A Mini review on Effectiveness of Reinforcement learning in Stroke Rehabilitation

Fatimah Kazi¹, Dr. Deepali Patil²

¹BPT student Ravi Nair Physiotherapy College, Datta Meghe Institute of Medical sciences (Deemed to be university) Sawangi (Meghe), Wardha, Maharashtra, India.

²Associate professor and HOD, Department of Musculoskeletal Physiotherapy, Datta Meghe Institute of Medical Sciences, Sawangi Meghe, Wardha, Maharashtra, India.

Email: dvjphysio@gmail.com
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Abstract

This review focuses on the Development of Reinforcement based therapies in the field of Rehabilitation of Post -Stroke Patients. The process through which a system’s (or organism’s) reaction to a stimulus is increased by reward and diminished by punishment (Positive and Negative Reinforcement, respectively) is referred to as reinforcement learning. [1] A plausible set of methods for recreating this reward distribution from experience has been discovered following recent breakthroughs in machine learning. Integration of Reinforcement learning through a Physiotherapeutic perspective is presented in this review. The Brain-Machine interface is a relatively newer as well as potential field which can be used for stroke rehabilitation based on the principles of reinforcement learning which is a subset of Machine Learning.

Keywords: Reinforcement learning, Motor rehabilitation, Stroke Rehabilitation, Machine Learning.

INTRODUCTION

Stroke, or Cerebrovascular Accident (CVA), is a type of vascular accident that affects the brain. It is a clinical Acute neurological impairment induced by a localized, cerebral, spinal, or retinal infarction with quick onset. [2] It occurs when the brain’s blood supply is cut off and is compromised due to blockage or interruption to blood flow. In 2010, there were an expected 16.9 million stroke incident, adding to the 33 million stroke survivors worldwide. [3] There are two Kinds of stroke: A blockage causes an ischemic stroke, while a ruptured blood artery causes a haemorrhagic stroke. Signs of Stroke are as follows: Hemiparesis, Hemi sensory loss, Hemianopia, Aphasia. Face and arm, motor and sensory impairments on the side opposite the occlusion. CT –scan and MRI is done to confirm presence of infarct and localise the area of cerebral oedema.

The Face Arm and Speech Test (FAST) is one of a diagnostic tool that aids in stroke screening It is just as sensitive for detecting as the ROSIER score (Recognition of Stroke in the Emergency Room). [3] The medical management Of stroke is primarily focussed on preventing worsening of the patient’s state and cerebral Oedema /development of neuronal cell death. A proven treatment is endovascular intervention combined with medical management, including IV (intravenous) tissue plasminogen activator.[4]

Rehabilitation is an important element of the recovery process after a stroke. More number of individuals will survive stroke thanks to advancements in acute stroke treatment. Motor impairment due to stroke accounts for profound limitation in activities of daily living, inability to perform significant tasks and participation restriction in various spheres of life. Physicians, therapists, nurses, and other healthcare specialists, as well as patients and their social networks, are all part of a multidisciplinary team that delivers post-stroke rehabilitation. The ability of the nervous system to change its activity in response to intrinsic or external stimuli by changing its structure, functions, or connections is known as neuroplasticity.

To further extend the boundaries of post-stroke therapy, electrophysiological therapies that enhance neuroplasticity are being investigated. Potential motor rehabilitation treatments, such as stem cell therapy, exogenous tissue engineering, and Brain–
computer interface technologies, could be critical in assisting stroke victims in regaining control of their bodies. [5] Virtual reality and game-based therapy are proven useful in rehabilitating stroke patients. They are also fun, engaging and personalised. Some aspects of traditional Physiotherapy that are administered one-on-one by an occupational therapist can be replaced with a mobile game-based VR upper extremity rehabilitation programme. [6] To improve the motor outcome of stroke rehabilitation, researchers are using brain computer/brain-machine interfaces (BCI/BMI) now being developed and experimented as an intervention prior to regular physiotherapy.

Feedback data about a product's reactions, a user's work performance, and so on, is utilised to improve the Work Performance. Neurofeedback is a form of biofeedback which emphasizes self-regulation using real-time displays of brain activity or electroencephalography (EEG). Neurofeedback is a type of training which involves ability to perceive surroundings, act, and learn through trial and error.

The process of promoting or creating a belief or habit of behaviour is known as reinforcement. It can be understood as the action or process of reinforcing or strengthening a particular thing/trait. The law of reinforcement is one of most fundamental concepts in all learning theory. Reinforcement learning is a machine learning training approach that rewards desirable behaviours while punishing those that are undesired. It's crucial to understand the difference between rewards and punishments if you want to survive. Classical investigations have shown that the firing of dopamine neurons in the mammalian midbrain is positively associated. [7] Reinforcement Learning (RL), a subset of Machine Learning (ML), has received a great deal of interest in the medical world because it has the potential to assist the development of customized therapies. [8-20] Through trial and error, a reinforcement learning agent may perceive and interpret its surroundings, act, and learn. Reinforcement Learning (RL) is a term that refers to an agent (also known as a controller) that learns in order to achieve a goal through interacting with the environment (or controlled system). The agent, in particular, chooses actions (or control signals), which cause the environment to change its status and return rewards in the form of specific numerical values, either positive or negative. The agent's goal is to maximise the amount of reward earned over time. A task is a detailed framing of an environment, including how the reward is generated. The reward generates the Goal for the agent.

Based on reinforcement learning Robotic devices are also being used for Motor rehabilitation. The reinforcement for this can be provided by Audio-visual or Haptic method [21-30]. Motor exploration, a trial-and-error approach designed to improve motor outcomes, is useful in the field of motor learning. Motor exploration has been connected to reinforcement learning, in which behaviours that result in positive consequences (i.e., reward) are reinforced and expressed more frequently, whereas acts that result in negative results (i.e., punishment) are avoided. [31-33]

In the journal of NeuroEngineering and Rehabilitation (2016) Ballester et al coined a new term known as Reinforcement-Induced Movement Therapy (RIMT) for motor rehabilitation technique. The experiment was performed using a strategy in Virtual Reality (VR) making the use of principles of Reinforcement. A significant improvement using this technique was observed. [11]

CONCLUSION:

Reinforcement learning has a significant potential in Motor rehabilitation. It can be used to improvise and understand various techniques utilised in rehabilitation in stroke patients through Machine – learning systems. The use of Reinforcement learning can be applied in various other platforms were motor rehabilitation as well as enhancement of motor skills are needed. Machine learning particularly utilizing Brain – Machine interface is an emerging field of note-worthy importance in rehabilitation.

REFERENCES
