Wearable Device for Interferential Current Therapy in Patient with Arthritis

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***Abstract*:- Arthritis is actually an informal way to specify more than one type of joint disorders .There are more than hundred different types of arthritis conditions that commonly affect a population ,irrespective of age ,sex and race .It is the leading cause of disability in America and many south Asian countries. The most common symptoms of an arthritis condition is pain and swelling , acute or chronic .These can be gradually progressive and thus, cause a great hindrance to mobility. This project is primarily aims to control the inflammation caused by the condition and gradually stop the disease progression in a more convenient and comfortable manner ,focusing more on the non-invasive strategy the interferential current has been selected from the group of electrical nerve stimulation .This therapy uses two medium frequency currents , passed through the tissues simultaneously as a pair, in such a way that their paths cross and they interfere with each other ,thus inducing current. This current acts not as a stimulation for pain-relief ,but also trigger the self-healing mechanism of the tissues, thereby enhancing the properties of the tissues and gradually decrease the swelling at the joint. The amplitudes are chosen depending on the desired magnitude of the beat frequency. Here, we have considered various parameters such as carrier frequency for PWM, beat frequency , pulse ,duration ,swing pattern,2poleVs 4poles treatment time and mode of electrode placement .We have employed MPLAB software and embedded C to design the control circuit program. The range of frequencies adopted comes within 0-100Hz and is varied as a set of sub ranges. The results obtained were satisfactory at it has been proven to be effective with minimal side effects.**

Keywords: Arthritis, inflammation, gout, pain relief, IFC, IFT, beat frequency, DMARDs , anti-TNFS ,NSAIDs.

INTRODUCTION

Arthritis can be defined as a group of joint disorders , rather than just a single disease.It commonly affects a population ,irrespective of the age ,gender ,race etc .The most common victims are women and the elderly sections of the society .This is due to the gradual decrease of bone density that occurs in the above mentioned people .This makes arthritis the leading cause of disability in VS and other south Asian countries .Over 50 million Americans have arthritis .This means that one in every five adulds,300000 children and countless families are affected by this disease .By conservative estimates ,about 54 million adults have doctor-diagnostic arthritis .Almost 3lakh babies and children have the disease or rheumatic condition.The most common type of arthritis is known as osteoarthritis ,that mainly concentrates on bones ,which affects and estimated 31 million Americans .Number of people who are expected to seek treatment is more in women (26%),then in men(18%).

Statistics

Arthritis is all around us, yet its impact on individuals, their families, employers and the country are far greater than most people realize. It is the leading cause of disability among adults in the US. Over 50 million Americans have arthritis, making it the number one cause of disability in the country. That means one in every five adults, 300000 children and countless families. By conservative estimates, about 54 million adults have doctor-diagnostic arthritis. Almost 3 lakh babies and children have the disease or rheumatic condition.

Types Of Arthritis

There are four main categories of arthritis that encompasses approximately 100 different types of conditions. They are:

- Degenerative Arthritis
- Inflammatory Arthritis
- Infectious Arthritis
- Metabolic Arthritis

DIAGNOSIS

Arthritis diagnosis often begins with a primary care physician, who performs a physical examination and may do blood tests and imaging scans to help determine the type of arthritis. An arthritis specialist, or rheumatologist, should be involved if the diagnosis is uncertain or if the arthritis may be inflammatory.

Rheumatologists typically manage ongoing treatment for inflammatory arthritis, gout and other complicated cases. Orthopedic surgeons do joint surgery, including joint treatments. when the arthritis affects other body systems or parts, other specialists such as ophthalmologists, dermatologists or dentists, may also be included in the health care team.

Existing Treatment

The usually prescribed treatment to help manage some of the symptoms of arthritis involve a course of physical therapies. Treatment for arthritis aims to control pain, minimize joint damage, and improve or maintain function and quality of life. A range of medications and life style strategies can help achieve this and protect joints from further damage. Treatment might involve: Medications,

Non-pharmacologic therapies, Physical or occupational therapy, Splints or joint assistive aids, Patient education and support. The major section of medications include aspirin, analgesics,NSAIDs(non-steroidal anti-inflammatory drugs), DMARDs(disease modifying anti-rheumatic drugs), counterirritants, biologics, corticosteroids, anti-TNFs etc.

