Use of neural network for optimization of energy cost in moving limb

Yadulla Manavy[1], Mona Zamanian-Azodi[2,*], Samira Gilanchi[2], Roghieh Omidi[2]

[1]Science and Research Branch, Islamic Azad University, Tehran, Iran
[2]Proteomics Research Center, Faculty of Paramedical Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

*Corresponding Author: email address: mona.azodi@gmail.com (M.Zamanin-Azodi)

ABSTACT

Artificial neural networks are used in many smart apparatus and different fields such as signal processing pattern diagnoses, military systems, medicine, financial systems, and artificial intelligence. In this article using quality of neural networks in optimizing energy cost in moving limb and its effectiveness in organization a cognitive function founded by presenting an algorithm for use in human smart robotics and worldwide research will be described and discussed. Neural system contributes to minimal cost energy in decision-making and command exportation to skeletal muscle and suggested optimal energy cost in skeletal muscle that could be presented in software conformation.

Keywords: Artificial Neural networks (ANNS); Muscle skeletal energy cost; Modeling.

INTORDUTION

Behavior and movements of living organism are performed by neurons and neural networks. Association of many neurons as a structural unit of neural network builds a neural network via synapse connections; data is transferred to processor by these neurons in electrical signal layout. In fact, these neurons are specially designed for conducting electrical potential without any reduction effect in self-length[1-3]. Processing is handled in different sites that are related to signal type and incidence site(1).The main site for data evaluating, thinking, and decision making is the brain[4]. Artificial neural network is a calculating system that includes high-connected processing elements resembling neurons in neural system. Artificial neurons are a simple demonstration of biological neuron excitation threshold from receiving signal by mathematical calculations[5, 6]. Data is transited through one processor element to other by synapse or inner communication. Indeed, this data could be excitation or inhibition. Input signals to processor elements are displayed as input vector $A = (a_1, a_2, \ldots, a_n)$. A specific weight factor is ascribed to every input and processed by determinant formula ,and in this basis, an output is defined. Artificial neural networks are used in many smart systems within divers field such as signal processing, pattern diagnosis, military systems, medical (nursing of patient, diagnosis systems & …), financial and artificial intelligence[7-10]. Competent models are designed and evaluated for building artificial limbs (hand, leg & …) with apprehension human neural system functioning in muscle skeletal recruit[11, 12]. Studies in motions quality by human limb locomotive are showed that necessary artifices for optimal energy cost and maximum saving[13, 14]. In this study, by reviewing human neural network in decision-making and muscle skeletal movement for executed different move, was determined optimum energy cost model.

MATERIALS AND METHODS

In this research, studied and evaluated articles and scientific writings relevant to functioning quality of human neural system relating to recruitment muscle skeletal in transaction divers actions and with regarding to two important parameters interested in functioning human muscle skeletal modeling (mentioned in continuance), were modeled functioning human muscle skeletal by presentation an algorithm. Important parameters in functioning human muscle skeletal are as following:

1.Reminiscence factor:

Considering this matter that experiences of divers functions are being stored and recorded in brain as a long-term memory [13, 15]. The brain is analyzing and sorting incoming data

constantly, until in next similar encounter will be providing energy and necessary ability for transaction similar function. Indeed, senses have been considering as brain input[16].
Brain has checking input regulatory for lifting the objects by minimum of energy consume (such as, in a provisions that object is slide in hand, increased energy or if object weight was lower than predicted weight the power would be decreased. It is important that in using the other muscle skeletal, previous reminiscences are essential aids in force powers and optimizing energy usage.

2. senses:

Sense is operating as an input for brain and neural networks and transferring data of environment to the brain. Vision and touch are two main senses for recruitment by muscle skeletal. Finger tips sensor have important role in use of energy precisely, as if numbed finger tips, increased use of energy, also use of finger force continually in a specified range have a important role in establish ecological pressure for neurons development in this range[17]. Required energy for taking object is relating to its shape, friction and finger contact area with the object. Ratiocination logic modeling system for muscle activity and muscle energy movement is shaping as mathematical fundamentals and accommodation divers models of shape, genus, and system training in contact with every of objects and environment qualification.

RESULTS

Proffered model for optimization energy cost in human skeletal muscle is presented in figure 1.

