Relief for Muscle Crampness and Detector for EMG and PPG

Ajay. R[1], Akshay P Rajan[2], Joe Jophy[3], Christo Varghese[4]
MR.MOHAMMED AZARUDDIN.D (M.TECH[IIT-M])
[1,2,3,4] Final year Biomedical Engineering,
Dhanalakshmi Srinivasan Engineering College, Perambalur.

***Abstract*-A muscle cramp is a sudden involuntary contraction of muscles. Muscle cramps can cause severe muscle pain. Some of the main factors causing muscle cramps include dehydration, low levels of electrolytes, being out of shape and muscle fatigue. Muscle cramps often occur when exercising in extreme heat. Muscle cramp is a common problem which have no particular age limits. So that it can occur from adult age to old age. The primary treatment of muscle cramps include methods to relax the affected muscle, mainly through stretching, massaging and heat application. Other treatments are directed toward the underlying cause of the muscle cramps and can include rehydration, electrolyte repletion, hormone treatment, calcium supplementation etc. The main difficulties in the muscle cramp section is that it do not have a proper first aid treatment in the transportation sector. As muscle cramp occur for long distance travelers , it is very much essential to provide the first aid treatment for muscle cramp in transportation. The project proposed by our team is an initiative step to provide the first aid treatment for muscle cramp during transportation along with the detection of EMG and PPG and further these signals can be used by the hospital authorities.**

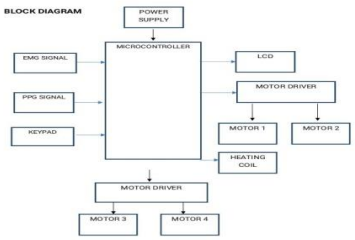
INTRODUCTION

The main intense is to keep away the pain caused due to the dislocation that take place while moving our hand or leg after over long period of rest condition, especially during travel time. After a long way of travelling the people may be distracted because of this cramps. The main reason is the lack of blood supply in our hand or leg. This occurs in the person those who are more than 40 age. The continuous occurring of this system can cause the problem of weakening of muscles. We can use this device in transportation as first aid.Muscle cramp is a common problem which have no particular age limits.it can to occur from adult age to old age .in medical history physical examination ,and a limited laboratory screen help to determine the various causes of muscle cramps .The third of pregnancy is associated with by cramps.in up to 30% of women .Endocrine disorders including thyroid disease and hypo-adrenalism may be associated with cramps among hypothyroid patient 20%-50% complains of muscle pain or cramps .liver disease and cirrhosis seem to be associated with increased cramps (due to decrease in intravascular volume in these patient).

MOTIVATION AND OVERVIEW

Muscle cramp is a common problem which have no particular age limits.it can to occur from adult age to old age .in medical history physical examination ,and a limited laboratory screen help to determine the various causes of muscle cramps .The third trimester of pregnancy is associated with by cramps.in up to 30% of women .Endocrine disorders including thyroid disease and hypo-adrenalism may be associated with cramps among hypothyroid patient 20%-50% complains of muscle pain or cramps .liver disease and cirrhosis seem to be associated with increased cramps (due to decrease in intravascular volume in these patient). Overall, our understanding of cramps has not progressed significantly in the last decade,although recent studies defining to proper system to get rid from the muscle cramps.

BLOCKDIAGRAM



CIRCUIT DIAGRAM

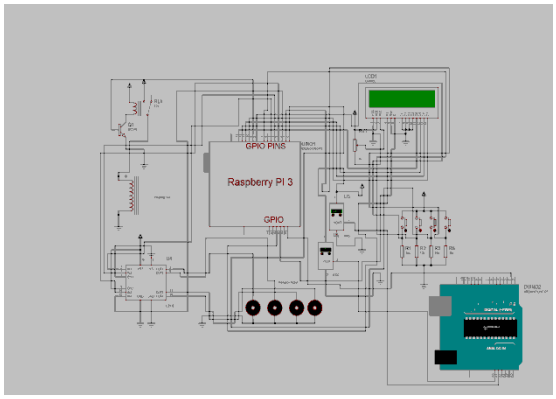
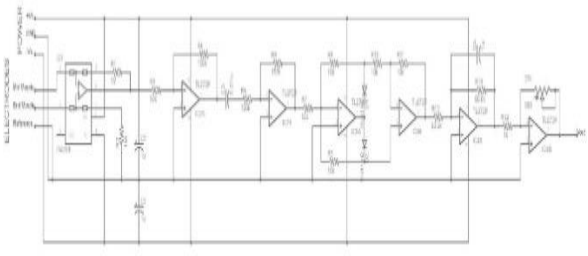


