Journal of Automation and Control, 2015, Vol. 3, No. 3, 67-70
Available online at http://pubs.sciepub.com/automation/3/3/5

DOI:10.12691/automation-3-3-5

Proposal of Mobile Application for Rehabilitation

Rudolf Jánoš*

Department of robotics, Technical university of Kosice, Kosice, Slovakia
*Corresponding author: rudolf.janos@tuke.sk

Abstract The article describes the first version of application designed for virtual rehabilitation patients. The aim of this application is to facilitate, access and helps patients get regular exercise. The basic requirement is to perform exercises without special equipment. Therefore, our idea emerged to specialize in smartphone and use sensors incorporated therein. The article describes two kinds of sensors normally based in a smartphone with examples how it could be used. The application was developed for the Android operating system because of the broader representation in our region.

Keywords: *rehabilitation, upper limb, android, virtual rehab*

Cite This Article: Rudolf Jánoš, "Proposal of Mobile Application for Rehabilitation." *Journal of Automation and Control*, vol. 3, no. 3 (2015): 67-70. doi: 10.12691/automation-3-3-5.

1. Introduction

Virtual rehabilitation brings several advantages over conventional rehabilitation practice. Level can be dynamically changed according to specific needs coming from previous exercise. Interactive games and activities bring greater motivation than conventional exercises hospital. Perhaps the most important is the recording of the results in real time, resulting in a better understanding of the progress of the treatment.

2. Virtual Reality for Rehabilitation

The main reasons for the introduction of virtual reality in rehabilitation practice is more attractive rehabilitation process as well as increase capacities and capabilities rehabilitation workers.

Popularizing the rehabilitation process is psychologically significant impact on speeding up the process and improve the overall results of healing. Degradation, or minimize the impact of the hospital environment has a positive effect on the psyche of patients. In a domestic environment in a circle of family members treated defect loses its priority status within the current priorities of the patient. It also deals with other activities that enable it to "forget" their health problems. [6]

This aspect is particularly significant in pediatric patients for whom the traditional rehabilitation exercises like something important and necessary. Transformation of classical rehabilitation exercises in various degrees of control computer applications and games can be suppressed perception of rehabilitation as medical acts. A similar effect has appropriately chosen a rehabilitation program for the elderly in which the patient suppresses the feeling of dependence on another person. Home rehabilitation allows for flexibility and easy access. Patients are able to carry out their rehabilitation programs in order to follow their individual plans. Depending on the severity of the defect, patients may participate in the intensive level of therapy several hours per week or follow a less demanding regime. Possibility home rehabilitation is usually used by individuals who are not able or willing to travel frequently, or require treatment of only one type of rehabilitation therapist. The main drawback is the lack of a home rehabilitation specialized equipment. However, the treatment received at home gives people the advantage to practice their skills and create your own strategy to reduce their disability in the space of their own environment. [2,11,12,13]

The second aspect is to increase the capacity possibilities of rehabilitation workers. As mentioned in Europe there is an aging population. This increases the number of residents who to speed up the recovery process as well as the most successful cure urgently need rehabilitation support. Increasingly, as rising demand for rehabilitation capacities. These may be increased movement of individual rehabilitation exercises in the home. On the physiotherapist would thus remain burden settings appropriate exercise and control. This could be realized by remote access, data sharing and automatic transmission of results exercise. The patient is not excluded from the review process, although the quality and clarity of transferred exercises at home is not completely controllable. For this reason, should be given the choice of appropriate exercises and different categories of eligible patients increased attention. [6,9,10]

In the implementation of concrete solutions rehabilitation exercises so far carried out two principles of control of interactive virtual environment:

• Position control and measurement components of the body / in hand users - joystick, interactive controls (Wii, PlayStation), virtual helmet, interactive jackets and gloves,

• Extracorporeal placement of components - cameras sensing movement microphones. [6]