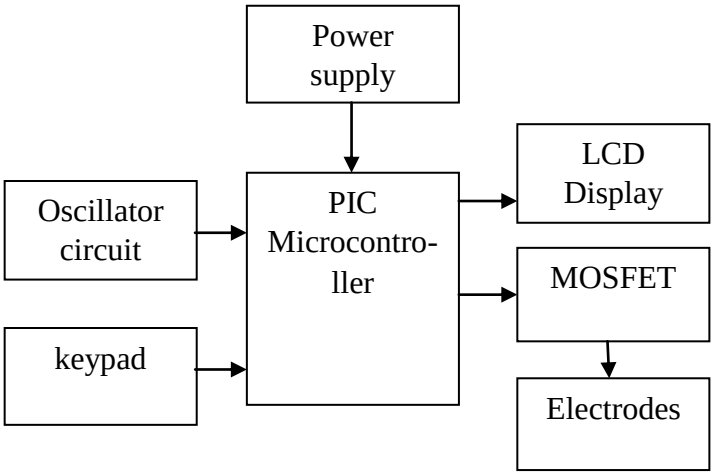
WORKING PRINCIPLE

The interferential current therapy is a form of electrical stimulation that utilises the remarkable physiological effects of low frequency nerve stimulation without the associated painful and uncomfortable side-effects that may usually occur with any low frequency stimulation. This is useful in the case of a muscle and nerve stimulation. The reason for using high frequency is that it reduces the skin otherwise caused by the low frequency current at the superficial tissues. The skin impedance at 50Hz is approximately 3200 whilst at 4000Hz it is reduced to approximately 40. The result of applying a higher frequency is that it will pass more easily through the skin, requiring less electrical energy input to reach the deeper tissues & giving rise to less discomfort.

Interferential therapy utilises two of these medium frequency currents, passed through the tissues simultaneously, where they are set up so that their paths cross & they literally interfere with each other – hence another term that has been used in the past but appears to be out of favour at the moment – Interference Current Therapy. This interaction gives rise to an interference current (or beat frequency) which has the characteristics of low frequency stimulation. The exact frequency of the resultant beat frequency can be controlled by the input frequencies. By careful manipulation of the input currents it is possible to achieve any beat frequency that you might wish to use clinically. Modern machines usually offer frequencies of 1-150 Hz, though some offer a choice of up to 250Hz or more.

HARDWARES USED

PIC 16F877A Microcontroller, LCD display, Electrodes, Oscillator Circuit, MOSFET, ADC, DAC, Step-down transformer, Keypad, Power Supply.



The use of 2 pole IFT stimulation is made possible by electronic manipulation of the currents - the interference occurs within the machine rather than in the tissues. There is no known physiological difference between the effects of IFT produced with 2 or 4 electrode systems. The key difference is that with a 4 pole application the interference is generated in the tissues and with a 2 pole treatment, the current is 'pre-modulated' i.e. the interference is generated within the machine unit. Whichever way it is generated, the treatment effect is generated from low frequency stimulation, primarily involving the peripheral nerves. There may indeed be significant effect on tissue other than nerves, but they have not as yet been unequivocally demonstrated. Low frequency nerve stimulation is physiologically effective (as with TENS and NMES) and this is the key to IFT intervention.

Nerves will accommodate to a constant signal & a sweep (or gradually changing frequency) is often used to overcome this problem. The principle of using the sweep is that the machine is set to automatically vary the effective stimulation frequency using either pre-set or user set sweep ranges. The sweep range employed should be appropriate to the desired physiological effects.

Here MPLAB software and Embedded C language has been used to design the program for the control circuit.

