Design and Application of a Novel Motorized Traction Device

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Abstract

Traction therapy which is a method is frequently used in the treatment of cervical disc hernia and hernia of the loins. Traction devices play big role in this therapy. One of the most commonly used traction device type is motorized traction device. Commercially available tackles apply tractive power to do patient depends on the some parameters which are duration and force level. If patients change their positions during the treatment, tractive power will covary with movement. In this study, motorized traction device has been designed and performed by using load sensors, dc motor and mechanical structure. The system has been controlled via microcontroller. Main focus of this design is to implement precision tractive power to the patient thanks to feedback from the sensors. Also realized traction system is cheaper than the other traction devices.

1. Introduction

Traction is the use of a pulling force to treat muscle and arthralgia. It is a signature method that is usually applied to the arms, the neck and the backbone. According to force level and duration, traction types can be divided into two classes. Also these two types again can be divided into different classes [1]. Types of traction can be seen in the table 1. Among these, motorized traction therapy is the most preferred technique [2]. In the motorized traction method, traction force and duration can be adjusted and changed before the treatment. However, during therapy, motor keeps its position against changing patient's position. Thus, current devices decrease effects of therapy and desired result cannot be obtained. The average motorized traction device contains motor, control panel and mechanical structure. Proposed motorized traction device sense pulling power falling on load sensors as a feedback signals to ensure that dc motor is pulling correctly.

Table 1. Classification of traction types [2]

Time dependent	Force dependent
Continuous traction	Manuel traction
Static traction	Traction with aid of gravity
Intermitten traction	Auto traction
	Traction in water
	Mechanical traction
	Motorized traction
	Spinal decompression

In this work, motorized traction device has been designed and performed by using two load sensors, dc motor, control card, touch screen and mechanical structure. Also pulling power and duration can be set via touch screen. In software part, control program was buried in microcontroller and implemented via microcontroller.

2. Material and Method

In this study, the motorized traction device comprise of 5 parts. These parts are touch panel, load sensors system, microcontroller and algorithm, DC motor driver part and mechanical system. Block diagram of system can be seen in Fig. 1.

The operation of the system is as follows:
(1) setting the force and time value via touch screen,
(2) receiving the signal sent from touch screen,
(3) dc motor is driven by microcontroller,
(4) receiving the analog signal from load sensor,
(5) convert from analog signal to digital signal in microcontroller.

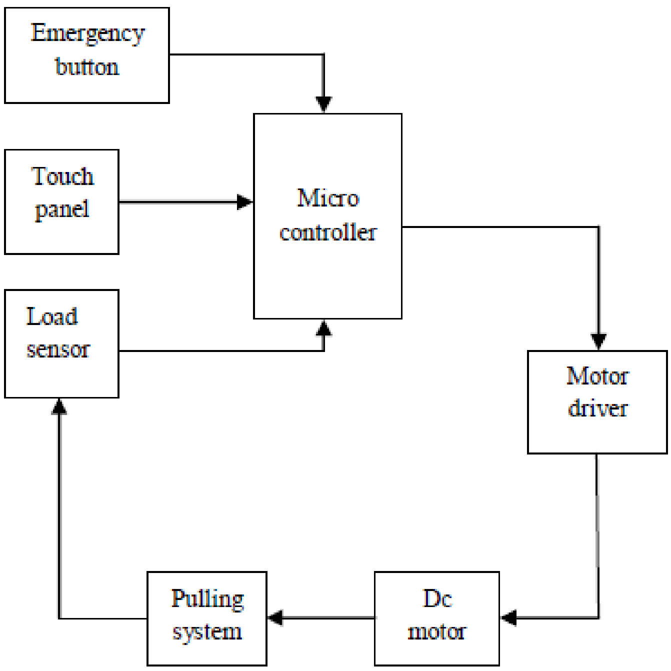

Fig. 1. Block diagram of the system

2.1. Touch screen

Touch panel is an analogue with 4-wire. Connection can be done via touch panel controller that is T6963C model. The

T6963C is an LCD controller designed to be used with LCD control driver LSıs and data display memories [3]. The touch panel is used to enter desired force and time variable. It sends values to microcontroller.

2.2. Sensors

Used load sensors in this project are based on the concept of Wheatstone bridge. The Wheatstone bridge is the electrical equivalent of two parallel voltage divider circuits. Output signal of this bridge is measured between the middle nodes of two voltage dividers [4]. Strain gauge configurations are arranged as Wheatstone bridge. These sensors are in the strain gauge sensor type. A strain gauge (or strain gage) is a device used to measure strain on an object [5]. A used load sensor is up to 50kg sensor range. Also sensor range can be increased with parallel usage. For example, two parallel sensors can measure up to 100kg. In this design, there is a metal part on the sensors also roller is coupled this metal part. It can be seen on Fig.2.

