USING BACKPROPAGATION NEURAL NETWORK FOR THE POSTURE CORRECTION

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Proper posture is relevant to any human being, regardless of age or gender. Maintaining and correcting posture affects the person's physical function, level of abilities and wellbeing. Improper posture may lead to poor postural habits that may ultimately result in muscle imbalance and muscle strain.

To form the correct posture, there are various declinators and corsets. They argue back and do the right shoulder. But these devices do not contribute to the development of muscles, so doctors prescribe them for a short period of time.

Unlike conventional correctors, electronic corrector warned of poor posture. Thus, the person is trained to keep your back straight at reflex level.

This posture corrector represented as two PCBs MPU6050, which include an accelerometer and a gyroscope [1]. The sensors are mounted on the back. One is located in the cervical region and the second in the lumbar region (fig.1).

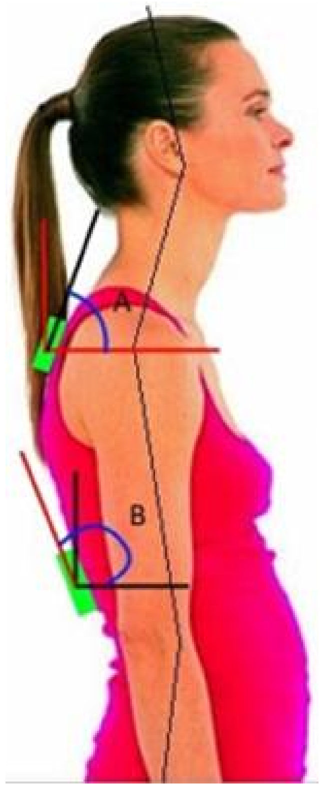

Figure 1. Location of sensors

They are connected via I2C bus to the PCB STM32F303VC Discovery [2].

In implementing, the posture corrector with the help of mathematical terms is well-defined front and sagittal curvature of the basic algorithm.

But some people have congenital changes in the backbone, or because of disease. For the correction tailored to each individual, I used a neural network.

To implement was chosen the method «Backpropagation». This is a modification of the conventional method of gradient descent, which was used in order to minimize operation errors of the perceptron and the desired result [3].

The implementation of the neural network was carried out in MATLAB.

Has been established a comfortable interface with the necessary graphics and buttons for work with neural network, wherein the first and second column of the graphics is the significance of the angles x, y, z the first and second sensors respectively, and third - the response of the neural network.

When the top panel accepts the meaning 1 - the back is curved, 0 - the back is straight.

As stated MathWork, Levenberg-Marquardt (trainlm) is recommended for most problems, but for some noisy and small problems Bayesian Regularization (trainbr) can take longer but obtain a better solution. For large problems, however, Scaled Conjugate Gradient (trainscg) is recommended as it uses gradient calculations, which are more memory efficient than the Jacobian calculations the other two algorithms use (fig. 2).

The neural network is trained for 17 iterations.

It consists of six inputs (angles x, y, z of the first sensor and the angles x, y, z of the second sensor), 9 hidden layers, one layer of output, and three outputs (only one is required, and the other two for further work).

Supposedly, it was created nine hidden layers. Two hidden layers to identify the standing position with a straight back and curved in the sagittal plane of the spine; two hidden layers to determine the standing position with a straight back and bent in the front plane of the spine; two layers to determine the seating position with a straight back and curved in the sagittal plane of the spine; two layers to determine the seated position with a straight back and bent in the frontal plane of the spine; one layer to determine the prone position. If the user is in a supine position, the measures are not carried out.