Fig 02

COMPONENTS

- EMG electrode
- Arduino UNO
- Raspberry Pi3
- PPG Sensor
- Vibration Motor
- Power Supply

1. EMG ELECTRODE



EMG electrode detects and records the electrical activity of the muscle. An electromyography detects the electrode potential generated by muscle cells. When these cells electrically or neurologically activated the signals can be analyzed to detect medical abnormalities,activation level, recruitment order, or analyze the biomechanics of muscle movement.

2. ARDUINO UNO

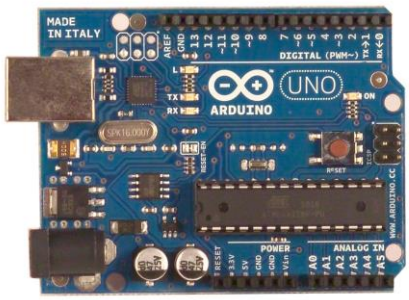


FIG 03

The maximum length and width of the Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Three screw holes allow the board to be attached toa surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not an even multipleof the 100 mil spacing of the other pinsTheArduino Uno is a microcontroller board based on the ATmega328 . It has 14 digitalinput/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, aUSB connection, a power jack, an ICSP header, and a reset button. It contains everything needed toRather than requiring a physical press of the reset button before an upload, the Arduino Uno is designed in away that allows it to be reset by software running on a connected computer. One of the hardware flow controllines (DTR) of the ATmega8U2 is connected to the reset line of the ATmega328 via a 100 nanofaradcapacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. TheArduino software uses this capability to allow you to upload code by simply pressing the upload button in theArduino environment. This means that the bootloader can have a shorter timeout, as the lowering of DTRcan be well-coordinated with the start of the uploadsupport the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DCadapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDIUSB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converterTheArduino Uno can be powered via the USB connection or with an external power supply. The powersource is selected automatically.External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adaptercan be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from abattery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5Vpin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage

regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

3. Raspberry Pi3

FIG04

The Raspberry Pi 3's four built-in USB ports provide enough connectivity for a mouse, keyboard, or anything else that you feel the RPi needs, but if you want to add even more you can still use a USB hub. Keep in mind, it is recommended that you use a powered hub so as not to overtax the on-board voltage regulator. Powering the Raspberry Pi 3 is easy, just plug any USB power supply into the micro-USB port. There's no power button so the Pi will begin to boot as soon as power is applied, to turn it off simply remove power. The four built-in USB ports can even output up to 1.2A enabling you to connect more power hungry USB devicesThe GPU provides Open GL ES 2.0, hardware-accelerated Open VG, and 1080p30 H.264 high-profile decode and is capable of 1Gpixel/s, 1.5Gtexel/s or 24 GFLOPs of general purpose compute. What's that all mean? It means that if you plug the Raspberry Pi 3 into your HDTV, you could watch BluRay quality video, using H.264 at 40MBits/s

The biggest change that has been enacted with the Raspberry Pi 3 is an upgrade to a next generation main processor and improved connectivity with Bluetooth Low Energy (BLE) and BCM43143 Wi-Fi on board. Additionally, the Raspberry Pi 3 has improved power management, with an upgraded switched power source up to 2.5 Amps, to support more powerful external USB devices..