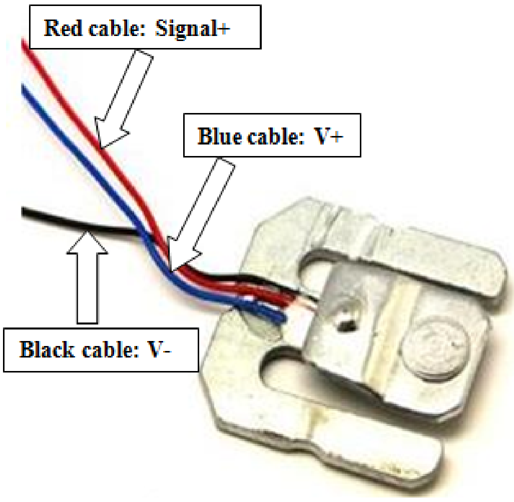

Fig. 2. Sensor [6]

2.3. Microcontroller and algorithm

PIC 16f877A has been used as the controller. The ADC in the microcontroller has 8 channels, 10 bits. At the beginning of the operation, microcontroller has received signal from touch panel. Secondly, sensors have started to send feedback signals. Amplified sensor signals are taken through INA 125, which is a low power, high accuracy instrumentation amplifier with a precision voltage reference [7]. If the signal is equal to desired value, microcontroller stops the motor. The DC motor can turn either in clockwise and counter clockwise direction depending upon the sequence sensor signal. If the force value coming from sensor is lower than the predefined value, it means that patient has changed his position. DC motor starts to turn in ascending direction. In addition, when patients feel pain, they can immediately push emergency button which is in the system. The algorithm of written code is given in Fig. 3.

2.4. DC motor driver

There are many different ways to control the speed of motors but one is very simple and easy way to use Pulse Width Modulation (PWM) [8]. PWM is a method for binary signals generation, which has two signal periods (high and low). The width (W) of each pulse varies between “0” and the period (T). The main principle is control of power by varying duty cycle. PWM signal can control motor speed with H-bridge via bridge driver. H-bridge which is used to drive DC motor is an electronic circuit that enables a voltage to be applied across a load in either direction. H- bridges are available as integrated circuit or can be built from discrete components. A solid state H- bridge is typically constructed using mosfets. N-channel mosfet is using for driving DC motor, also motor drive circuit needs mosfet driver for controlling the mosfets.

