker Pro

Fig. 10. - Training session viewed on the internet platform

To analyse in details the HR dynamics we have to download the file from producer's website. After that we can process the data on Windows 7 with SportTracks software. Data can be downloaded in three types of files: ".kmz" ".gpx", ".csv". Best format for analysis in this case is ".gpx". SportTracks for Windows 7 allows the import of HR .gpx file. This software allows, in fact, several file types for import: .gpx, .hrm, .fitlog, .pwx, .bdx, .csv, .xml, .hst, .tcx, .fit (see Fig. 11).

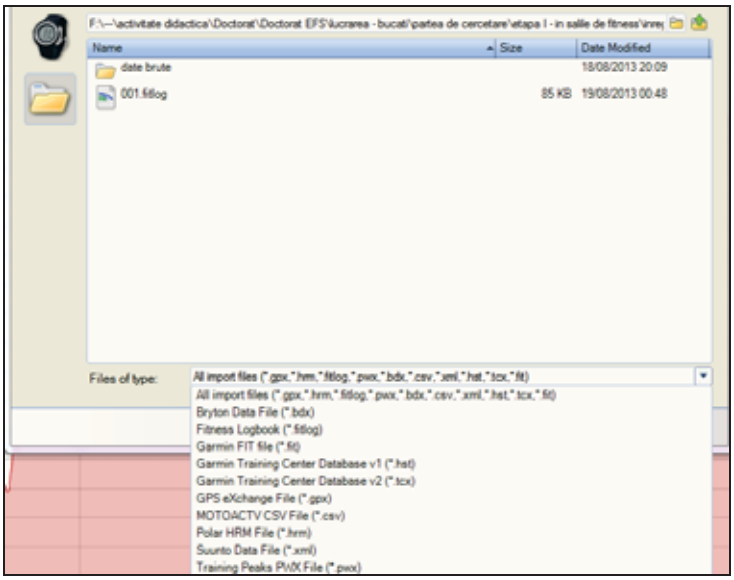


Fig. 11. - File types that can be imported by SportTracks for Windows 7

Analysis of the HR dynamics requires accurate recording of time (minutes and seconds) when every exercise starts and ends. For an accurate data analysis we need to access in SportTracks the "Splits" section (see Fig. 12). We select only the columns that we have a need for (enter the selection by using the right mouse button on the blue header) (Fig. 13 and Fig. 14).

