Vibrational Bone Therapy - Research Tool

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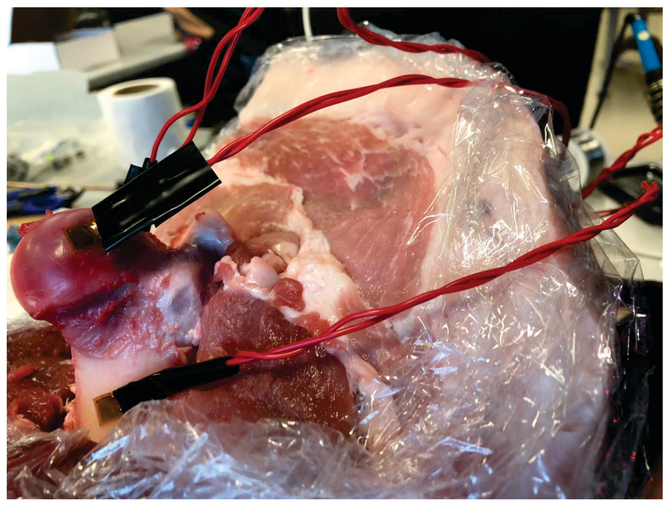
BACKGROUND

- Osteoporosis is characterized by decrease in bone mineral density
- 33% of hip fracture patients die within 1 year of injury
- Vibration therapy mimics effects of mechanical loading, increasing bone growth rate
- Smallest strain shown to inhibit bone resorption is 70 με

SCOPE

- Design and build prototype capable of applying local vibration to achieve 70 με at femoral head
- Investigate frequency range of 0-60 Hz at constant amplitude of 5 mm on pig femur

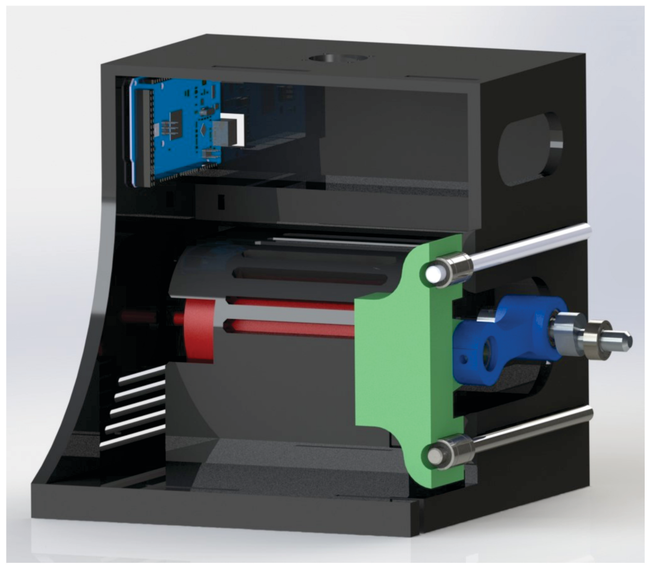


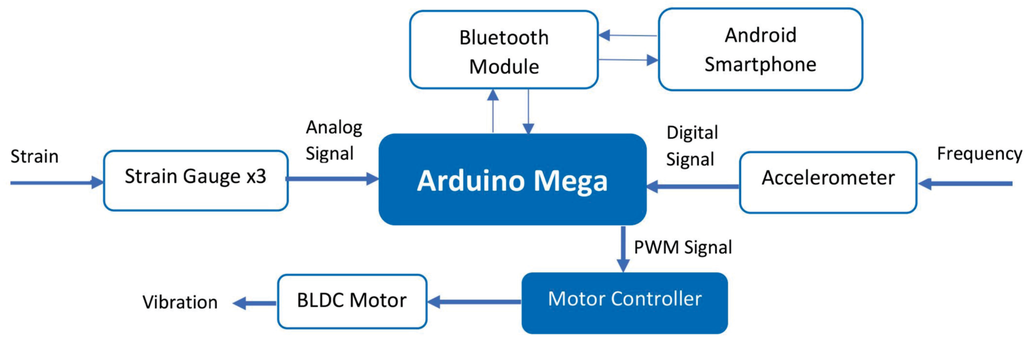
FUTURE WORK

- Investigate multiple parameters:
  - Locations of vibration: at knee, midway to knee
  - Depth of tissue surrounding femoral head
  - Amplitude (1mm - 6mm)
  - Magnitude of vibration
- In-vivo testing:
  - Animal and human trials
  - Key parameter: BMD
- In-home design - beyond research tool:
  - Additional safety precautions
  - Enhance ergonomics and portability

DESIGN

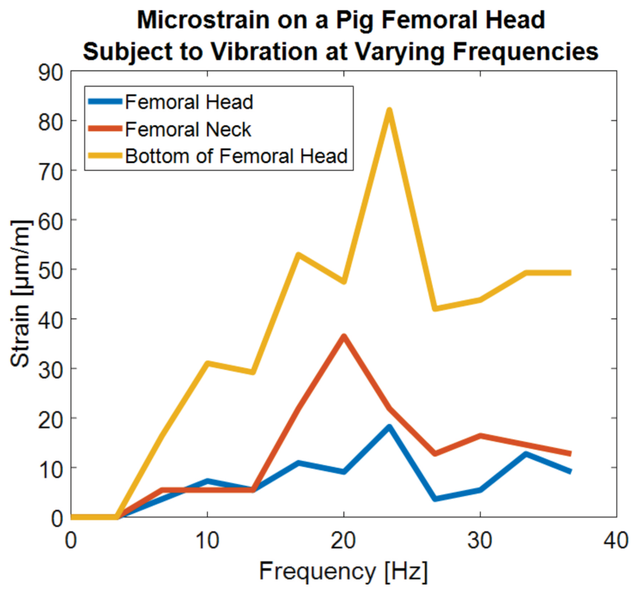
- Ardiuno Mega to process and collect data
- BLDC motor to achieve 4000 RPM (67 Hz)
- Slider crank mechanism to translate rotational motion to linear motion
- Aluminum CAM shaft & set screws to ensure safety at high rotation speeds
- Bluetooth module enabling wireless control
- Three strain gauges across femoral head and neck





TEST RESULTS

- Peak response at 20-25 Hz
- Maximum strain of 82.15 με achieved at femoral neck
- Lowest strain at femoral head
- Unable to test frequencies >36 Hz due to shaft failure



CONCLUSION

- Potential to achieve target strains at femoral head → theoretically increases bone deposition
- Optimal frequency of 20-25 Hz when vibration is applied to lateral thigh
- Immediate next steps:
  - Redesign and machine with higher strength material
  - Retest (frequency range: 0-90 Hz)

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