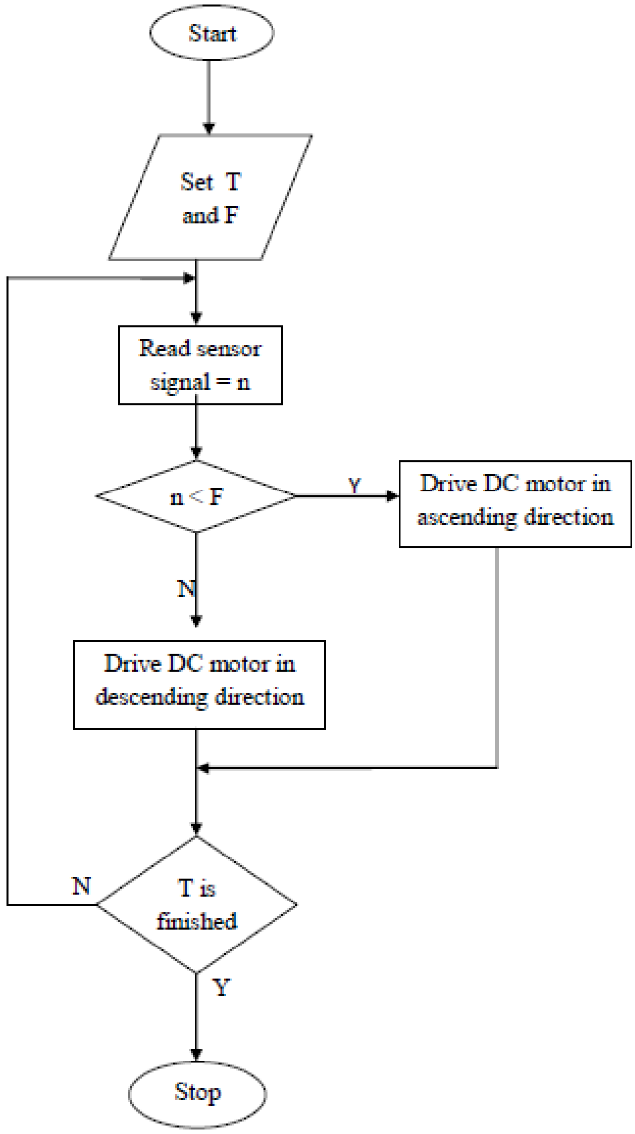

Fig. 3. Code flow diagram

2.5. Mechanical structure

The technical drawing of proposed motorized traction device is illustrated in Fig.4. Steel has been used in body of the device because it is sturdy to lift about 100kg. Sensors have been placed on the structure as shown in Fig.4. Aim of this mechanical structure is simple building and low cost. Furthermore, all of the components are dismountable for easy shipping.

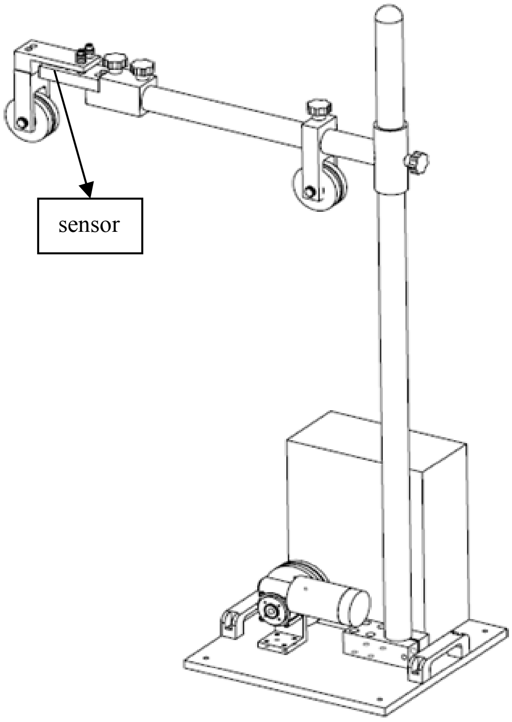

Fig. 4. Technical drawing of applied device

Fig. 5. Last form of the device

3. Realized application

The main purpose of this study is to apply correct force to patient. First test has been performed with 5kg weight. At the beginning, heaviness was coupled to engine with rope. Force and operation time value were set via lcd touch screen. Motor was driven to pick heaviness. When the load is completely up in the air, motor has stopped to turn. During the equilibrium state, some forces were applied on the load from the outside of system. Perceived imbalance by sensors was examined in microcontroller. Applied force on the sensors was set to desired level by DC motor. If perceived force is bigger than the desired, motor will rotate clockwise direction, else it will rotate counter clockwise direction. At the second test, 10kg weight coupled on the system. Same procedures were carried out for this heaviness. In terms of speed, performance of the system on this load was a little slow. Final test has been realized with a volunteer patient. According to medical advices, time duration and tractive power has been set 5 minutes and 10kg respectively. Before treatment, patient was informed about emergency button. During the therapy, patient has changed his position to increase perceived force. Sensors sent analogue signal to microcontroller and motor has rotated clockwise direction. When the time is finished, operation has stopped. This system can pick maximum 80kg as seen on Fig. 5.

6. Conclusions

This paper presents design and implementation of motorized traction device for treatment of servical disc hernia and hernia of the loins. Control of system is realized by the agency of PIC 16F877A microcontroller. In the system, load sensors are used to sense tractive power. The proposed system can apply desired variables thanks to sensors feedback. The main goal of this study is reducing cost of motorized traction device and to apply correct tractive to patient. In economical perspective, almost two thousands Turkish Liras has been sent for building sample and cheap device. On the contrary, used devices in hospitals are quite expensive such as 7200 Turkish Liras. The test has been carried out to illustrate that the realized system works as it is intended. Future work will analyze effects of this device usage on surgery of the fractured bone. In these type surgery,it is believed that the device could be used to align two end of the fractured bone with constant traction force like as Fig.6.

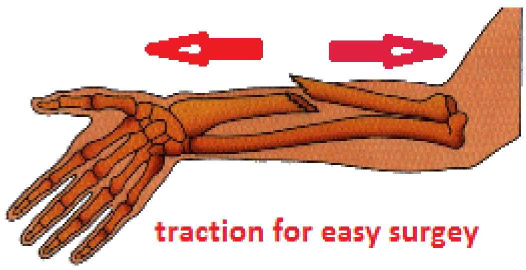

Fig. 6. Traction for easy surgey

7. References

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