Outside, it was not only in the virtual rehabilitation using other sensors to collect information on the current status and condition of the patient - infrared temperature sensors, Heart Rate, Blood Pressure and under. Said sensors allow application deployment adjust the load and speed exercises adequately state the user. This feedback minimizes the risk of overloading, but adapts the load sufficiently, which helps the patient to quicker healing process. [6]

3. Design and Implementation of Application Virtual Rehab

In order to minimize the complexity of the structure and the resulting application was at the beginning of each exercise should be classified based on how they are measured by internal sensor mobile device. This classification at a later stage helped unify the various sub-programs of exercise and thus greatly help to reduce the final size of the application. [1]

The distribution of individual exercises is based on the choice of measuring parameters of each sensor as well as the method for measuring the specific exercises. On balance, I suggest six basic categories which, in the current version of App Inventor 2 environment and the possibilities of mobile devices designed cover my rehabilitation exercises, suitable for application solutions in program Virtual Rehab and on exercises using:

- Touch screen
- Sensor lateral inclination (roll)
- Sensor lateral tilting of the retaining phase (Roll)
- Sensor vertical inclination (Pitch)
- compass sensor (Azimuth)
- A combination of lateral and vertical sensor.

When designing the basic structure of Virtual Rehab I came from the design flow chart that describes the structure of the program, each stage of the selection rehabilitated area and the final rehabilitation practice. Finally, the structure reflects the proposed category 6 exercises which are schematically noted of such subprograms of the application Figure 1. [6]

The actual exercise starts calibration phase. This phase is used to define the initial position of the mobile device before exercise and at the same time is used to determine the average dispersion of the current measured values precisely measured parameter sensor. The need for calibration is based on the uncertainty of measurements of individual sensors. Elaboration of such variance values should absolutely avoid relevant measurement and evaluation of results. Therefore, I have the judgment and decided to test several test sample as relevant for the determination of the average take into account the 100 measurements. At the same time expressing the determination of the average current location of the mobile device it is in the calibration of determining the average dispersion values. This variance in further measurements determines the range of values. It expresses the interval in which it is possible to expect change the value of the measured parameter without changing the position of a mobile device. After this phase comes the actual calibration exercises that course and structure for each program is different, so the following subprograms are described in separate sections. [3]

