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Design and development of voice coil actuator device for examination of skin sensitivity of diabetic patients

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ABSTRACT

Diabetic neuropathy can cause lose in the sensation of feet skin that provokes amputation and wounds. In the occasion that diabetic neuropathy influences one to lose feeling in your skin especially under the feet, one may not feel the loss of sensation or wounds. The voice coil actuator is basically used in the industrial purpose and specifically designed for those industrial applications specifically one other motivational reason is that the voice coil actuator for this particular application isn't accessible and consequently should have been produced for this undertaking. This paper tells how the voice coil actuator is developed and the controller required. This also shows how the tone and vibration levels can be controlled individually to improve the system. Diabetes can make these wounds hard to recover and increase the likelihood of ailments. These wounds and infections can provoke the takeoff of a toe, foot, or part of the leg. Finding and treating skin issues early can cut down the chances that will make real contamination.

Keywords: Voice Coil, Frequency, Duty Cycle, Diabetic Neuropathy.

1. INTRODUCTION

The main aim includes design, implement and test a voice coil actuator and the controller particularly for the medical purpose and to detect the sensitivity of skin in diabetic patients. The voice coil actuator is an assisting device for the doctors as well as the users. Voice coils (VC) are produced for speakers for the change of electrical signals into sound wave using a diaphragm. VC Actuators are an immediate drive, sans hysteresis gadgets utilized for giving profoundly precise straight or rotating movement. By excellence of their high speeding up and the nonappearance of recompense, voice coil actuators offer various points of interest in such applications as medicinal valve actuators, Z pivot applications and instruments utilized as a part of spectroscopy, and chromatography. Also, they arrive at stop focuses with astonishing velocity and precision. A voice coil is a straight actuator that moves a mass along a line. To be exact, it pushes and pulls a mass wherever it is along a line. When periodic waves are passed through this coil it results in to and fro motion resulting in vibrations. These vibrations can be fed to the skin to detect the sensation. Peripheral neuropathy is a sort of nerve harm that regularly influences the feet and legs and in some cases influences the hands and arms. One may feel outrageous torment in your feet, legs, hands, and arms, notwithstanding when they are touched gently. You may likewise have issues detecting agony or temperature in these parts of your body.

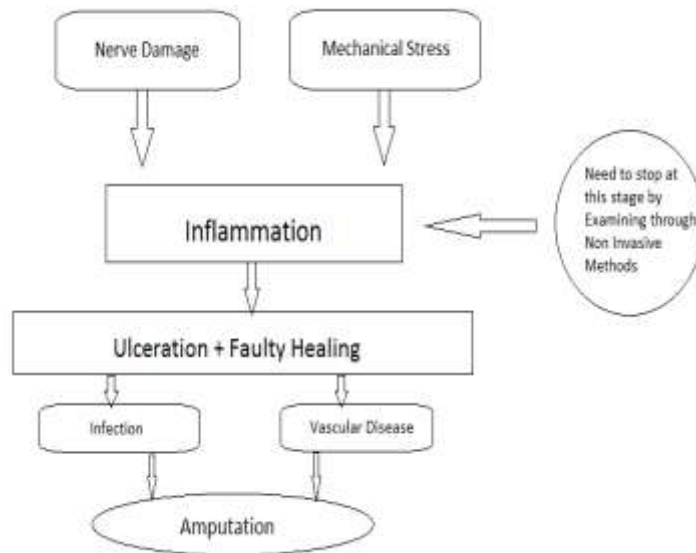


Figure 1 Flow diagram showing the results if the sensation in the skin is lost

Over time, high blood glucose, likewise called glucose, and abnormal amounts of fats, for example, triglycerides, in the blood from diabetes can harm nerves and the little veins that sustain your nerves, prompting fringe neuropathy. Using a Controller system helps the doctor control both Frequency and Duty cycle. Section II offers a brief explanation of the proposed methodology.

2. PROPOSED METHODOLOGY

The actuator needs a controller which will independently provide an option to vary both frequency and the duty cycle. By doing so the disadvantage of the damping in frequency over time can be eliminated.

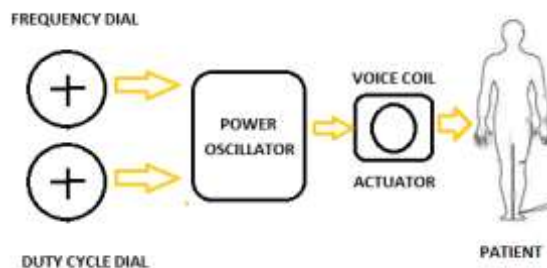


Figure 2 Block Diagram of VCA System

The fig2 represents the solution for the working of the actuator. The two dials are the variable potentiometer which is used to regulate the frequency and the duty cycle individually. Both the parameters can be altered. The power oscillator comprises the operation amplifiers which in stage wise are responsible to generate both the frequency and the duty cycle. The actuator used in this project is the moving coil and is designed to work on the lesser voltage value. The internal structure of the actuator is shown in the next section in the design part. The existing device by the name Biothesiometer has the option to vary only its duty cycle and not the frequency where the frequency is fixed by the manufacturer. The Biothesiometer can have a perusing from 0 to 50 volts. The perusing is low in youthful typical people (i.e. they are exceptionally touchy to vibration). As we get more established, the Biothesiometer perusing turns out to be logically higher. From encounter, it is realized that the danger of building up a neuropathic ulcer is significantly higher if a man has a Biothesiometer perusing more noteworthy than 30-40 volts if the high perusing can't be clarified by age.