4. PPG Sensor

Inch product specification pulse rate sensor is used to detect heartbeats. It can be wore on the finger or earlobe and connected to arduino via cables. It also carries an open source program to display heart rate via diagrams in real time. It is an optical heart rate sensor integrated with amplifying circuit and noise cancellation circuit. Specification: power supply: 3v~5v package include 1 x heartbeat module for Arduino inch.The photoplethysmographic (PPG)waveform, also known as the pulseoximeter waveform, is one of the most commonly displayed clinical waveforms. First described in the 1930s, the technology behind the waveform is simple. Thewaveform, as displayed on themodern pulse

oximeter, is an amplified and highly filtered measurement of light absorption by the local tissue over time. It is optimized by medical device manufacturers to accentuate its pulsatile components. Physiologically, it is the result of a complex, and not well understood, interaction between the cardiovascular, respiratory, and autonomic systems. All modern pulse oximeters extract and display the heart rate and oxygen saturation derived from the PPG measurements at multiple wavelengths. “As is,” the PPG is an excellent monitor for cardiac arrhythmia, particularly when used in conjunction with the electrocardiogram(ECG).With slight modifications in the display of the PPG (either to as trip chart recorder or sloweddown on the monitor screen), the PPG can be used to measure the ventilator-induced modulations which have been associated with hypovolemia.

5. Power Supply

100% brand new and high quality Connect your device to AC wall power jack for power charging. I ntelligent Switching circuit will recognize a full battery & automatically switches to a save modePlug never heats or overcharges the battery LED Charging indicator Short circuit protection Compact design, light and easy to carry The input to the circuit is applied from the regulated power supply. The a.c. input i.e., 230V from the mains supply is step down by the transformer to 12V and is fed to a rectifier. The output obtained from the rectifier is a pulsating d.c voltage. So in order to get a pure d.c voltage, the output voltage from the rectifier is fed to a filter to remove any a.c components present even after rectification. Now, this voltage is given to a voltage regulator to obtain a pure constant dc voltage. Transformer**:** Usually, DC voltages are required to operate various electronic equipment and these voltages are 5V, 9V or 12V. But these voltages cannot be.obtained directly. Thus the a.c input available at the mains supply i.e., 230V is to be brought down to the required voltage level. This is done by a transformer. Thus, a step down transformer is employed to decrease the voltage to a required level

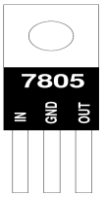
Rectifier**:**The output from the transformer is fed to the rectifier. It converts A.C. into pulsating D.C. The rectifier may be a half wave or a full wave rectifier. In this project, a bridge rectifier is used because of its merits like good stability and full wave rectification. The Bridge rectifier is a circuit, which converts an ac voltage to dc voltage using both half cycles of the input ac voltage. The Bridge rectifier circuit is shown in the figure. The circuit has four diodes connected to form a bridge. The ac input voltage is applied to the diagonally opposite ends of the bridge. The load resistance is connected between the other two ends of the bridge.

For the positive half cycle of the input ac voltage, diodes D1 and D3 conduct, whereas diodes D2 and D4 remain in the OFF state. The conducting diodes will be in series with the load resistance R_L and hence the load current flows through R_L.

For the negative half cycle of the input ac voltage, diodes D2 and D4 conduct whereas, D1 and D3 remain OFF. The conducting diodes D2 and D4 will be in series with the load resistance R_L and hence the current flows through R_L in the same direction as in the previous half cycle. Thus a bi-directional wave is converted into a unidirectional wave.

Voltage regulator**:** As the name itself implies, it regulates the input applied to it. A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. In this project, power supply of 5V and 12V are required. In order to obtain these voltage levels, 7805 and 7812 voltage regulators are to be used.