RESULT

The circuit has MOSFET as the driver. With the help of the MOSFET, the current is passed to the 12V transformer that helps to convert AC to DC current. The obtained 5V DC current passes to the microcontroller that has 3 switches connection respectively. The same DC current, undergoes pulse width modulation to become a 4 pulsed current. This current is fed to the optocoupler, which is the only connection between the high voltage and low voltage circuits, thus providing the necessary isolation in the form of insulation resistance.

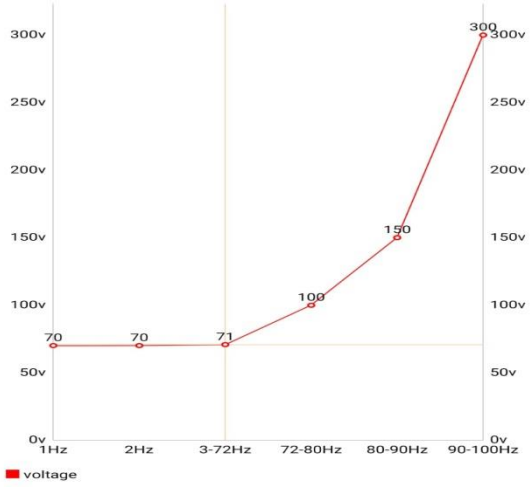
The processed current passes to 4 power MOSFETs which are connected to the DC to AC converter. The DC to AC converter operates on 3V supply and

converts the current to the form that is suitable for the safe penetration through the tissue. This current is passed to the tissue via electrodes which act as the interface between the electrical circuit and the biological tissue and can be in the form of an arm cuff or rather a knee belt.

Here, a range of frequencies have been adopted in which the variation is performed with the help of a crystal oscillator(0-100Hz). This frequency variation causes a corresponding variation in the voltage which is measured using a multimeter. This range of frequency is set in the program designed for the microcontroller. Each incrementation of the frequency and its corresponding variation in the voltage is shown in the table below.

S. No	FREQ (Hz)	VOLT (V)
Patient 1	1	70
Patient 2	2	70.1
Patient 3	3-72	70.72
Patient 4	72-80	100

The graph obtained from the output is as follows:



It has been suggested that IFT works in a 'special way' because it is 'interferential' as opposed to 'normal' stimulation. The evidence for this special effect is lacking and it is most likely that IFT is just another means by which peripheral nerves can be stimulated. It is rather a generic means of stimulation – the machine can be set up to act more like a TENS type device or can be set up to behave more like a muscle stimulator – by adjusting the stimulating (beat) frequency. It is often regarded (by patients) to be more acceptable as it generates less discomfort than some other forms of electrical stimulation.

The clinical application of IFT therapy is based on peripheral nerve stimulation (frequency) data, though it is important to note that much of this information has been generated from research with other modalities, and its transfer to IFT is assumed rather than proven. There is a lack of IFT specific research compared with other modalities (e.g. TENS). The bipolar (2 pole) application method is perfectly acceptable, and there is no physiological difference in treatment outcome. Recent research evidence supports the benefit of 2 pole application.

Treatment times vary widely according to the usual clinical parameters of acute/chronic conditions & the type of physiological effect desired. In acute conditions, shorter treatment times of 5-10 minutes may be sufficient to achieve the effect. In other circumstances, it may be necessary to stimulate the tissues for 20-30 minutes. It is suggested that short treatment times are initially adopted especially with the acute case in case of symptom exacerbation.

Selection of a wide frequency sweeps has been considered less efficient than a smaller selective range in that by treating with a frequency range of say 1-100Hz, the effective treatment frequencies can be covered, but only for a relatively small percentage of the total treatment time.

CONCLUSION

This project could successfully attain success regarding the issues concerned with the provision of the therapy in an efficient manner to the arthritic patients. The setup produced minimal side effects when compared to the other known treatments. It showed that IFC treatments were effective interventions for the management of knee OA, with some advantages in pain and disability outcomes. Moreover, a diligent survey conducted among the patients regarding the project produced results in favour to its implementation and further commercialization.

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