Knee Pain Self-Massager With Knee Range of Motion Measuring Device

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Abstract- *This paper presents an approach for measuring and monitoring knee joint synovial and angle movement using inertial measurement unit (IMU) sensors and vibration sensor. This type of monitoring is beneficial for therapists and physicians because it facilitates remote assessment of patient activities. In our approach, IMUs are mounted on the lower leg to measure the angles of each segment. In our experiments, we utilized a motion capture system to accurately measure the knee joint angle and used this as the ground truth to assess the accuracy of the IMU and vibration system. The range of average error of the system across a variety of motion trials was 0.08 to 3.06 degrees. The accuracy of the IMU measurement system currently outperforms existing wearable systems such as conductive fiber optic sensors and flex-sensors. This system gives massaging therapy, which is controlled by user.*

Keywords- Synovial fluid, joint inflammation, inertial measurements.

I. INTRODUCTION

The action of restoring someone to health or normal life through training and therapy after imprisonment, addiction, or illness. "she underwent rehabilitation and was walking within three weeks "the action of restoring someone to former privileges or reputation after a period of disfavour.

"Posthumous rehabilitation of the activist"

SYNOVIAL FLUID

Synovial fluid analysis is also known as joint fluid analysis. It helps diagnose the cause of joint inflammation. Each of the joints in the human body contains synovial fluid. This fluid is a thick liquid that lubricates the joint and allows for ease of movement. In joint diseases like arthritis, the synovium of the joint is the main place where inflammation occurs. Limited mobility in the joint, or pain and stiffness with movement, are often the first signs of joint disorders.

How do you reduce synovial fluid?

- ✓ Physical therapy.
- ✓ Acupuncture.
- ✓ Knee taping.
- ✓ Joint aspiration – removal of excess synovial fluid (decrease swelling and pain)

Does massage help synovitis?

Remedial Massage may also stretch the joints and stimulate the viscous synovial fluid found in cavities of synovial joints. After the fluid is stimulated into the joint cavity, the fluid forms a thin later, which reduces inflammation and pain by acting as a buffer of sorts. Taping can be used to reduce pain in knee osteoarthritis. There are different methods of taping, but the common effect is to exert a medially directed force on the patella to increase the patellofemoral contact area, thereby decreasing joint stress and reducing pain.

II. IDENTIFY, RESEARCH AND COLLECT IDEA

Existing System

They have developed a prognostic tool predicted the progression of pain in Knee Osteoarthritis (KOA) patients using data collected at baseline. In order to do that we leverage a feature importance voting system for identifying the most important risk factors and various machine learning algorithms to classify, whether a patient's pain with KOA, will stabilize, increase or decrease. This models have been implemented on different combinations of feature subsets, and results up to 84.3% have been achieved with only a small amount of features. The existing methodology demonstrated unique potential in identifying pain progression at an early stage therefore improving future KOA prevention efforts using machine learning.

Proposed system

The joints of the human body, especially the knees, are continually exposed to varying loads as a person goes about their day. These loads may contribute to damage to tissues including cartilage and the development of degenerative medical conditions such as osteoarthritis

(OA). Our system consists of clinical hammer with mechanical setup, triple axis accelerometer with 10-bit resolution, flex sensor and vibration sensor and therapeutic massaging treatment is developed to reduces knee pain. The three sensors were mounted on simple straps and located on the knee and ankle. Before powering and wearing the sensors, the IMUs were calibrated on a flat surface that was parallel to the ground. In this case, both sensors have the same zero reference coordinator.The outputs of all sensors are processed using an on-board PIC (16F877A) microcontroller and angle variation is measured by using theses sensor, to measure volume of synovial fluid/range of motion in human knee joints.

An accelerometer is a device that measures proper acceleration; proper acceleration is not the same as coordinate acceleration (rate of change of velocity). This is placed in ankle of patient leg. For example, an accelerometer at rest on the surface of the Earth will measure acceleration due to Earth's gravity, straight upwards (by definition) of g ≈ 9.81 m/s2. By contrast, accelerometers in free fall (falling toward the center of the Earth at a rate of about 9.81 m/s2) will measure zero.

