LOW COST WEIGHT MEASUREMENT TECHNIQUE WITH FUZZY CONTROLLED PNEUMATIC MUSCLE

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By

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DECLARATION

The work submitted in this dissertation is the result of my own investigation, except where otherwise stated.

It has not already been accepted for any degree, and is also not being concurrently submitted for any other degree.

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Date : 31 . 03 . 2008

I endorse the declaration by the candidate.

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Abstract

Weighing of material has been a basic human need since ancient times. Currently there are requirements in the general industry to assess approximate weights of objects electronically for various purposes at a low cost. The possibility of using pneumatic muscle for this purpose has been explored in this research attempt since pneumatic muscle is becoming very popular among robotic designers due to its very high power to weigh ratio, the low price and because of its ease of use.

Apart from this main objective, another area is also focused in this research. This is to obtain servo pneumatic actuation from pneumatic muscle or fine control of actuation. The increasing number of muscle based robotic arms and manipulation systems built through out the world for various tasks, need to assess the weights of objects manipulated by the particular system in order to establish a proper control function for the system. Therefore a solution for this requirement has been given priority and explored during this research. The methodology proposed is to design suitable pneumatic control system for fine elongation control of the muscle in order to eliminate the highly non-linear dynamic behavior of the muscle. Thereafter to do research studies in order to identify the characteristic curves of the required properties. Final stage has bee focused on the design of a suitable electronic controller and to establish an electronic set up for the measurement of weight. Design and implementation of a suitable Fuzzy controller is descriptively explained under this section. After this step the setup was practically utilized to measure weight and results were tabulated against the measured weight with load cell based weighing scales. Finally the conclusions were raised and also the suitability of this apparatus as a smooth actuation controlling device is also discussed.

Dedications

I dedicate this thesis to my parents who have dedicated their entire life for my education, my career building and to make me a productive person to the society.

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List of Acronyms and Symbols

PAM	-	Pneumatic Artificial Muscle
FE	-	Finite Element
PMA	-	Pneumatic Muscle Actuator
SLR	-	Sri Lankan Rupees
PID	-	Proportional, Integral, Differential
PI	-	Proportional, Integral
PWM	-	Pulse Width Modulation
LCD	-	Liquid Crystal Display
POT	-	Potentiometer
SSR	-	Solid State Relay
LED	-	Light Emitting Diode
MPPE	-	Term used for proportional Pressure Regulator
G	-	Distance between nodes
C	-	Circumference of muscle
l	-	Inter-strand separation
θ	-	Braid angle
N_c	-	Number of nodes in one circulation of the muscle's circumference
D_0	-	Theoretical muscle diameter at 90^0
b	-	Length of one strand of braid
n	-	Number of times the strand spirals around the actuator
W_B	-	Thickness of the strand
θ_{min}	-	Minimum braid angle
N	-	Total number of strands
S	-	Number of parallel strands
D_s	-	Strand diameter
L	-	Length of fibre strand
V	-	Volume of the muscle
P	-	Pressure
F	-	Generated force