

# A NEUROMOTOR CONTROL MODEL FOR SPASTICITY : AN EXPERIMENTAL VERIFICATION

by

**DINESH KANT**

**Centre for Biomedical Engineering**

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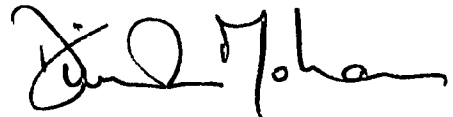
**Centre for Biomedical Engineering**  
INDIAN INSTITUTE OF TECHNOLOGY

NEW DELHI-110016

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## CERTIFICATE

This is to certify that the thesis entitled "A Neuromotor Control Model for Spasticity : An Experimental Verification" being submitted by Mr. Dinesh Kant is a record of original bonafide research carried out under my supervision. The results contained in this thesis have not been submitted in part or in full to any other university or institute for the award of any degree.



(Dr. Dinesh Mohan)  
Professor  
Centre for Biomedical Engineering  
Indian Institute of Technology  
New Delhi-110 016

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## ABSTRACT

Spasticity is a neuromotor disorder in which the stretch reflex of the affected muscles is exaggerated. However there is no general agreement regarding mechanism of this disorder.

This thesis reports the results of the study undertaken to investigate the neuromotor control mechanism of spastic and normal human beings. The control mechanism was studied theoretically by mathematical modelling of the system in which the gamma efferent activity was considered to be linked to the alpha motoneurone activity. Experimental study involved the study of the stretch reflex of the digitorum superficialis muscle of the spastic and normal subjects with the muscle under preload and no load conditions.

The results of the experiments and the modelling show that :

1. There is a link of the gamma efferent activity to the alpha activity.
2. The gain control disorder of reduced inhibition to the gamma neuron results in spasticity.
3. In spastic patients, when the muscle is contracting, the fusimotor activity is hyper.
4. The alpha motoneurons of the spastic patient are unaffected and behave normally.

## LIST OF SYMBOLS

### Symbols using English Alphabets

S.No.	Symbol	Description
1.	C	Central Nervous System activity.
2.	CE	Excitation signal from the Central Nervous System to the neurons.
3.	CI	Inhibitory signal from the Central Nervous System to the neurons.
4.	F <sub>aa</sub>	Force generated as a result of the contraction of the antagonistic muscle.
5.	F <sub>ap</sub>	Passive component of force of resistance offered by the antagonistic muscle.
6.	F <sub>ba</sub>	Force generated (active) as a result of the contraction of the bicep (agnostic) muscle.
7.	F <sub>bp</sub>	Passive component of force of resistance offered by the agnostic muscle.
8.	g	Acceleration due to gravity.
9.	G <sub>a</sub>	Gamma afferent activity.
10.	G <sub>ad</sub>	Gamma afferent activity from the dynamic spindle receptors.
11.	G <sub>as</sub>	Gamma afferent activity from the static spindle receptors.



25. OA' Distance between the fulcrum point and the point of insertion of the antagonistic muscle.
26. t Time.
27. T<sub>a</sub> Torque at the fulcrum point due to the contraction of the antagonistic muscle.
28. T<sub>b</sub> Torque at the fulcrum point due to the contraction of the agnostic muscle.
29. T<sub>f</sub> Time to build up of maximum strength of contraction of the type F fibres.
30. T<sub>h</sub> Lower threshold of the motoneurone when it begins to fire.
31. T<sub>i</sub> Torque on the forearm due to the load.
32. T<sub>S</sub> Time to build up of maximum strength of contraction of type S fibres.
33. TVR Tonic Vibrational Reflex.
34. T<sub>1</sub> Delay in transmission of the neural signal for the alpha nerve fibres.
35. T<sub>2</sub> Delay in transmission of the neural signal for the gamma nerve fibres.
36. Z4 Neural activity (alpha) to the muscle.

### Greek Symbols

1.  $\alpha$  Neural activity to the muscle.
2.  $\gamma_a$  Neural activity from the spindle receptors to the spinal cord (gamma afferent).
3.  $\gamma_e$  Neural efferent activity to the intrafusal fibres of the spindle receptors.
4.  $\theta$  Angle of the forearm with the x-axis.
5.  $\phi_0$  Angle of the biceps with the forearm at the point of insertion.
6.  $\phi_1$  Angle of the triceps with the forearm at the point of insertion.
7.  $\omega$  Angular acceleration of the forearm.

## CONTENTS

	PAGE
ACKNOWLEDGEMENTS	i
ABSTRACT	iii
CHAPTER I	
INTRODUCTION	1
CHAPTER II	
NEUROMOTOR CONTROL MECHANISM	6
CHAPTER III	
SPASTICITY	41
CHAPTER IV	
A MODEL PROPOSED TO EXPLAIN THE NEUROMOTOR CONTROL MECHANISM	54
CHAPTER V	
EXPERIMENTAL METHODS	82
CHAPTER VI	
RESULTS AND ANALYSIS	114
CHAPTER VII	
DISCUSSIONS	136
REFERENCES	154
APPENDIX A	
APPENDIX B	
APPENDIX C	
APPENDIX D	
APPENDIX E	