The flex sensor perceives changes in bend angle as a linear proportional change in current or voltage. Different flex angles cause the area of the resistor to differ from its un-flexed 10K value , resulting in this characteristic. The bending of the sensor is registered as a change in resistance only when the sensor is flexed in one direction (out of the screen in relation to the picture at the top of screen). There are simple configurations of the flex sensor circuit: Voltage divider circuit allows you to measure a changing voltage due to a change in the bend angle (the one used in the demo circuit). This vibration sensor buffers a piezoelectric transducer. As the transducer is displaced from the mechanical neutral axis, bending creates strain within the piezoelectric element and generates voltages.

These sensors output is given to PIC (16F877A) microcontroller, which is a programmable IC. If the above sensor value is exceeds compared with predefined values, which is accrued in the development phase to measure knee angle and GSM module is used to send SMS about knee angle to doctor/patient/user and Bluetooth module is used to control massager . The massager is equip with acupuncture and vibrator and which is controlled by Bluetooth communication with help of driver relay circuit and microcontrollers.

These tiny electronic sensors are fabricated by Micro Electro Mechanical System (MEMS) technologies to compute motions of an object in free space relative to an inertial frame with relatively low power consumption. Accelerometers and flex sensor are two primary types of IMU sensors for inertial measurement. This study proposes a method to measure the range of motion of the knee joint using two IMU sensors mounted on the body shank and thigh.

III. HARDWARE SUMMARY

1. POWERSUPPLY:

Power supply is a reference to a source of electricalpower. A device or system that supplies electrical or other types of energy to an output load or group of loads is called a power supply unit or PSU. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely toothers.

Power supplies for electronic devices can be broadly divided into linear and switching power supplies. The linear supply is a relatively simple design that becomes increasingly bulky and heavy for high current devices; voltage regulation in a linear supply can result in low efficiency. A switched-mode supply of the same rating as a linear supply will be smaller, is usually more efficient, but will be more complex.

2. TRANSFORMER:

Transformers convert AC electricity from onevoltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC.Step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage (230V in UK) to a safer lowvoltage.

3. BRIDGERECTIFIER:

A bridge rectifier can be made using four individual diodes, but it is also available in special packages containing the four diodes required. It is called a full-wave rectifier because it uses the entire AC wave (both positive and negative sections). 1.4V is used up in the bridge rectifier because each diode uses 0.7V when conducting and there are always two diodes conducting, as shown in the diagram below. Bridge rectifiers are rated by the maximum current they can pass and the maximum reverse voltage they can withstand (this must be at least three times the supply RMS voltage so the rectifier can withstand the peak voltages).

4. SMOTHING:

Smoothing is performed by a large value electrolytic capacitor connected across the DC supply to act as a reservoir, supplying current to the output when the varying DC voltage from the rectifier is falling. The diagram shows the unsmoothed varying DC (dotted line) and the smoothed DC (solid line). The capacitor charges quickly near the peak of the varying DC, and then discharges as it supplies current to the output.

5. REGULATOR:

Voltage regulator ICs are available with fixed (typically 5, 12 and 15V) or variable output voltages. They are also rated by the maximum current they can pass. Negative voltage regulators are available, mainly for use in dual supplies. Most regulators include some automatic protection from excessive current ('overload protection') and overheating ('thermal protection').

6. ARDUINO UNO:

The Arduino Uno is an open source microcontroller platform based on simple input-output board (I/O). It has 14digital input/output pins. Of the 14 pins, 6 can be used as PWM outputs, 6 as analog inputs. It has a 16 MHz quartz crystal and a USB connection. The Arduino Uno is inexpensive, supports cross-platform, open source, easy programming environment.

IV. WRITE DOWN YOUR STUDIES AND FINDINGS

IMPLEMENTATION
MPLAB

MPLAB is a proprietary freeware integrated development environment for the development of embedded applications on PIC and dsPIC microcontrollers, and is developed by Microchip Technology.MPLAB X is the latest edition of MPLAB, and is developed on the NetBeans platform. MPLAB and MPLAB X support project management, code editing, debugging and programming of Microchip 8-bit, 16-bit and 32-bit PIC microcontrollers.

MPLAB is designed to work with MPLAB-certified devices such as the MPLAB ICD 3 and MPLAB REAL ICE, for programming and debugging PIC microcontrollers using a personal computer. PICKit programmers are also supported by MPLAB.