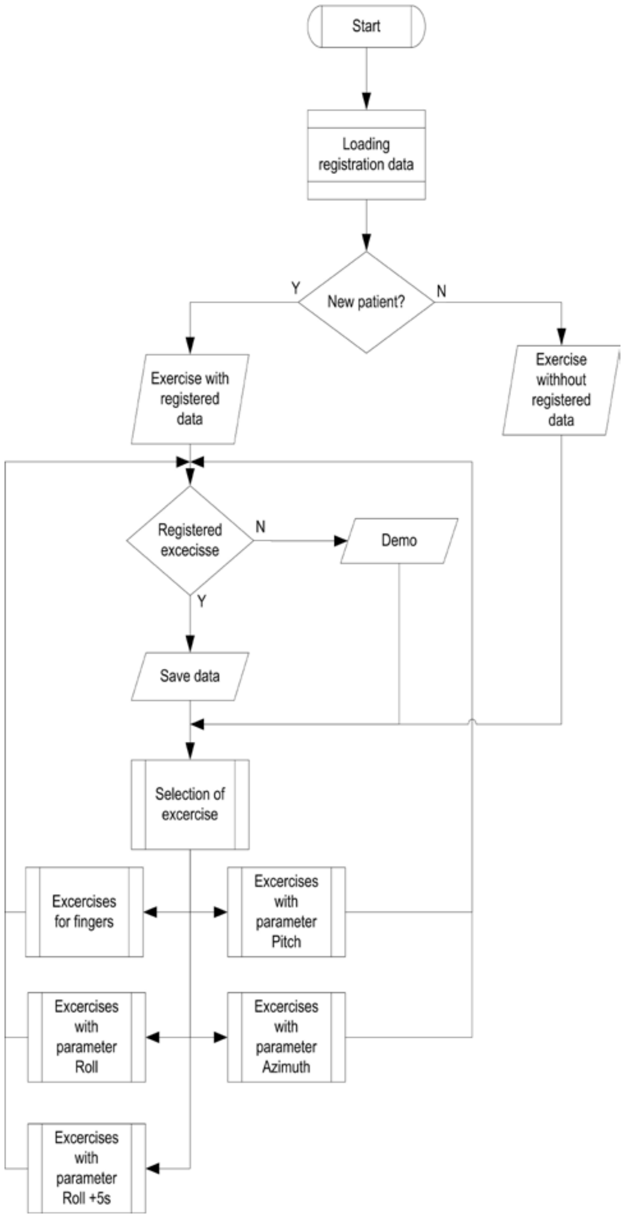

Figure 1. Basic structures of application

Exercises using azimuth sensor

To verify the functionality of the program I chose to exercise the extension of the wrist mobility - simple backward movement from the open position to the maximum flexion and then to the maximum extension. As previously mentioned, measurement principle is based on measuring of position smartphone to the magnetic field of the Earth. The purpose of this type of exercise is practicing mobility particular rehabilitated areas, while improving range of motion stretching and lengthening tendons withdrawn after long-term fixation in the plate, respectively, after surgery. The aim is to obtain a measurement value of angle, which reflect the scope of the free movement of limbs rehabilitated. At the same time during exercise extreme values they recorded maximum range of motion. This ensures that the recording not only the range of motion, but in the case of reduced mobility and the area in which this reduction occurs, Figure 2. [7,8,9]

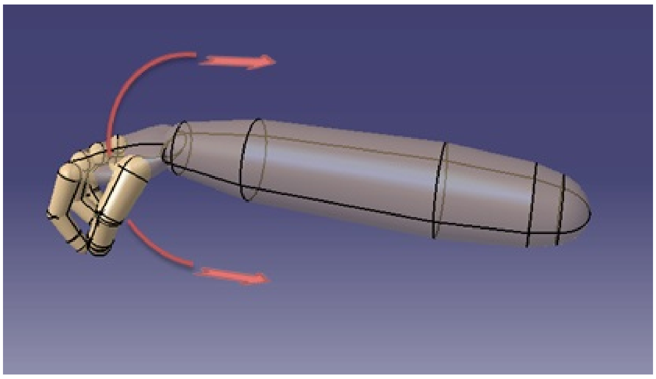

Figure 2. Wrist movement in the median plane

Then passed the initial phase of the program to measurements on which the user is alerted short vibrating. Initial phase measurement I have proposed in order to prevent distortion of the results. I suppose that, despite the clear and understandable instructions to instructional videos, are found several users who start during exercise in the opposite direction. In this part of the program therefore will wait to move in the right direction and to subsequently undergo a phase of exercise itself, which records the number of exercises as well as range of motion applied by the user.

Detecting the direction of movement is carried out by comparing the difference in the measured values of the last and the current angle. During the motion, when the differential value changes from positive to negative (or vice versa), the limit values of the last measured angle recorded as the maximum angle in a given direction. To simplify the conditions for recognizing the value of difference, I suggested a coefficient k = -1 (initial value). The coefficient at each change of direction multiplied by the number (-1). This ensures that the differential value is multiplied by the always / m at most equal to the number 0. At the same time we coefficient indicates the direction of movement (k = -1 - direction; k = 1 - direction). On this basis, it is possible to determine the end of the cycle, which phase of the exercise, the user is recorded and possibly complete a repetition of exercise (worth repeating count assign a value to count = count + 1).

Exercise cycle is repeated as far as count variable takes the value of 10, which passes through the score subroutine phase. In this phase, the display shows the measurement results achieved with color-coded values. I suggested three categories of colors.