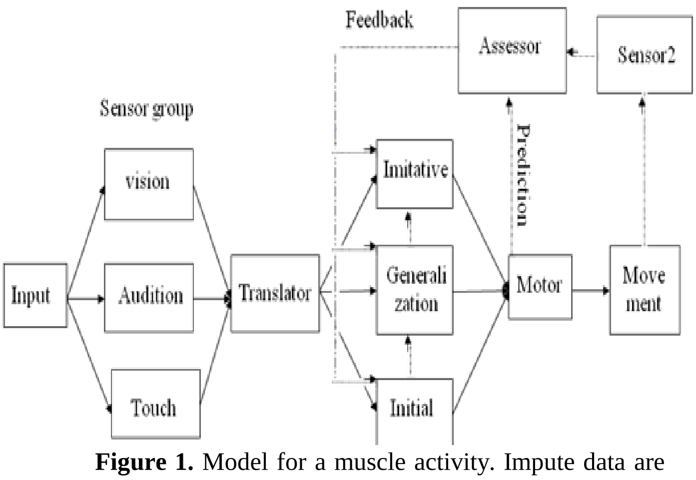

Figure 1. Model for a muscle activity. Impute data are receiving by environment data, and are sent to next part for processing. After processing, necessary commands are sent to the motor (Muscle).

Considering figure 1, given model is constituted of divers sections including sensor group, proffered model is constituted of divers sections including sensor group, translator, processor, motor, feedback, sensor and assessor.
Divers section of model, are explained as below:
a. Sensory group 1 :
This group as the first receptor has been receiving environment data and transferring to translator simply and has a determinant threshold. If inputs data go above than threshold limits, this group is activating and sending an output to next part. In this part, sensors have two statuses, ON and OFF. If input go upper than threshold bounds, sensor is becoming ON and otherwise is sets to OFF.
b. Translator:
Translator is converting input data to binary number (essentially translator is an intensity determinant). Translator is operating similar the computer language with this divers that computer is receiving user instructions directly, but in translator, perceptual sensory data (including commands and data environment) is being converted to binary numbers. Founded on conversion data to binary numbers, raw data is sending to next part for the decision-making. In this part, perceptual data differentiate that the " remove pen " is different from "remove sandal " and those are being converted to different binary data. Important point is that, analyzed data is the convert raw data by translator that after processing, it will result in executing an action in next step.
c. Processor:
Processor is the main part of model that processing analyzed data and orientating those with previous data and causing appropriate commands will export to next part that is including three parts as follow:
c_1.Imitative path:
This path is including movements that in part had been command exactly and determined specified weight vector. Therefore, by reproduction of prior path, by coming data processing in this path is interference maximum probability, but should have noted that if act be recurrent this is not cause perfect probability and is visualize a immaterial error that retrospectively will analysis in feedback and correct probable error. After data

processing in this part, an output that is excitation or inhibition will send to motor.

c_2. Generalized path:
This path includes movements that in past had not been executed exactly, but has similarity for generalization. In this path, processing is performed founded on input data and similarity past movements and with considering to probability, optimal weight vector is utilized and output is determine that this output sent to motor.
c_3. Initial path:
This path is including movements that have not precedent and cannot generalize. This path is act founded on trial and error, and with recurrence is determinant weight vector and stored in simulation path until will be used in next. Training in neural networks is advocated in this matrix until by effecting in imitation path and determinant weight vector, system is act accurately, quickly and proficient.
d. Motor
Output in previous parts is transfer to motor and in this part, origin particular action such as muscle contraction or distension. The key point is that, this enter specified data to previous parts is cause export several diverse command, that is if founded on input data, processing derived to hand bending, for execution should at least two different command sent that including distension extensor and contraction constrictor. Consequently, with arrive an output, may some input will be produced that notwithstanding different in output.
Finally, the proffered model, by command is reached the motor, observation a specified movement, but in this state in order to the act approach of system will improvement, is necessary in feedback pathway, investigate quality of act execution.

Feedback pathway:

Feedback path has fundamental role in update weight vector, correction probable error, vector determinant, and network training. In this way, resulted output of network is received by sensor 2 and compared with network prediction of input processing and consequently error is found and corrected. This pathway includes sensor 2 and assessor.
Sensor 2:
This sensor receive, resulted output of the model and send to feedback path for checking probable errors. In this way, calculate input to sensor 2 that are including incoming pressure amount to sensors and amount of contraction and distension muscle (contraction and distension force) and play an important role in error correction. Assessor is a comparator, that compare data receive by sensor 2 with model prediction resultant of input data processing, detect probable error, and correct by change in relate weight to each of processing path. Hence, assessor cause pathway is optimized and error be minimized.
If the input is X_i, with function weight (W_i), generate converted input (X) in neuron. In now with function f(x) function by neuron, generate a signal that cause movement. F(x) function could have divers shape that is reagent qualification of neuron functioning(see figure2).

