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# A framework for the development of measurement and quality assurance in software-based medical rehabilitation systems

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**Abstract**

The field of computer and robot-assisted rehabilitation system is rooted in the principle that software must be largely errorless, user-friendly, robust, accurate with respect to data, respond in a timely manner, and yet inexpensive, which lead to enhanced patient outcomes. In this digitized age, computerized and robotic rehabilitation systems act as a vital support for disabled individuals. Till today, different types of software for medical rehabilitation systems have been developed and applied to the rehabilitation process successfully, but improvement in quality and measurement of rehabilitation software is continuously in progress. Some ways of the software production have been established but further measurement process has always been a necessity. This paper presents the framework and recommends establishment of software quality measurement in computer- and robot-assisted automated medical rehabilitation system. Also, a brief discussion of rehabilitation technique and their software quality is also included. Lastly, we include its importance in medical technology and quality. To satisfy the end user, vendor satisfaction, software measurement and quality assurance are important components in software-based medical rehabilitation systemsy.



*Keywords*: *Measurement, Medical, Quality, Rehabilitation, Robot, Software*

## 1. Introduction

In the past few years, there has been a rising awareness about using more precise approaches to software measurement and quality assurance in medical technology devices. Software is the set of instructions or computer programs which instruct the medical device to run smoothly. In software engineering, measuring software effectiveness and value has become critical and central part of the software development project [1-2].

Researchers endeavour to develop original, easy, portable, inexpensive, and real-time automatic system for rehabilitation with the help of other suitable methods, such as biosensor, suitable hardware, software, Internet technology, robot, etc. [3]. A computer with software-supported rehabilitation system is one of the core parts of the medical recovery technology. Because, nowadays, computer technology is very commonly employed in the field of medicine.

Moreover, virtually all electrical medical components contain some computerized devices [4]. As software is the central part of computerized rehabilitation process, obviously the embedded software must be errorless, user-friendly and of assured quality, because superiority of software has been always one of the prime challenges in the computerized

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rehabilitation system. In this paper, we tried to get answers for the following key point: necessity and methodology of software measurement and quality assurance in software-based rehabilitation technology.

Previously, many studies have been conducted on the results of software measurement, quality, testing, validation, cost and other attributes related to computerized devices. But, particularly, applications of these measurement attributes are relatively new in rehabilitation software. Few articles were explored for this topic where authors have discussed and explained the software measurement, quality assurance and cost analysis in supported software in medical applications. Miniati et al. analysed and evaluated medical applications using different clinical aspects [5]. They also presented the methodology for clinical software safety plan and necessity for software maintenance. Forstrom reported about the necessity of medical software certification and focused on the validation of Internet medicine and treatment system [6]. Then, Dolores et al. analysed several medical devices used for medical software [7]. An article dealt with medical software [8]. Harwin et al. made a comparison of rehabilitation robotics languages and software to assist individuals with disabilities [54]. Also, in some of the other papers, all these issues related to software and rehabilitation systems are discussed briefly [9–11,51].

However, we did not find any guideline and specific article for medical rehabilitation software measurement and their quality assurance. So this field is still relatively undeveloped or new for researchers. To develop a high-quality and error-free software, following points need to be taken into account [12]:

- During development of the software, the input value should be very clear, because it helps to simplify software development process.
- Better workplace for software development, good technique, and highly skilled people are essential for medical software measurement.
- Planning for software development should be very clear, i.e. developing, measuring, controlling and improving processes.

In a nutshell, in this paper, we have presented a correlation between software measurement process with its quality and robot- and computer-assisted rehabilitation systems. The paper is organized as follows. In section 2 we provide the concise aim of our research and important as others. In section 3 we attempt to summarize some difficulties without software measurement in the medical recovery process. In section 4, we discussed the responsible persons for the software. Then, in section 5 we present assumptions of our work. After this, several methodologies are presented in section 6. The remaining two sections are discussed as probable outcomes and conclusion with the future research work.

### *1.1. Automated Medical Rehabilitation Systems*

In this computerized world, the automatic rehabilitation system plays a vital and fundamental role to improve a disabled person's life. Rehabilitation engineers always try to develop easy-to-operate, cost-effective and flawless systems. Presently, software-assisted technology for rehabilitation is becoming a skill to be acquired quickly than the other traditional systems. As the word “automatic” is included in rehabilitation technique, it obviously focuses on the engineering term. On this basis, rehabilitation engineering is described as the design, development and application of engineering methods and devices to improve disabled patients’ problems. In addition, after successfully applying these recovery technologies on the subject with impariment, it is clear that the need for further development and fulfilling any gap within the device is always present [14]. Moreover, proper use of the assistive technology improves the quality of life, self-determination and quality of care for the immobilized subject [19]. Nowadays, there are many commercial software-assisted rehabilitation systems available such as PDA-based system, telemonitoring system, haptic device, orthosis, virtual reality (VR) software, biosensor-assisted device, wireless system, Internet-based system, and so on.

Rehabilitation robotics is a field of study that aids in the understanding of the treatment process through the application of robotic devices. It includes the development of robotic psychoanalysis and the application of robots as rehabilitation aids instead of exclusively used as assistive tools [52,53]. Automated rehabilitation by means of robotics is usually welcomed by patients and has been found to be a useful supplement to treatment of individuals suffering from any injury of the body. The various types of rehabilitation robotics include assistive and therapeutic robotics, mechatronics in prosthetics, artificial human, exoskeletons, robotics for caregiving, neural-machine interfaces and control, robotics for human-motion analysis, psychosocial robotics, etc. However, to make them automated and effective, software is essential.

### *1.2. Software Measurement*

Software measurement and metrics are interrelated. A quantifiable characteristic of software is the metric, where the process of mapping from real-world attributes to a mathematical representation is done. A mathematical relationship between metrics and measurement is called a model, which needs to be validated [27].

Entity and attribute are the two fundamental components of measurement [13]. The entity is any object or more preciously any item. For example, any particular job in the real world is an entity. In software engineering, testing a phase