• Red - Mobility of up to 60% compared to a standard mobility

• Orange - mobility in the range of 61-85%

• Green - mobility better than 86%

If the user does not share their results with their exercise rehabilitation specialists, application subsequently transmit measurement data to a Web database accessible only to the appropriate specialist. The current version of the transmitted data:

• date of the exercise

• particular kind of practice

• The average amount of exercise

• The maximum and minimum values of angles in both directions of movement. [7]

Exercises utilizing sensor lateral tilting with the retaining phase

In the first step was also mentioned calibration of the smartphone and the calculation of confidence.

The aim of the exercise is to improve the mobility impaired and weakened tendons, this category is a priority objective of strengthening not only the tendon apparatus, but also to improve muscle tone. To this end, it is necessary to measure the time priority of the patient and the angle in the retention phase and measurement of the range of movement of secondary importance. Limb movement after the retention phase is for relaxation, not on trying to achieve the maximum deflection, Figure 3.

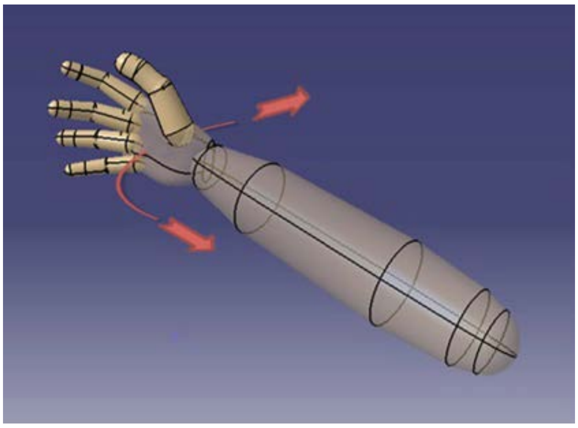

Figure 3. The basal plane and the wrist plane are perpendicular

This category has the most numerous exercises exercises (up to six). For a preview of the functionality I because of the integrity of the application chosen as in the previous subprogram area with two wrist exercises on extension and flexion. I tried to point out the possibility of using a category of sub-program for the use of multiple exercises, no writing exercises and results are presented separately.

The structure of a subroutine is nevertheless significantly different from previous practice. The main difference is the initial position of the limbs and the initial direction of motion. The previous practice, the initial position in the open position (balanced wrist). When exercise the retention phase it is based on the relaxed limit position to the maximum deflection, which leads to the arrest of movement, which aims to strengthen the ligaments and muscles in a stretched mode. [4]

The first phase is carried out initial calibration and measurement identical to the former category. From the concept and structure of the program, this step is identical for all the suggested categories. The difference will consist only in the measured parameters.

Direction of motion detection is performed similarly by comparing the difference in the measured values of the last and the current angle. When changing direction, however, records the maximum range of motion, that is the angle only in extreme retention phase. Similarly, and as with other proposed exercise is the basic number of repetitions of 10 exercises in the series. If necessary, increase rehabilitation doctor advises you to exercise several times a day. Rarely a larger series. This strategy aims to minimize the instantaneous overload. [13] The end of this phase of the exercise is similar to display the results, while the results of the color scale is divided into categories:

• Red - achieving maximum angle of 60% compared with a standard value or time in the retention phase is less than 2.5 seconds

• Orange - get the maximum angle at the level of 61-85% while retaining the time phase at least 2.5 seconds

• Green - get the maximum angle at a level higher than 85%, while the maximum time position of at least 4.5 seconds

Writing the results of measurements it is required for all measurements other exercises for a better comparison of each exercise. Shared data are entered into the website database.

