

Robotic and sensor technology for frozen shoulder Rehabilitation

Chinmay Bahirde¹, Pratik Phansopkar²

¹UG Scholar, Department of Musculoskeletal Physiotherapy, Ravi Nair Physiotherapy College, Datta Meghe Institute of Medical Sciences (DU), Sawangi (Meghe), Wardha, Maharashtra, India.

²Associate Professor & HOD, Department of Musculoskeletal Physiotherapy, Ravi Nair Physiotherapy College, Datta Meghe Institute of Medical Sciences, Swangi Meghe, Wardha, Maharashtra, India.

Email: drpratik77@gmail.com

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Abstract

A common clinical shoulder problem is frozen shoulder. The degree of shoulder joint movement must be measured as part of the rehabilitation procedure. These assessments can be used to assess the severity of a patient's disease, set rehabilitation goals, and determine the appropriate level of activity difficulty, as well as comprehend the rehabilitation's impacts. In the healthcare industry, robots are rapidly being used; as they are in many other industries, Specifically for hospital logistics support, surgery, and rehabilitation. Because rehabilitation affects millions of individuals all around the world, there has been steady growth in the rehabilitation robotics sector over the last decade, with the advent of new technology aimed at overcoming the different challenges that this industry faces. A model is proposed in this study for identifying movements produced during frozen shoulder rehabilitation activities. The model is made up of wearable wireless sensor network (WSN) inertial sensor nodes that were built particularly for this investigation and enable for the identification of inertial sensor nodes of physiological movements anywhere. We describe current robotic systems for shoulder rehabilitation in this work, with an emphasis on indicators and further emerging technologies that, when used with robots, can enhance the advantages of rehabilitation for regaining shoulder function.

Keywords: Frozen shoulder, IMU sensor, WSN (wireless sensor networks), Exoskeleton, End-Effectors.

INTRODUCTION

Using robotic technology, therapeutic activities led by a therapist who manipulates the body of a patient, traditional rehabilitation aims to regain motor function. In both neurological and orthopaedic patients, early and consistent therapy can significantly enhance long-term shoulder mobility. These devices can help patients repetitive practise allows you to limb movements that have been pre-programed and build associated sensory-motor abilities by providing external assistive support to the human body. This might permit the patient to prolong their workouts while also giving a measurable aim of consistency, which is difficult to obtain with traditional physiotherapy(1).

Frozen Shoulder-

Frozen shoulder is a phrase that describes shoulder mobility impairment due to damage to the shoulder capsule and soft tissues, causes this condition. In clinical practise, frozen shoulder is a usual shoulder issues patient faces. This ailment is characterised by a limitations of active or passive joint movements, stiffness, discomfort, and a decrease of shoulder muscle mass and strength(2).



Frozen shoulder affects between 2% and 5% of people in the general population. This illness primarily affects adults between the ages of 40 and 65, with women experiencing it at a greater rate than men (58:42)(3). Frozen shoulder is a unique syndrome with a natural history of spontaneous resolution that necessitates treatment that is separate from rotator cuff tears or osteoarthritis, among other shoulder ailments(4).

Potential applications of robotics in Shoulder Rehabilitation

SHOULDER PATHOLOGIES

Orthopedic	Neurological
Instability	Paralysis/paresis
Conservative	Post stroke
Postoperative	Post traumatic brain injuries
Stiff shoulder	Peripheral nervous system injuries
Idiopathic	
Postoperative	
Post traumatic	
Anthroplasty	Degerative diseases of the central nervous system
Rotator cuff tears	Muscular dystrophies
Other tendon or Muscle ruptures pectoralis major Deltoid	

Sensor Technology:

By giving external assistive assistance to the human body, these devices can help patients limbs that have been pre-programmed motions and build corresponding sensory-motor coordination through recurrent practises. This might help the patient to prolong their workouts while also giving an objective measure of consistency, which is difficult to do with traditional physiotherapy(5).

