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A Knee Brace for Pressure Reduction in Injured Articulations

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Introduction

- Articulations in general and the knee in particular are made up of connective tissue which is characterized by a poor recovery capability
- Knee surgeries involve several complications and are not a good option in many cases
- In non life-threatening injuries there is usually a long delay between the injury an the surgery.

Goals

- Bridge to surgery
  - Actively remove work load on knee
  - Add minimal work to unloaded stages of walk
  - Low power consumption

Challenges

- Gait cycle varies between subjects
- System has to be as light as possible
- System should be trainable with little data

Raw Data

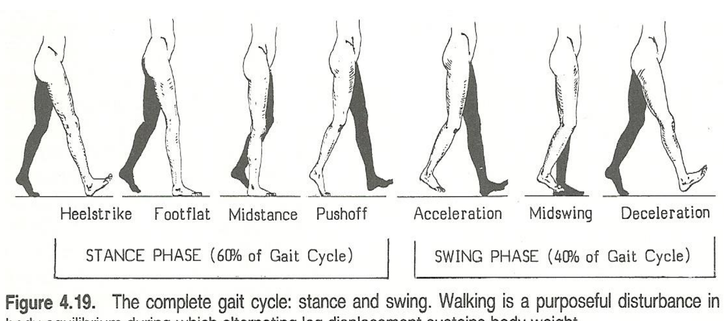
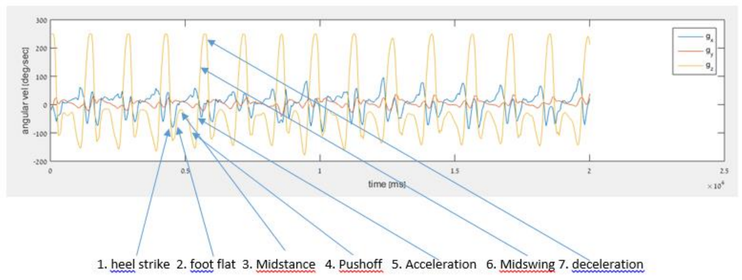
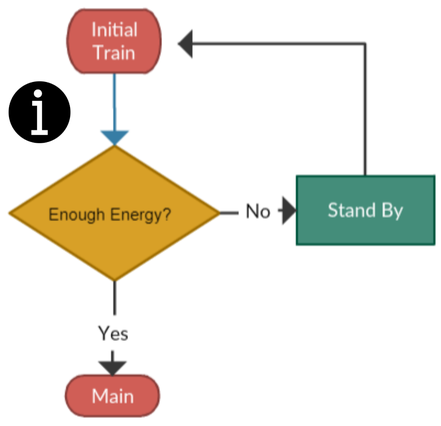


Figure 4.19. The complete gait cycle: stance and swing. Walking is a purposeful disturbance in body equilibrium during which alternating leg displacement sustains body weight.



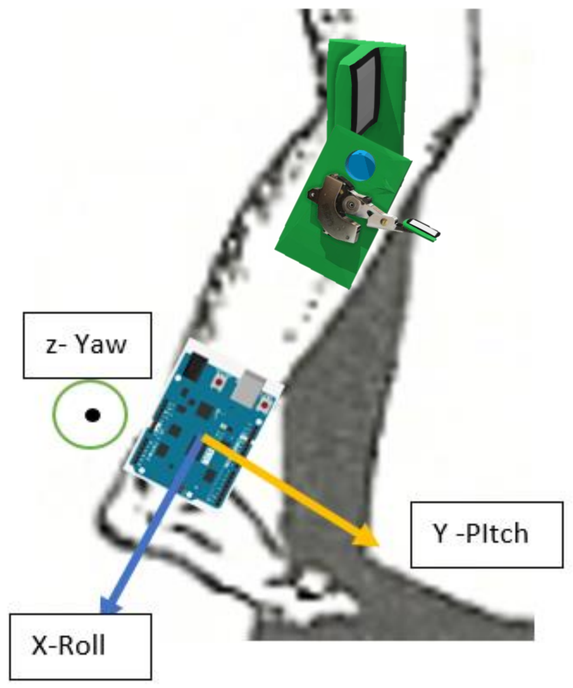
Algorithm



- Check for signal energy

  If low go to stand by (save energy)
- Measure :
  - ➢ Threshold for g_z
  - ➢ Threshold for a_x
  - ➢ Average step frequency
- **Main**
  - ➢ Scan for max of g_z an then max of a_x
    - ➢ ON state
  - ➢ Scan for first min of g_z during ON state
    - ➢ OFF state

System



- OFF state
  - ➢ No current flows through the magnet
  - ➢ The system behaves like a free axis
- ON state
  - ➢ The magnet is activated
  - ➢ The system behaves like a rigid rod, connected in parallel with the knee

Main Advantage

- The system proposed has two separated working states
- Allowing for impact absorption when landing the heel and improved comfort when shock absorption is not needed

Tests

- Step detection
- Low friction was obtained by sanding the #d printed prototype
- Relatively smooth movement was obtained with fast docking velocities
- The system is rigid enough to stay in position during normal walks and even sprints

Conclusions

- We have improved the functionality of the knee brace with a minimal increase in complexity
- Our system is considerably cheaper than in-market solutions, which is a key advantage for short term use knee braces

Suggestions for the Future

- Add a ball bearing to virtually eliminate friction
- Change hard disk motor for tailored made motor
- Use an Arduino adapter to control de motor instead of two independent circuits connected through a transistor

Bibliography

Shamaei et al. Design and functional evaluation of a quasi-passive compliant stance control knee–ankle–foot orthosis IEEE Transactions on Neural Systems and Rehabilitation Engineering 22.2 (2014): 258-268.

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