The 78xx (sometimes LM78xx) is a family of self-contained fixed linear voltage regulator integrated circuits. The 78xx family is commonly used in electronic circuits requiring a regulated power supply due to their ease-of-use and low cost. For ICs within the family, the first number 78 represents positive supply and the *xx* is replaced with two digits, indicating the output voltage. 78xx ICs have three terminals and are



6. Vibration Motor

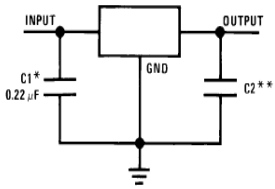
This is a tiny Vibrator Motor which works at 3V to 4.5V DC voltage. This motor can be found inside your mobile phone to generate vibration alert. A DC motor is a mechanically commutated electric motor powered from direct current (DC). The stator is stationary in space by definition and therefore so is its current. The current in the rotor is switched by the commutator to also be stationary in space. This is how the relative angle between the stator and rotor magnetic flux is maintained near 90 degrees, which generates the maximum torque.

DC motors have a rotating armature winding but non-rotating armature magnetic field and a static field winding or permanent magnet. Different connections of the field and armature winding provide different inherent speed/torque regulation characteristics. The speed of a DC motor can be controlled by changing the voltage applied to the armature or by changing the field current. The introduction of variable resistance in the armature circuit or field circuit allowed speed control. Modern DC motors are often controlled by power electronics systems called DC drives.

The introduction of DC motors to run machinery eliminated the need for local steam or internal combustion engines, and line shaft drive systems. DC motors can operate directly from rechargeable batteries, providing the motive power for the first electric vehicles. Today DC motors are still found in applications as small as toys and disk drives, or in large sizes to operate steel rolling mills and paper machines.

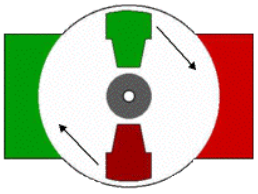
The speed of a DC motor is directly proportional to the supply voltage, so if we reduce the supply voltage from 12 Volts to 6 Volts, the motor will run at half the speed. How can this be achieved when the battery is fixed at 12 Volts?- The speedcontroller works by varying the average voltage sent to the motor. It could do this by simply adjusting the voltage sent to the motor, but this is quite inefficient to do. A better way is to switchthe motor's supply on and off very quickly. If the switching is fast enough, the motor doesn't notice it, it only notices the average effect.

OPERATION :In any electric motor, operation is based on simple electromagnetism. A current-carrying conductor generates a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the strength of the external magnetic field. As you are well aware of from playing with magnets as a kid, opposite (North and South) polarities attract, while like polarities (North and North, South and South) repel. The internal configuration of a DC motor is designed to harness the magnetic interaction between a current-carrying conductor and an external magnetic field to generate rotational motion.



Let's start by looking at a simple 2-pole DC electric motor (here red represents a magnet or winding with a "North" polarization, while green represents a magnet or winding with a "South" polarization).

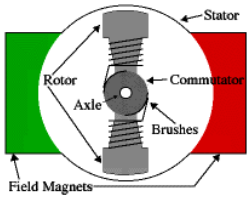
Every DC motor has six basic parts -- axle, rotor (a.k.a., armature), stator, commutator, field magnet(s), and brushes. In most common DC motors (and all that BEAMers will see), the



external magnetic field is produced by high-strength permanent magnets[1]. The stator is the stationary part of the motor -- this includes the motor casing, as well as two or more permanent magnet pole pieces.

The geometry of the brushes, commutator contacts, and rotor windings are such that when power is applied, the polarities of the energized winding and the stator magnet(s) are misaligned, and the rotor will rotate until it is almost aligned with the stator's field magnets. As the rotor reaches alignment, the brushes move to the next commutator contacts, and energize the next winding. Given our example two-pole motor, the rotation reverses the direction of current through the rotor winding, leading to a "flip" of the rotor's magnetic field, driving it to continue rotating.

In real life, though, DC motors will always have more than two poles (three is a very common number). In particular, this avoids "dead spots" in the commutator. You can imagine how with our example two-pole motor, if the rotor is exactly at the



middle of its rotation (perfectly aligned with the field magnets), it will get "stuck" there. Meanwhile, with a two-pole motor, there is a moment where the commutator shorts out the power supply (i.e., both brushes touch both commutator contacts simultaneously). This would be bad for the power supply, waste energy, and damage motor components as well. Yet another disadvantage of such a simple motor is that it would exhibit a high amount of torque "ripple" (the amount of torque it could produce is cyclic with the position of the rotor).