Acknowledgement

Testing of proposed applications are confirmed despite slight lack of opportunity to deploy Virtual Rehab in rehabilitation practice. A prerequisite for the realization is to implement the remaining 4 exercise categories to final solution applications. A secondary objective is to solve the question of writing the results of the exercise. As I mentioned, the sharing of data on a database project, App Inventor is easy and fast, also a way of creating new databases for rehabilitation workers and their patients is relatively simple and easily manageable even for less computer-savvy people. Processing and presentation of results is stored in this way but rather limited. The possibility of sharing data by using the tool “Fusiontables”, also in the web interface of Google. Shared data are clearly listed in the tables, but the setting is a bit more challenging. There would be in place to verify the possibility of automated creation of spreadsheets, or creating multi-purpose table that could be used as a template for all future users. [10]

The continuation of the project will be devoted to verify operation on the test specimen. The data obtained from the measurements and the observations incorporated into application solutions that will output of the project.

This contribution is the result of the project implementation: 059TUKE-4-2014 Rozvoj kvality života, tvorivosti a motoriky hendikepovaných a starších osôb s podporou robotických zariadení.

References

[1] CAMEIRAO, Mónica S. et al.: The Rehabilitation Gaming System: a Virtual Reality Based System for the Evaluation and Rehabilitation of Motor Deficits. In: Virtual Rehabilitation 2007: Zborník z medzinárodnej konferencie, Benátky: IEEE, 2007. s. 29-33.

[2] CHARLTON, Paula C. et al.: Reliability and concurrent validity of a Smartphone, bubble inclinometer and motion analysis system for measurement of hip joint range of motion. In: Journal of Science and Medicine in Sport. Roč. 18, č. 3 (2015), s. 262-267.

[3] MILANI, Patrizia et al.: Mobile Smartphone Applications for Body Position Measurement in Rehabilitation: A Review of Goniometric Tools. In: PM&R Journal. Roč. 6, č. 11 (2014), s. 1038-1043.

[4] HAJDECKER Alexander.: Návrh virtuálnej robotickej rehabilitácie. Diplomová práca. 2015.

[5] KUTTUVA, Manjuladevi et al.: The Rutgers Arm: An Upper-Extremity Rehabilitation System in Virtual Reality. In: Fourth Int. Workshop on Virtual Rehabilitation 2005. [online]. Catalina Island: Rutgers, 2005. [cit. 2015-04-08]. Dostupné na internete: <http://www.ti.rutgers.edu/publications/papers/2005_iwvr_kuttuva.pdf>.

[6] JÁNOŠ Rudolf, SUKOP Marek, HAJDECKER Alexander: Transfer inovácií. Č. 31 (2015), s. 85-87.

[7] Yoon, Jungwon et al.: Control Optimization of the Rutgers Ankle Rehabilitation Interface. In: Proceedings of Advances in Robot Dynamics and Control Symposium 2002, ASME International Mechanical Engineering Congress and Exposition, Louisiana: 2002. IMECE2002-32655.

[8] MILANI, Patrizia et al.: Mobile Smartphone Applications for ;Body Position Measurement in Rehabilitation: A Review of Goniometric Tools. In: PM&R Journal. Roč. 6, č. 11 (2014), s. 1038-1043.

[9] FERRIERO, Giorgio et al.: Reliability of a New Application for Smartphones (DrGoniometer) for Elbow Angle Measurement. In: PM&R Journal. Roč. 3, č. 12 (2011), s. 1153-1154.

[10] MILANESE, Steven et al.: Reliability and concurrent validity of knee angle measurement: Smartphone app versus universal goniometer used by experienced and novice clinicians. In: Manual Therapy. Roč. 19, č.6 (2014), s. 569-574.

[11] KRANZ, Matthias et al.: The mobile fitness coach: Towards individualized skill assessment using personalized mobile devices. In: Pervasive and Mobile Computing. Roč. 9, č. 2 (2013), s. 203-215.

[12] JESENSKÝ, Ján: Uvedení do rehabilitace zdravotně postižených. Praha: Karolinum, 1995. 159 s.

[13] SMRČKA, Václav – DYLEVSKÝ, Ivan: Flexory ruky. Brno: IDV PZ, 1999. 162 s.