3. DESIGN OF ACTUATOR AND OSCILLATOR

The actuator comprises three main components that is 1. External Casing, 2. The Magnet and 3. The coil. The diaphragm material used in this actuator is rubber sheet and the other is the Tin which is a sheet which is cut out into the haptic structure. The casing is of mild steel which has the inner Diameter of 15mm, the External Diameter is 18mm. The wall thickness is 3mm and the length of the casing is 15.5mm. The coil is of insulated copper wire and is of 40 gauge thickness, the length of the wire is 210cm, the impedance value is 8ohms and the diameter of the coil is 13.5mm. The magnets are of button shape with a hole in the center and the diameter of each magnet is 10mm and the thickness is 3mm a total of four such magnets are considered making the total length of 12mm. The magnet is held in the center with the shaft which is also of mild steel.

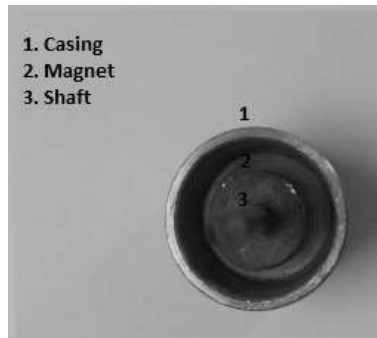


Figure 3 Top view of the actuator assembly

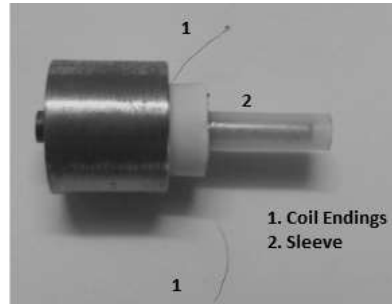
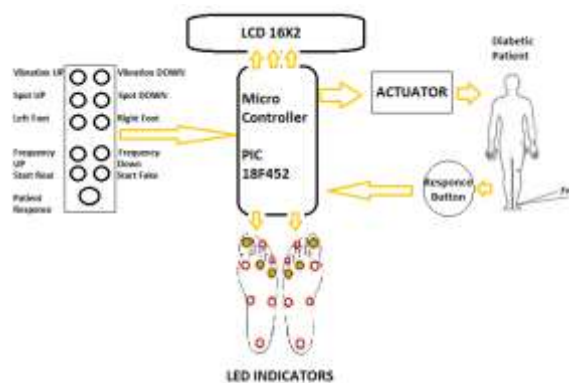


Figure 4 Voice coil assembly with the coil

The use of a sleeve is necessary in this case as the whole coil is fixed to the sleeve. The materials which need to move should of lesser weight as much as possible hence the sleeve is of a plastic material other options are also considered. The design for the oscillator is done in three stages. The first stage is where the voltage is divided using voltage divider circuit and is applied for the buffer were the reason being that we cannot draw current direct from the voltage divider as it will get loaded. The second stage is where the oscillator is designed were the non-inverting and the inverting terminal is short and the output of the buffer is applied to both. The combination of the RC circuit is responsible to generate the square wave at the output the charging and discharging level of the capacitor is determined by the combination of the resistors at the non-inverting terminal. This is where a pot is used to vary the frequency without altering the duty cycle. The third stage is where the duty cycle is varied without changing the frequency. This stage acts as the comparator and the output of the oscillator is fed to the non-inverting terminal and a pot of higher resistance value is used to vary amplitude between the set of voltages making it possible to have duty cycle from 10% up to 100%.

4. IDEA IMPLEMENTATION

The above idea including the controller principle and the actuator is implemented in the ongoing project where the frequency and the duty cycle are generated from the microcontroller. The controller has inputs from the push buttons assigned and the output is applied to the actuator through the driver circuit. The results are similar and good.



The LCD display provides the information of the vibrations levels and the frequency and the storage of the data obtained from the patient.

5. DISCUSSION ON RESULTS

The results are good but lack accuracy the reason being the alignments of the components of the actuator that is the movement of the coil in the air gap between the casing and the magnet. During the movement of the coil, the lack of stability of the rubber diaphragm causes the displacement of the coil to slip from its mean position. The other reason being the light weight of the coil and the sleeve. The output of the oscillator is very good and the expected wave form is achieved.



Figure 5 Results from the oscillator and VCA

The wave form is the output of the actuator system and the CRO is showing the frequency change in the above figure 4 in the figure 5 the amplitude that is the duty cycle is varied. The oscillator works good and the output is applied to the actuator simultaneously to the actuator. The frequencies are low and to improve or to have multiple frequencies the crystal oscillator along with the microcontroller can be used by doing so the data can also be stored.



Figure 6 Results of Frequency and Duty cycle

6. CONCLUSION

In conclusion, the outcomes obtained provided some insight into the further improvement in the Voice Coil Actuator serving the purpose of this project that is the testing the sensation of the skin of diabetic patients. The testing of the actuator showed the need for significant development of the components comprising the actuator. Another implementation of the project is to interface the hardware with the computer for further improvements and understanding the data which is in progress in the up gradation of this project. To improve the significance of the system more enhancements can be made which are as follows one is the interfacing of the system with the computer for further analysis next could be the involvement of another testing parameter that is the temperature through the heat probe, in the upgrade of this product all the above feature are considered.

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