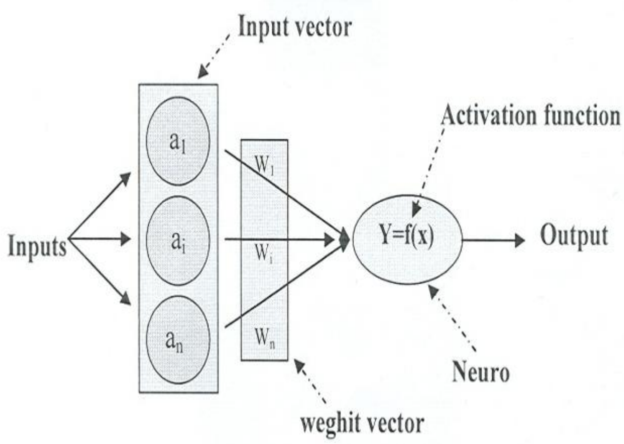

Figure2. Quality activity of artificial neuron. For every input is specified weight factor that found on specific formula, processing, input, and weight factor is determined an output.

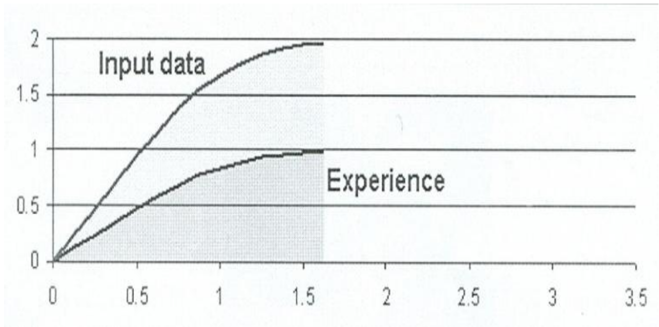

Figure3. In this figure, function is resulted from sensors, experimental data, and shape quality determination of decision area.

For imitation and generalization, functioning is delineated sensory data graph with proximate experimental graph of previous similar movements and interface of these two graphs (figure 3) is propounded as a best probable functioning space and determinant peer energy amount. Surface variance in two graphs, is calculated by graphs integrant and surfaces are subtracted and defined as an act transaction error or accuracy in decision-making. The algorithm for muscle movement is modeled via software(see figure4).

