

Robotic Restorative Massage to Increase Working Capacity

Vadim Golovin^{1*}, Aleksey Samorukov², Maksim Arkhipov³ and Liudmila Kocherevskaya⁴

¹Moscow Scientific and Practical Center of Medical Rehabilitation, Restorative and Sports Medicine, Moscow, Russia

²Russian Scientific Center for Medical Rehabilitation and Balneology, Russia

³Moscow Polytechnic University, Moscow, Russia

⁴Moscow Aviation Institute, National Research University, Moscow, Russia

*Corresponding author: Vadim Golovin, Moscow Scientific and Practical Center of Medical Rehabilitation, Restorative and Sports Medicine, Moscow, Russia; Tel: 74952230523; E-mail: medicalrobot@mail.ru

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Abstract

The possibilities of manipulative robots to perform techniques of restorative massage, increasing the psycho-physiological mood of the working population in order to increase the productivity of labor are considered in this article. The robot control making possible to perform a mass preventive massage is offered. Most of the studies were carried out using the so-called force points trained on robots with one-dimensional force training. The more convenient and quick training method by demonstration is proposed. At the same time, the unloading of the masseur's hand and the accuracy of reproduction of trained trajectories are provided to a much greater degree. The hand of the masseur by means of the massage tool deforms the patient's soft tissues. To teach by the demonstration of spatial trajectories, the robot is in admittance control mode, without resisting the movements of the masseur's hand, fixed on the robot end link. In admittance control mode, the robot tracks exactly the movements of the masseur's hands or corrects them with the necessary force. Currently, there are robots with force control, which can organize the required admittance control mode. These robots are not specialized to perform mode massage and are not mass-produced, so they are quite expensive. If the demand increases, the cost would be much lower. Studies that will determine the techniques for performing robotic massage are needed. As an initial basis, methods of manual restorative and sports massage can be taken.

Keywords Restorative medicine; Massage robot; Force control; Mass application; Training; Working capacity

Introduction

Labor productivity is the main indicator of the economy of the state. Productivity increases with the growth of automation level, but while the person manages production then his knowledge and psycho-emotional state determine the results of work. Concerning for daily bread, fatigue, stress are typical for a working person, except his creative activity. To get rid of some disturbing effects of work, a person should be preventively prepared.

Among sensations perceived by the senses of a man, tactile are widely used as informative and medical ones. The use of tactile influences as restorative and therapeutic has been known to mankind for a long time [4]. The theme of massage will never cease to be relevant, because tactile contact is a natural need of any living organism. There are medical and technical problems with the use of tactile stimulation. Despite the positive influence of massage on human health, the physical culture that provides massage is not sufficiently developed to make massage an available procedure. This hampers the development of new devices and techniques for their joint work with humans [1].

Prevention and Mass Application

For each nation massage is a part of their cultural heritage, including Russians, it cannot be the prerogative of any department. All ancient healing practices rely on massage. And now it must be an

obligatory means of promoting human life and health. Restorative massage has preventive direction. Do not treat diseases, but prevent them. Russian scientist I. Zabludovsky wrote in his dissertation "Materials to a question on massage action on healthy people" in 1882 about necessity of application of massage devices for healthy people [4]. The word "robot" appeared much later.

Robotic Massage

The main obstacle to the mass introduction of a restorative massage for the population is the deficit of masseurs, the limitation of massage devices, and the cost of automated equipment. Developed mass-produced means are massage chairs, having a number of restrictions in comparison with the hand of a masseur.

The natural methods of development of massage device are bionic ones, which repeat the motor abilities of the person, his hands and feet, their coordination and power capabilities [1].

The manipulation robots with adaptive control and their work together with other means of restorative medicine are the most promising. Only manipulation robots of a restorative use can solve the problem of mass replacement of masseurs.

Massage is necessary for everyone as a restorative, preventive one and as a therapeutic means of treatment. This type of massage can be performed by contemporary robots. Restorative massage for health improvement of the population in the future will be affordable and mass used. Some research designs of manipulation robots for performing massage, indicating an increased interest in robotic massage are known [3].

Robot Training

One of the compulsory procedures for interaction between the robot and the patient during massage is to train the robot some necessary trajectories, which must contain geometric and force information.

If the robot is equipped with force control along the tool axis, then deformation of the soft tissue can be achieved with a given pressure of the tool in the so-called force point [5]. A number of such force points are further interpolated into massage trajectories, taking into account the given forces. The disadvantage of the method is a large number of force points and the difficulty of retraining during patient shifts.

To eliminate the drawbacks of the method of training force points, method of spatial training by demonstration with a manual assignment of massage trajectories was proposed [3]. At the beginning of the procedure an experienced masseur diagnoses the area of soft tissues with his hands and outlines a massage plan. Then he moves robot end link with the tool fixed on it along the necessary trajectory taking into account the preliminary diagnostics. The mode of not sharp, not fast movements of a masseur's hand, inherent for massage, allows the robot, working in an admittance control mode, not to resist the hand of the masseur. The hand of the masseur feels resistance only to interaction with soft tissues. The robot sensors record the trajectory in order to repeat it.

Considering the repeated diagnostics, the masseur easily retrains the robot, as well as easily performs the first training after patient's positioning on the table.

In proposed method of training masseur's hands deform soft tissues with the help of the tool, which material and form can amplify the massage impact.

Development Prospects

Immobility of a patient, especially during relaxation massage practically does not cause complications. Small shifts in the direction of the robot tool axis can be compensated by the control subsystem for the given force impact.

The technical vision system aimed at the reference points of the patient's massaged area can make compensation of significant deviations. At present, it is planned to repeat or change the massage movements considering the diagnosis of the patient's condition [3].

However, diagnostic data can also be used for trajectory planning, taking into account the model of massage interaction. Diagnostic data and the rules for their use, accumulated in practice, will be the basis of the knowledge base necessary for creating a model of massage interaction.

Performing massage, especially therapeutic, requires knowledge of the patient's condition parameters. One of the measured parameters characterizing the patient's condition is his electric skin resistance [2]. Measurement of electric skin resistance can determine the course and end or change of the massage procedure. When the attitude to preventive massage as a necessary means of relaxation changes, the demand for specialized robots would increase, the cost of serially produced robots would constantly decrease. There will be robots not only for clinics and salons, but fully safe family robots and robots for individual use [3].

Conclusion

This article supports the optimism of medical specialists of restorative medicine and developers of medical robotics. The problems are both medical - to prove the need for mass application of robots for massage, and technical - to expand the possibility of developing inexpensive robots. The problem of employment of human-masseurs can be solved by the organization of their training, adapted to the joint work of a person and a robot, considering the individuality of the patient as a healthy person.

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