CONCLUSION

In this system we have provided an integrated approach for our embedded system design. We discussed various design components that are the integral part of embedded system. Here we mainly use the PPG and EMG sensor to play perfect role in our mechanism. Then the patient must be get rid from the muscle cramp in body with the help of vibration. The main objective of the system is to provide a mechanism with which a good design includes micro controller and other parts. Thus our main approach is to exploring new system to medical field for the treatment of muscle cramp, effects should be made to ensure cramps assesments are patient comprehensive, accurate and reliable populations

REFERENCE

[1] Severinghaus JW, Astrup PB. History of blood gas analysis. VI. Oximetry. J ClinMonit 1986;2(4):270e88.
[2] Wukitsch MW. Pulse oximetry: historical review and Ohmeda functional analysis. Int J ClinMonitComput 1987;4(3):161e6.
[3] Hertzman AB, Spielman C. Observations on the finger volume pulse recorded photoelectrically. Am J Physiol 1937;119: 334e5.
[4] Hertzman AB. The blood supply of various skin areas as estimated by the photoelectric plethysmograph. Am J Physiol 1938;124(2):328e40.
[5] Hertzman AB, Dillon JB. Distinction between arterial, venous, and flow components in photoelectric plethysmography in man. Am J Physiol 1940;130(1):177e85.
[6] Hertzman AB, Dillon JB. Applications of photoelectric plethysmography in peripheral vascular disease. Am J Physiol1940: 750e61.
[7] Hertzman AB, Roth LW. The absence of vasoconstrictor reflexes in the forehead circulation: effects of cold. Am J Physiol 1942;136:692e7
[8] de Trafford J, Lafferty K. What does photoplethysmography measure? Med BiolEngComput 1984;22(5):479e80.
[9] Schmitt JM. Simple photon diffusion analysis of the effects of multiple scattering on pulse oximetry. IEEE Trans Biomed Eng 1991;38(12):1194e203.
[10] August B. Versuch der absorptions-verhaltnisse des cordierites fur rotheslichtzubestimmen. Ann PhysikChemGer 1851; 84:37e52.

[11] *Mannheimer PD. The light tissue interaction of pulse oximetry. AnesthAnalg 2007;105(6S_Suppl.):S10e7.
[12] Shelley KH, Dickstein M, Shulman SM. The detection of peripheral venous pulsation using the pulse oximeter as a plethysmograph. J ClinMonit 1993;9(4):283e7.
[13] Nijboer JA, Dorlas JC, Mahieu HF. Photoelectric plethysmographyesome fundamental aspects of the reflection and transmission method. ClinPhysPhysiolMeas 1981;2(3):205e15.
[14] *Aoyagi T. Pulse oximetry: its invention, theory, and future. J Anesth 2003;17(4):259e66.
[15] Shelley K, Tamai D, Jablonka D, et al. The effect of venous pulsation on the forehead pulse oximeter wave form as a possible source of error in SPo2 calculation. Anesth Analgesia 2005;100(3):743e7.
[16] Walton ZD, Kyriacou PA, Silverman DG, et al. Measuring venous oxygenation using the photoplethysmograph waveform. J ClinMonitComput 2010;24(4):295e303.
[17] Kim JM, Arakawa K, Benson KT, et al. Pulse oximetry and circulatory kinetics associated with pulse volume amplitude measured by photoelectric plethysmography. AnesthAnalg 1986;65(12):1333e9.
[18] Spigulis J. Optical noninvasive monitoring of skin blood pulsations. Appl Opt 2005;44(10):1850e7.
[19] *Ruskin KJ, Shelley KH. Patent medicine and the "Black Box. AnesthAnalg 2005;100(5):1361e2.
[20] *Shelley KH. Photoplethysmography: beyond the calculation of arterial oxygen saturation and heart rate. AnesthAnalg 2007;105(6 Suppl.):S31e6