Feature Extraction Of Knee Joint Vibroarthrography (VAG) Signal Using Statistical Means
OUTLINE

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CON’T INTRODUCTION

Knee Joint

• The human knee joint is the largest and most complex joint structures in human body which it is surrounded by numerous of ligaments and tendons.

• Known as synovial joint as it contains lubricating fluid (synovia fluid).

  ➤ Patella - To protect the joint from any external injury.
  
  ➤ Lateral and medial collateral ligaments
  ➤ Anterior and posterior cruciate ligaments

  Give support to the knee (main stabilizer)
KNEE ANATOMY

- Degenerated Cartilage
- Meniscus Tear

Diagram showing knee anatomy with labels for femur, patella, PCL, articular cartilage, lateral and medial collateral ligaments, lateral meniscus, and tibia.
INTRODUCTION

• Factors caused typical changes in knee structures:
  ✓ Aging process
  ✓ Injury misalignment
  ✓ Joint trauma
  ✓ Etc

Knee Pathology

Tear Arthritis ➔ OSTEARTHROIS
- Degeneration joint disease
- Presence of inflammation in the synovium
- Full thickness articular cartilage degeneration
- Exposed bone (slowly expose to corrosion)
Normal Knee

Abnormal Knee

- Femur
- Tibia
- Bone Spurs
- Destroyed Cartilage
**Problem Statement**

- Imaging techniques (X-rays, CT scan, MRI, Ultrasound) can only capture gross cartilage defects and may not be useful for early detection of cartilage pathologies.
• Image evaluation is normally underestimates the extent of cartilage damage.
• Cannot provide the accurate diagnosis
  ➔ They are unable to supply clear vision of the degeneration sign, especially during the early stage of osteoarthritis
Magnetic Resonance Imaging (MRI)

- A very expensive and sensitive imaging technique.
- Demonstrate reactive bone edema.
- Can access osteoarthritis’ severity levels through the degeneration of articular cartilages.
- Useful to diagnose other entities such as meniscal tears, ligaments injury, internal joint derangement, bone and joint infections.

Not commonly used ➔ expensive (too uneconomic)
• Semi invasive method
• Give detailed comparative research on the efficiency of radiography compared to others in detecting the cartilage pathology.
• Has the highest reliability among modalities or diagnostic methods.

→ Not helpful → give some side-effect if having repetitive assessment.

✦ Many researchers look for alternatives tool → Vibro-arthroscopy (VAG).
VIBROARTHROGRAPHY (VAG)

The knee joint generates vibration signal and could be used to detect early stage knee joint pathologies. The method of detecting the vibration signal to diagnose injury is known as vibration arthrography or vibroarthography (VAG).

→ Prevent is better than cure!

This project aim to measure vibration signals produced by knee joint movement (extension-flexion) by using accelerometer. The signal is further analyzed using the statistical methods to understand the different between normal and asymptomatic joint signal.
OBJECTIVES

- To obtain the joint’s vibration signal using accelerometer while undergoing joint movement.
- To identify the differences in the joint vibration signal between healthy person and the person experienced knee injuries. (normal and abnormal subjects).
- To apply suitable and precise features extraction techniques for data extraction.
METHODOLOGY

Type of experiment:
→ Knee flexion and extension

Subjects:
→ Normal: 10 persons
→ Abnormal: 10 persons
Figure 3.1: Block Diagram of Methodology Process
Placement of the Accelerometer

Location:
Medial compartment and slightly below the midline of patella

WHY???

- Enhance accuracy of the results as it is closest to the area of contact between surfaces moving against each other in the knee joint.

- Offer a relatively stable position for the sensor as less affected to the movement of the knee joint.
Sensor Placement for Subject

Accelerometer
Knee Flexion and Extension
Block Diagram of Data Acquisition Protocol

1. **New Subject**
2. **Fill the consent form and questionnaire**
3. **Data Collection from the subject**
4. **Data Acquisition Protocol (DAP)**
5. **Warm up exercise by subject**
6. **Sensor Placement**
7. **Brief explanation to subject about the data acquisition method**
8. **End**
Attach accelerometer sensors to the Medial and Lateral Retinaculum of the right knee joint.

Connect the sensors to the MotionNode Bus host unit then connect to laptop via wireless network system.
RESULT 1 – TIME DOMAIN

Typical example of normal and asymptomatic signal. Asymptomatic produced more vibration compare to normal signal.
RESULT 2 - FREQUENCY DOMAIN

A typical difference between normal and asymptomatic knee signal in terms of frequency range.
RESULT 3 – FREQUENCY RANGE

Comparison between frequency range of subjects
RESULT 4 – STATISTICAL FEATURES

Only mean and Standard Deviation show clear differences.
CONCLUSION

The research is done for extraction and screening of knee joint vibroarthrographic (VAG) signal during flexion and extension movements.

Obvious differences between the VAG signal from with and without knee pathological condition were established.
REFERENCE


THANK YOU