Clasp-Knife Model of Muscle Spasticity for Simulation of Robot-Human Interaction

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IEEE ACCESS
Volume: 7 **Pages:** 1355-1364
DOI: 10.1109/ACCESS.2018.2846595
Published: 2019
Document Type: Article
View Journal Impact

Abstract

The objective of this research was to replicate the muscle tone moment feedback of elbow upon passive mobilization and classify them based on modified ashworth scale criterion using a mathematical model. The proposed model enables the visualization of muscle tone pattern for robotic interaction simulation. A concurrent muscle tone model necessitates a jerk effect to fully replicate the catch and release effect, also known as, clasp-knife phenomenon of muscle tone feedback. However, the research of passive mobilization control interaction between robot and subject does not emulate such phenomenon. Thus, the model was improvised to replicate the clasp-knife phenomenon according to the robot's gross kinematics and dynamics. The model was designed based on the quantitative pattern of muscle tone feedback from subject with spasticity. The simulated model was then correlated to clinical measures using similar kinematic and dynamic input. The velocity dynamic input was splined to obtain the velocity trend without the jerk effect. The results obtained from the proposed model were relatively promising with an overall (n = 9 x 4) linear (Pearson) correlated average of (r) over bar = 0.8348 for nine subjects with correlation significant at the 0.01 level ($p < 0.01$) and five of them presented a distinctive clasp-knife phenomenon with correlation average of <(r)over bar> = 0.8631.

Keywords

Author Keywords: Modeling; motion analysis; mathematics; biomedical engineering
KeyWords Plus: MODIFIED ASHWORTH SCALE; RELIABILITY

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Funding

Funding Agency	Grant Number
Ministry of Science, Technology and Innovation Malaysia	SF15-015-0065

View funding text

Publisher

IEEE-INST ELECTRICAL ELECTRONICS ENGINEERS INC, 445 HOES LANE, PISCATAWAY, NJ 08855-4141 USA

Journal Information

Impact Factor: Journal Citation Reports

Categories / Classification

Research Areas: Computer Science; Engineering; Telecommunications

Web of Science Categories: Computer Science, Information Systems; Engineering, Electrical & Electronic; Telecommunications

Document Information

Language: English

Accession Number: WOS:000455682000001

ISSN: 2169-3536

Other Information

IDS Number: HH4HC

Cited References in Web of Science Core Collection: 22

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