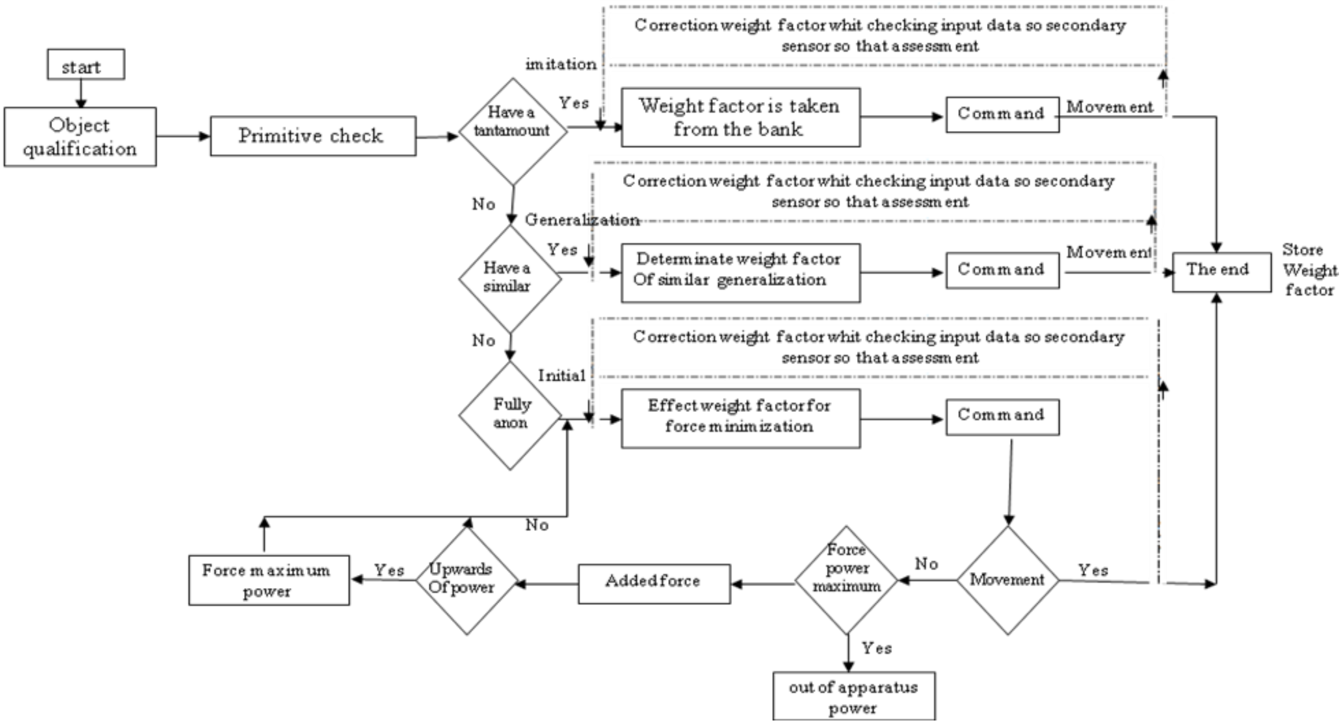

Figure4. Muscle activity algorithm for impalement in software

DISSCUSION

Multiple input data received by sensors, transmitted by translator, and displayed number and figures shaped that is indicator of environment and object qualification[18, 19]. This observations constitute sensory and motor information and characterize accurate movement [20, 21]. As an example, in figure 1, data that is received by vision sensor, after transit of translator display shape, size and type of object; as a result, optimal feedback is originated. As it is shown in figure 2, every function that will be defined should be optimize considering to nature of signal production and defined parameter. In this theme, sin x function defines for signal processing. Considering the input function that is $X=\sum W_iX_i$ define function (1):

$$F(x)=\sin\sum W_iX_i \qquad (1)$$

Consideration taking into positive amount of signal productive, negative part of function productive is deleted. Considering to maximal amount of function that is (+1); in fact, (+1) is equivalent excitation threshold, but in fact, signal productive can reach upper than threshold limit, so signal processing function with α modulus convert to function 2:

$$F(x)=\alpha\sin\sum W_iX_i \qquad (2)$$

With divers amounts selecting of W_iX_i variables and measure processing F(x) signal can determinant moderating modulus and W for neuron. Intervene experiences of previous similar acts have specific function Sinus that is stored in system memory.

In figure3, with recurrence and the surface variation, is established oppose of decision-making conditions. This correction act is performed by feedback path. For initial behaviors is chosen as $Y=\alpha\sin\sum W_iX_i$ graph as a reference and then corrected functioning in feedback. In this method, by optimization movement commands, it would impede the energy losing. This subject is explained in more details as blow:

With energy amount control, necessary commands for moving responses, is sent to motor and will be result an act. By act execution, quality execution data is received by secondary sensor and in assessor part is checked with prediction of quality execution, probable errors are resolved by weight factor correction related to each of sense group in act execution, and weight factors are stored as optimal weight factor for use in next events of act recurrence.

For establishing preparation in designed network (constituting of neurons) can train a network for determination of primary weight factor (primary path) for each character that can utilize a primary conjecture for determination weight factor. Considering to primary act execution for derive to competent weight factor, is acted by trial and error method.

For executing each type of movement, is necessary modeling and using of specified algorithm for that movement and input relating to each of this algorithm designate necessary energy for that specified movement and or type of specified muscle. The up events algorithm for movement a muscle is founded on algorithm figure 4, is modeled in a software. For execution complex movements should be modeling similar algorithm such as this algorithm and apposite whit contemplation movement and then transplant those that be possible execution divers movement.

Algorithm for determination of a muscle activity:

1. Environmental data are received by sensors, then are analyzed in central system, and finally regulate for the specific task.
2. Considering the input, determinant amount of W function (amount of W for every character is determinant in imitation and generalization path) and functions relating to input divers characters is drawn and obtain functioning space amid this function and probable W" is determinant.
3. Proximate experimental function to determination functional is drawn with W' weight factor and with determinant functioning space, founded on this two function is determinant W" amount.
4. Functions relating to divers sensors, are connected to each other and is determinant W''' amount.
5. Proximate experimental function to that, is drawn and communal acreage inter this two function is taken into consideration as a best space probable functioning.
6. In this functioning space X amount that optimization in that Y amount, take into consideration as act criterion and is derived W'''', and determinant equivalent energy amount for that and necessary command is sent to movement motor.
7. Movements are analyzed and assessed in feedback.
8. Amount of weight factor W'''' is corrected and as optimal amount, is stored in memory.

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