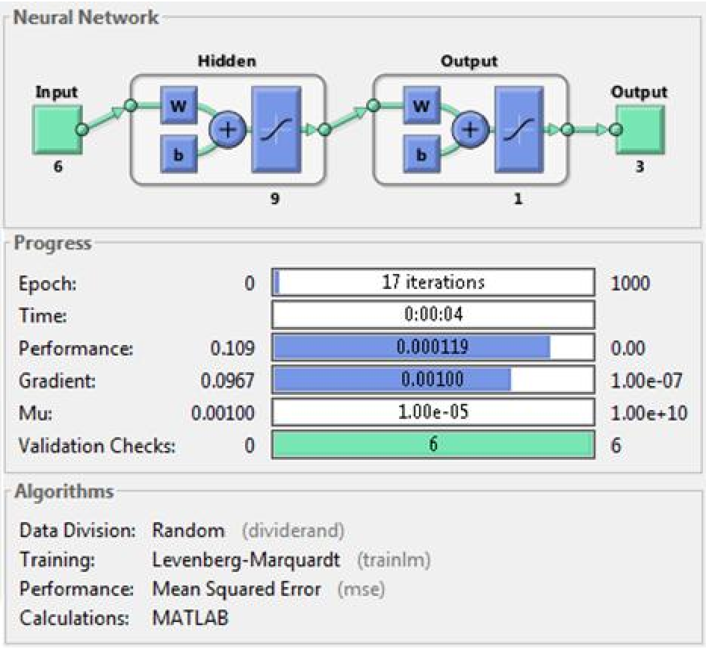

Figure 2. Training the neural network

For this example, the training data for regression indicates a good fit. The validation and test results also show R values that greater than 0.99. In this case errors fall in -0.01.

This training stopped when the validation error increased for six iterations, which occurred at iteration 17. The final mean square error is small. The test set error and the validation set error have similar characteristics. No significant overfitting has occurred by iteration 9, where the best validation performance occurs (fig.3).

Each time a neural network is trained, can result in a different solution due to different initial weight and bias values and different divisions of data into training, validation, and test sets. As a result, different neural networks trained on the same problem can give different outputs for the same input (fig.3).

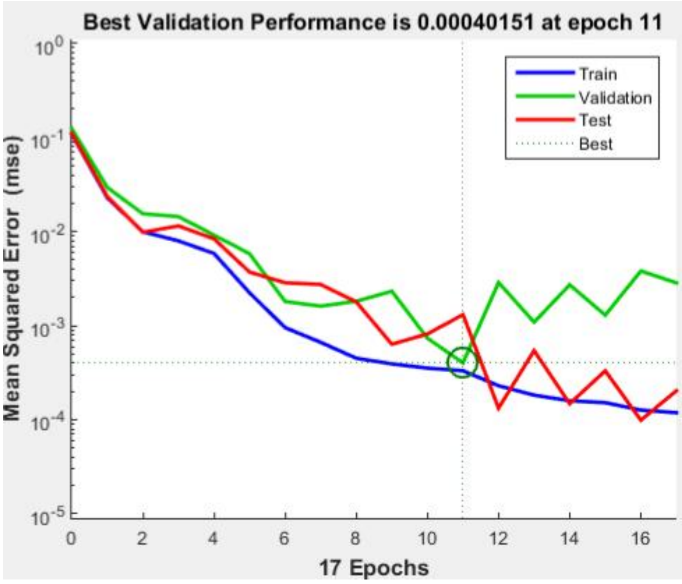

Figure 3. The performance

Correction arrangement of the robust and practical posture was built using techniques from the accelerometers and gyroscopes. The system monitors the angles associated with the spine, and notifies the user of the improper posture.

The corrective work to be performed using the neural network to be able to use the smart garment by people in whom have postural defects.

In future the neural network can be formed simultaneously for determining the position in which the person is located (sitting, standing, lying), and add individual conditions for each of them [4].

References

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Abstract

This paper presents the development of the neural network by the method Backpropagation for the modernization of previously developed posture corrector. Analyzed charts neural network training in the application package MATLAB.

Keywords: posture corrector, an accelerometer, a gyroscope.

Аннотация

Эта статья представляет разработку нейросети методом обратного распространения ошибки для модернизации ранее разработанного корректора осанки. Проанализированы графики обучения нейронной сети в пакете прикладных программ MATLAB.

Ключевые слова: осанка, корректор, акселерометр, гироскоп.

Анотація

Ця стаття представляє розробку нейромережі методом зворотного поширення помилки для модернізації раніше розробленого коректора постави. Проаналізовано графіки навчання нейронної мережі у пакеті прикладних програм MATLAB.

Ключові слова: постава, коректор, акселерометр, гіроскоп.