MPLAB 8.X is the last version of the legacy MPLAB IDE technology, custom built by Microchip Technology in Microsoft Visual C++. MPLAB supports project management, editing, debugging and programming of Microchip 8-bit, 16-bit and 32-bit PICmicrocontrollers. MPLAB only works on Microsoft Windows. MPLAB is still available from Microchip's archives, but is not recommended for new projects.

MPLAB supports the following compilers:

- MPLAB MPASM Assembler
- MPLAB ASM30 Assembler
- MPLAB C Compiler for PIC18
- MPLAB C Compiler for PIC24 and dsPIC DSCs
- MPLAB C Compiler for PIC32

V. RELATED WORK

EMBEDDED SYSTEMS

An embedded system is a computer system with a dedicated function within a larger mechanical or electrical system, often with real-time computing constraints.It is embedded as part of a complete device often including hardware and mechanical parts. Embedded systems control many devices in common use today.

Ninety-eight percent of all microprocessors are manufactured as components of embedded systems. Examples of properties of typically embedded computers when compared with general-purpose counterparts are low power consumption, small size, rugged operating ranges, and low per-unit cost. This comes at the price of limited processing resources, which make them significantly more difficult to program and to interact with.

However, by building intelligence mechanisms on top of the hardware, taking advantage of possible existing sensors and the existence of a network of embedded units, one can both optimally manage available resources at the unit and network levels as well as provide augmented functions, well beyond those available.

For example, intelligent techniques can be designed to manage power consumption of embedded systems. Modern embedded systems are often based on microcontrollers (i.e. CPU's with integrated memory or peripheral interfaces),but ordinary microprocessors (using external chips for memory and peripheral interface circuits) are also common, especially in more-complex systems.

In either case, the processor(s) used may be types ranging from general purpose to those specialised in certain class of computations, or even custom designed for the application at hand.

A common standard class of dedicated processors is the digital signal processor (DSP). Since the embedded system is dedicated to specific tasks, design engineers can optimize it to reduce the size and cost of the product and increase the reliability and performance.

Some embedded systems are mass-produced, benefiting from economies of scale. Embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, and largely complex systems like hybrid vehicles, MRI, and avionics. Complexity varies from low, with a single microcontroller chip, to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure.

VI. RESULTS

Knee OA is often diagnosed by the presence of osteophytes (bone spurs) and loss of joint space seen on x-rays.1 Although scientists are unsure of the specific cause of knee OA, some influential factors include genetics, obesity, previous knee injuries and overuse. Additionally, researchers have investigated the possible causative role of the quadriceps muscle group. The quadriceps femoris, located on the anterior thigh, is made up of four distinct muscles that have different points of origin and a common insertion around the knee. These muscles work together to extend the leg, such as in the movement you make when kicking a ball, and also help stabilize the leg while climbing up and down stairs. Joint protection and shock absorption (when walking or running) are also common functions of these muscles. ULTS Although this condition can occur in any of the weight-bearing joints, knee OA affects approximately 9 million American adults. Unfortunately, this condition does not have a cure, and researchers predict the prevalence of this type of OA will increase as the population ages.The current combination of treatments include exercise, physical therapy, weight control, supportive devices, medications and surgery. However, conventional treatments often don't provide enough symptom relief, and so more and more people are turning to proven alternatives for pain relief, including massage therapy. Recent studies showing the efficacy are helping drive demand, and can also facilitate better discussions between you and your clients about the benefits of massage

VII. CONCLUSION

Osteoarthritis of the knee is very common. This is probably because your knee has to take extreme stresses, twists and turns as well as bearing your body weight. Osteoarthritis often affects both knees.Osteoarthritis of the hip or knee is particularly disabling because it limits ambulation, but the affliction also strikes the hands, the spine, and the feet with the same destructive joint process.5,8 The end point of the OA disease process is total loss of joint cartilage in the affected area and the need for joint replacement.Massage therapy seems to be efficacious in the treatment of OA of the knee. Further study of cost effectiveness and duration of treatment effect is clearly warranted.Massage therapy may diminish symptoms and improve the course of OA by increasing local circulation to the affected joint, improving the tone of supportive musculature, enhancing joint flexibility, and relieving pain.14 Massage therapy has been evaluated and found to be effective for various painful musculoskeletal conditions.15,16 However, to our knowledge, to date, no study has specifically evaluated the effectiveness of massage therapy for OA. We performed a randomized, wait-list controlled trial of 8 weeks' duration of Swedish massage therapy for OA of the knee.

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