Integration of Artificial Intelligence (AI) Software in Bionic Prosthetics for Active Gait Correction

Josh Key & Connor Sims
Tickle College of Engineering
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Background

- Around 2 million people in the U.S. currently living with limb loss
- Leading causes
  - Vascular disease
  - Trauma
  - Born missing a limb
- Most prosthetic advancement within last 200 years due to modern material manufacturing
Need for Research

- Vast majority of prosthetic users walk with at least one gait abnormality.

Abnormal gait

- Excessive knee flexion, lack of knee flexion, lateral whip, foot slap, lateral or anterior trunk bending, uneven stride length
  - Patient Causes
    - Muscle weakness, Pain, Decreased confidence in prosthesis, habitual/learned behavior
  - Prosthetic Causes
    - Poor prosthetic fitting, prosthetic misalignment
Need for Research (cont...)

Secondary conditions
- Osteoarthritis in intact limb
  - From unequal distribution of forces on stump
- Back Problems
  - Not necessarily caused by abnormal gait, but definitely a result of having lower limb amputated
    - Could be from dependence on other leg
- Osteoporosis in residual limb
  - Bone degrades faster than regenerated
Previous Investigations

- Powered ankle prosthesis
  - Decreased unaffected leg peak resultant forces by 11%
    - Due to lack of dependence on unaffected leg
  - Significantly greater range of motion than energy storing & returning prosthesis
  - Overall increased velocity, lowered metabolic energy costs, and helped to normalize gait in users
Previous Investigations (cont...)

- SYMBIONIC® LEG 3
  - Is adaptable across varying terrain
    - Uses sensors and microprocessors to interpret terrain and change resistance and flexion
  - Helps keep user from falling
  - Emergency lock keeps knee extended
  - Allows the leg to swing more naturally
Google’s Deepmind AI Software
Proposed Research

- Enroll subjects from Eastern TN to compile data by means of a gait study.
  - Gait study will consists of 50 subjects that have a lower limb amputation
  - Preliminary Questions to determine background
    - History of therapy/years using prosthetic
  - Markers placed on Lower iliac crest, hip, knee, ankle, heel, and 5th metatarsal.
  - 200 Hz Sampling rate
Proposed Research (cont...)

- Compile data to use for the development of software that will correct the abnormal gait of the subject.
- Bring subjects back in for another round of studying to determine if findings are true, and compile data that will corroborate results.
Goals

- To increase the quality of life for people with amputation by:
  - Correcting abnormal gait caused by prosthesis in order to prevent secondary conditions/other problems later on in life.
  - Increasing Mobility by preventing health disorders that develop from poor gate
  - Less time/need for therapy, so more time spent away from doctor
Materials Needed

- Access to Biomechanics Motion Capture Lab
  - Infrared cameras
  - Motion capture markers
  - Force plates
- State of the art software development
- Access to Bionic prosthetics (SYMBIONIC® LEG 3)
- Willing subjects with amputated lower limb.
<table>
<thead>
<tr>
<th>Step</th>
<th>Duration</th>
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<tbody>
<tr>
<td>Identify Potential Subjects for Study</td>
<td>8-10 Weeks</td>
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<tr>
<td>Abnormal Gait Study</td>
<td>6-8 Weeks</td>
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<tr>
<td>Compile Data/ begin Software Development</td>
<td>4 Weeks</td>
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<tr>
<td>Software Development/ Apply Software to Symbionic® Leg 3</td>
<td>10-12 months</td>
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<tr>
<td>Bring Back Subjects for Proof of Concept Study</td>
<td>6-8 Weeks</td>
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<td>Present Findings and Monetize Results</td>
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Potential Setbacks

- Taking gait data acquired from the motion capture lab, and applying it to an AI software.
- Inability to find subjects that are willing to participate in our research.
- Drastic reduction in the amount of lower limb amputees. This could be made possible by a sudden advancement in treatment of diseases such as diabetes that contribute to many of these types of amputations.
References


References

Questions...?