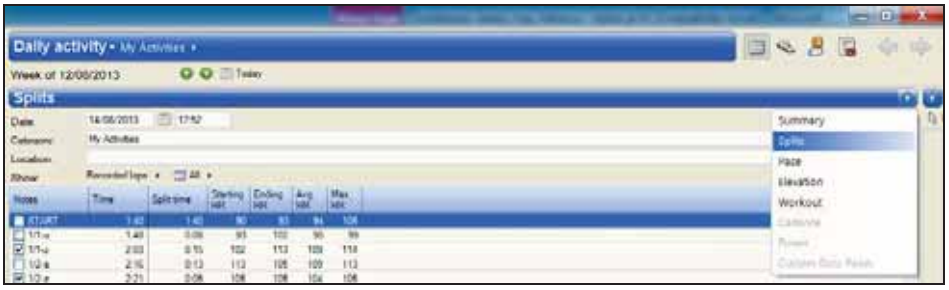


Fig. 12. - The "Splits"section

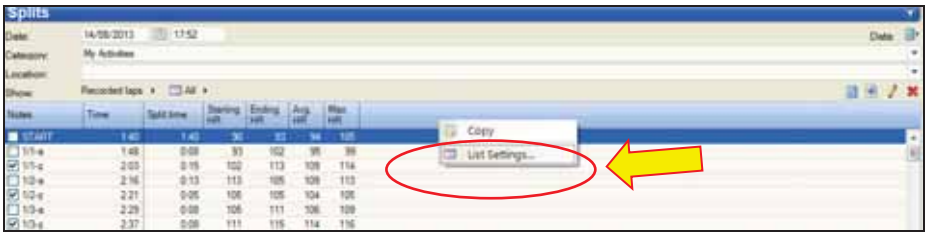


Fig. 13. - Enter the section for needed columns

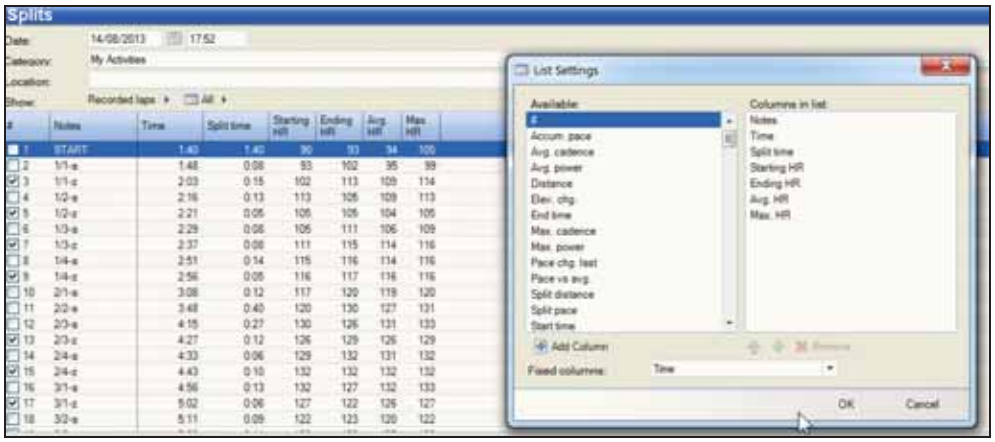


Fig. 14. - Choosing columns for the table header

After selecting the desired columns the data for each exercise can be inserted (Fig. 15 and Fig. 16). During recordings a specific coding was used: 1/1, 1/2, 2/1 etc. The first digit refers to the number of exercise and the second digit refers to the number of set for that exercise. To this coding we added two letters when the data was inserted in SportTracks "-a" and "-z" (where "-a" marks the beginning of the set and "-z" its end). This approach has facilitated the observation of dynamic for every exercise recorded without the need to modify the codes used in the observation sheet (for codes in observation sheet, see Fig. 17).