Wearable IMU-based sensor-



Inertial measurement units (IMUs) are employed to determine a physical object's movement direction and orientation. The wireless IMU (WIMU) sensor was presented as a wearable sensor that incorporates wireless transmission technology, and its uses in motor rehabilitation have expanded(6). Accelerometers gyrosopes were among the 6-axis microelectromechanical systems employed in the IMU-based sensors. These sensors gather information on the afflicted shoulder's angular motion. Shoulder angular measurements necessitate the use of three sensors. (7). The study's main constraints were the size, weight, and "wearability" of the wireless IMU sensor gear, all of which impact the desire for individuals application of the system. The accuracy and speed of transmission through wireless sensors can have a direct impact on the sensitivity of the user's interactions with the guiding system, and hence on the user's perceptions indirectly. This system's guiding software is incapable of giving patients with the support and trust have psychological characteristics that can only be provided by a true therapist(5).

Robotic rehabilitation systems may be classed or analysed from a variety of perspectives. Robots can be designed to aid patients in a variety of ways, depending on the control strategy: i) Passive: the patient's arm is moved by the robot; ii) active unassisted: the subject performs the exercise with no assistance from the robot; iii) active assisted: When the individual tries to proceed, the robot aids when the voluntary motions are insufficient; iv) resistive: When the individual tries to move, the robot aids when the voluntary motions are insufficient.

Robots may be classed into at least three types based on their mechanical characteristics: a) exoskeletons, b) end-effectors (also known as "operational type machines" or "manipulators"), and c) cable-driven(1).

a) Exoskeleton-

In recent years, exoskeleton-assisted rehabilitation has grown in popularity, and the employment of exoskeletons have proven a significant success in the realm of rehabilitation. Exoskeletons enhance therapy by providing a consistent training environment, adjustable support, and the ability to increase treatment intensity and dose while reducing physical strain on therapists. Rehabilitation using an exoskeleton methods allow patients to increase their number of motions, while also including safe and rigorous rehabilitation activities and allowing the patient's motions to be objectively assessed. As a result, rehabilitation exoskeletons are an excellent approach to enhance standard clinic therapy while also allowing patients to continue using simpler and more portable technologies, therapy and care may be provided at home(8-24).

b) End Effectors-

End-effector robots limit patient-machine contact to a single location on the forearm or hand of the patient. They don't require much in the way of patient size and morphology adjustment, but they clearly don't regulate all upper limb DOFs, mostly those involving the shoulder joint and shoulder girdle(1).

c) Cable Driven-

Various wires operated separately by different motors support and parallel manipulators that are cable-based or cable-driven can manipulate the patient's arm. External connections link cables having a fixed frame and an end-effector. It is possible to move the end-effector by adjusting the length of the cable while ensuring that none of the cables get slack. Because these systems just include wires and end-effectors, they have a little moving mass, the structures are modular and have excellent inertial properties. They are also simple to transport, have a cheap cost, and need little maintenance, all of which are important attributes for commercial use. Wires' physical properties, which allow them to only pull and not push, is one significant disadvantage. They also make a comparison between the human shoulder and a more basic machine-like spherical joint with three degrees of freedom, with no control over the shoulder joint or shoulder girdle(25-35).

Robotic Rehabilitation-

The pace, residual voluntary activity's direction and strength can be measured with robotic shoulder mechanical devices, as well as interactively assess and help patients during a motor activity, they can move a limb along a predetermined path, but they lack knowledge on specific muscle activation and scapular compensatory motion control. Using rehabilitation robots with functional electrical stimulation (FES) to maximise the advantages of each treatment and broaden the range of impairments is becoming more common(36-40).

Robots must offer appropriate input in order to help patients through sensory-motor rehabilitation training. Haptics is important because it allows the robot and the patient to communicate in both directions, which allows the brain to access the causal link in effort and error that is essential for motor learning. Patients can, for example, watch their motions while exercising in a virtual reality (VR) setting and in the virtual setting, strive to imitate the best motion patterns that are displayed in real life. By improving ambient diversity and promoting the subject's interest, VR can offset adaptation, avoid boredom, and so maintain attention(11).

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