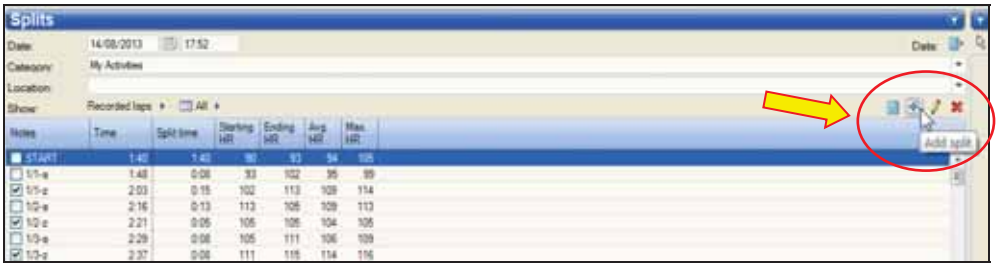


Fig. 15. - Opening a window to insert the data recorded

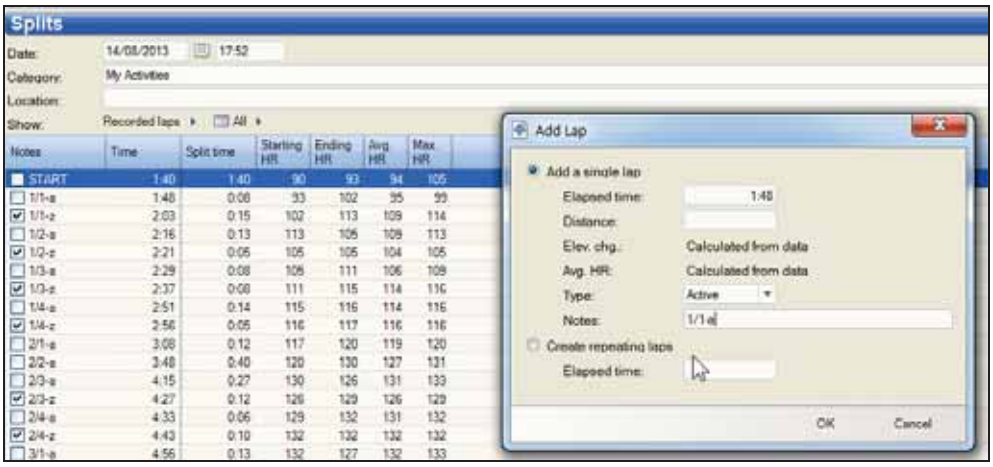


Fig. 16. - Inserting the recorded data in SportTracks

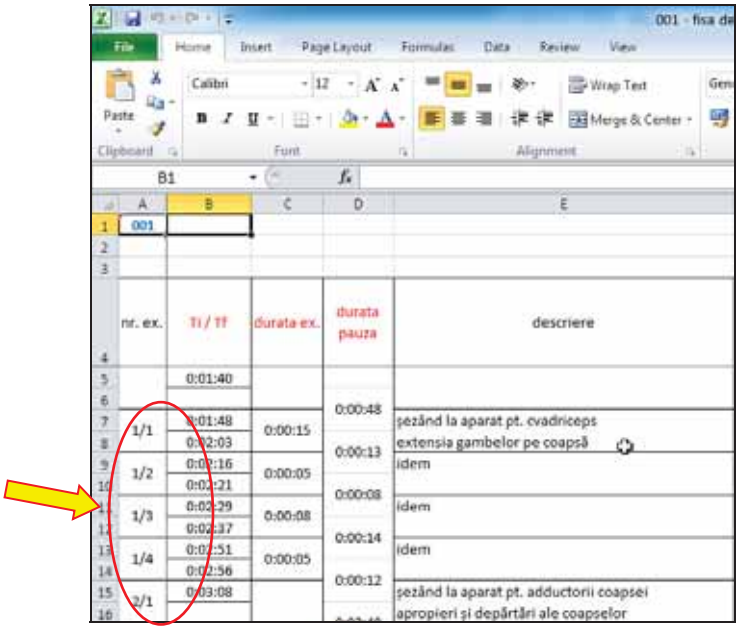


Fig. 17. - Codes in an observation sheet

After entering all the exercises in SportTracks it is possible to copy data into Microsoft Excel using the right button of the mouse, applied in the data field (Fig. 18 and Fig. 19).

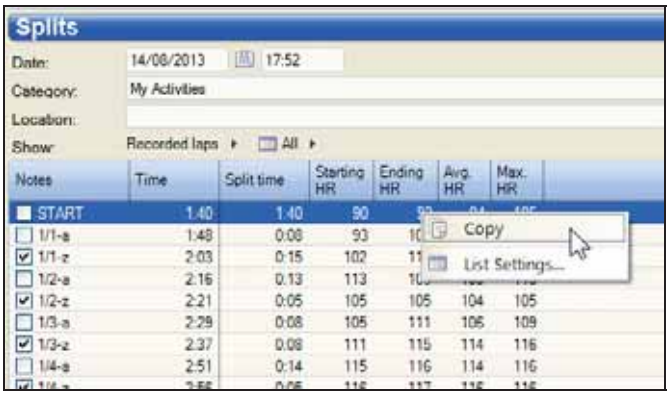
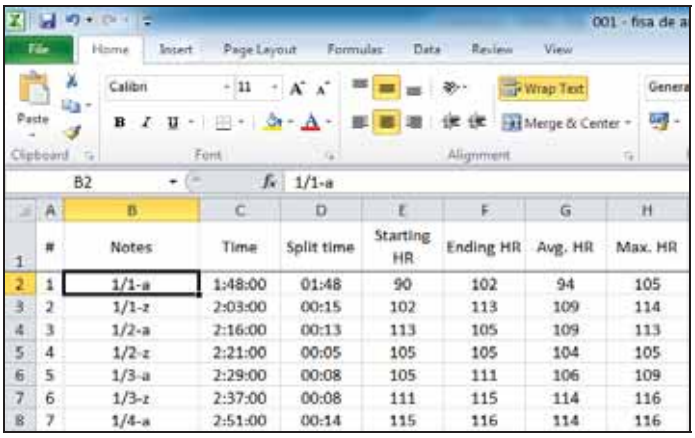


Fig. 18. - Copying data from SportTracks



#	Notes	Time	Split time	Starting HR	Ending HR	Avg. HR	Max. HR
1	1/1-a	1:48:00	01:48	90	102	94	105
2	1/1-z	2:03:00	00:15	102	113	109	114
3	1/2-a	2:16:00	00:13	113	105	109	113
4	1/2-z	2:21:00	00:05	105	105	104	105
5	1/3-a	2:29:00	00:08	105	111	106	109
6	1/3-z	2:37:00	00:08	111	115	114	116
7	1/4-a	2:51:00	00:14	115	116	114	116

Fig. 19. - The data recorded for each exercise copied to Microsoft Excel

HR values recorded during exercise are on the rows which contains the encoding "-z". With all necessary data entered into Microsoft Excel the opportunities to use them for statistics are manifold.

SportTracks allows analysis of the HR dynamics in any area of the chart by an easy selection of areas of interest. The program will display the extreme values (beginning and end) and the average of selected surface (Fig. 20).

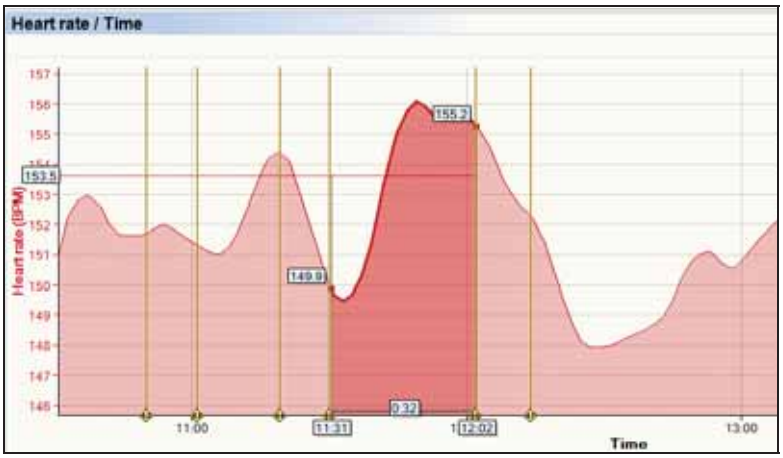


Fig. 20. - Analysis of a single zone in SportsTracker Pro

There are many systems that are used to record the dynamics of HR during physical activities, but their importance is given by the mobility that users have in terms of control and analysis of data recorded. The proposed system in

this case is used for over a year and has allowed, so far, the use of data in all forms needed for research.

We believe that the main advantages of the proposed system are the high compatibility between system components and a high mobility of data usage and data transfer within the system from one software to another.

Acknolwdgements

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REFERENCES

American College of Sports Medicine. (2005). *ACSM's Guidelines for Exercise Testing and Prescription - Seventh Edition.* Statele Unite ale Americii: Lippincott Williams & Wilkins.

Billman, G.E. (2011, November 29). *Heart Rate Variability – A Historical Perspective.* Retrieved January 27, 2013, from *www.frontiersin.org*: *http://www.frontiersin.org/Journal/DownloadFile.ashx?pdf=1&FileId=1969&articleId=16984&Version=1&ContentTypeId=21&FileName=fphys-02-00086.pdf*

Burke, E.R. & Polar Electro Inc. (1998). *Precision Heart Rate Training.* Statele Unite ale Americii: Human Kinetics Publishers.

Derevenco, P. (1998). *Elemente de fiziologie ale efortului sportiv.* Cluj-Napoca: Editura Argonaut.

Google Inc. (2014). *Android*. Retrieved aprilie 29, 2014, from android.com: *http://www.android.com/*

Microsoft Corporation. (2014). *Explore Windows 7 features*. Retrieved April 29, 2014, from microsoft.com: *http://windows.microsoft.com/en-us/windows7/products/features*

Parker, S. (2007, November 6). *History of Heart Rate Monitors.* Retrieved January 27, 2013, from *www.articlesbase.com*: *http://www.articlesbase.com/health-articles/history-of-heart-rate-monitors-253755.html*

Polar Electro. (2014). *Polar WearLink®+ transmitter with Bluetooth®*. Retrieved May 2, 2014, from polar.com: *http://www.polar.com/en/products/accessories/Polar_-WearLink_transmitter_with_Bluetooth*

Samsung Electronics Co. Ltd. (2014). *Samsung GALAXY Note II*. Retrieved May 2, 2014, from samsung.com: *http://www.samsung.com/global/microsite/galaxynote/note2/index.html?type=find*

SportsTrackLive. (2014). *Android*. Retrieved May 2, 2014, from sportstracklive.com: *http://www.sports-tracker.com/*

Wilmore, J., & Costill, D. (1999). *Physiology of sport and exercise - 2nd edition.* Statele Unite ale Americii: Human Kinetics Publishers.

Zone Five Software LLC. (2014). *SportTracks 3 Features*. Retrieved May 5, 2014, from zonefivesoftware.com: *http://www.zonefivesoftware.com/sporttracks/features/?b1*