Project Identity
Project Title: Second Week Report on Assisted Leg Holding Device
Week #:2 (Jan 28- Feb 1)
02/04/2008
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Work Completed

Last week, I read the following published articles on Anti-Gravity mechanism by Professor Tariq Rahman and Sunil Agrawal from the University of Delaware.

- A Simple Technique to Passively Gravity-Balance Articulated Mechanisms
- A body-powered functional upper limb orthosis
- Design and Fabrication of an Active Gravity Balanced Planar Mechanism Using Auxiliary Parallelograms
- Theory and Design of an Orthotic Device for Full or Partial Gravity-Balancing of a Human Leg During Motion
- A Gravity balancing Passive Exoskeleton for the Human leg
- Assessment of Motion of a Swing Leg and Gait Rehabilitation With a Gravity Balancing Exoskeleton

Before, coming with all the new ideas, we designed the prototype of a single link spring mechanism to make sure if it would be able to lift foundation bar and be able to move on up-down motion. With the result, we came to conclusion that this idea would not work with our particular design and maybe we needed to look into new anti gravity methodology. Following this conclusion, all the team were to come up with new ideas as soon as possible.

Based upon the different theory of anti gravity mechanism published on the paper, three of us came up with three different ideas. My idea was based upon “ A Gravity Balancing Passive Exoskeleton for the Human Leg” where they design the gravity balancing exoskeleton by doing the following steps: (Shown figure 1)

1. locating center of mass using parallelogram mechanism
2. one spring will be connected through the center of mass and the other springs are placed at suitable locations so that the potential energy of the combined leg/exoskeleton system becomes invariant with configuration.

Figure 1: Basic component of Gravity balancing exoskeleton.
Based upon the Figure 1 above, I came up with the following idea for our new anti gravity mechanism while everyone from the group had their own ideas from the papers as well.

At Initial, using similar methods as stated above. Here, the dotted line is the spring.

At maximum movement of the foundation bar, the side portrait of the design would look as following,

Nevertheless, as a team, we decided to use the Anti gravity theory from “Theory and Design of an Orthotic Device for Full or Partial Gravity balancing of a human leg during motion” by Sunil. K. Agrawal. In this design, they use springs to balance the gravity which seemed perfect for our design. Shown below is the schematic picture of the anti gravity spring mechanism:
Here, the figure shows a single link connected by a revolute joint and supported by a spring. As a team we decided that this might be a better anti gravity technique than the one with single link system. As a team, we also decided to have a meeting with Dr. Enderle before making the final decision on this particular setup. After the meeting, we decided that further knowledge of moments, forces and energies of the above figure were needed to make sure it would work on our particular design.

Hence, this week was productive than last week because of our new anti gravity technique that we hope will work. Additionally, this week, Weekly reports 1 were updated on the BME engineering website.

**Future Work**
- Setup meeting time with Dr. Enderle
- Depending upon the prototype result, discuss the new ideas.
- Review all the parts ordered and needed to be ordered.
- Update Website
- Review the Timeline
- Presentation Review

**Project Review**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>All team members: Explore methods for making project anti-gravity</td>
<td>5 days</td>
<td>1/21/2008</td>
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<tr>
<td>All team members: Examine parts, nothing missing or broken</td>
<td>1 day</td>
<td>1/25/2008</td>
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<tr>
<td>All team members: Search for appropriately priced supports</td>
<td>1 day</td>
<td>1/25/2008</td>
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<tr>
<td>All team members: Meet to choose materials for prototype</td>
<td>1 day</td>
<td>1/26/2008</td>
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<tr>
<td>Kade: Order foot and knee supports</td>
<td>1 day</td>
<td>1/28/2008</td>
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<tr>
<td>All team members: Build structure for prototype</td>
<td>1 day</td>
<td>1/28/2008</td>
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<tr>
<td>Jenny/Kade: Meet with Dave Kaputa to test on Tinius Olsen</td>
<td>1 day</td>
<td>1/30/2008</td>
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<tr>
<td>All team members: Meet with Dr. Enderle to talk about project</td>
<td>1 day</td>
<td>1/30/2008</td>
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<tr>
<td>All team members: Design ways to incorporate anti-gravity into ALHD</td>
<td>5 days</td>
<td>1/25/2008</td>
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<tr>
<td>Jenny: Use mechanics calculations to determine best ALHD design</td>
<td>3 days</td>
<td>1/30/2008</td>
</tr>
<tr>
<td>All team members: team meeting</td>
<td>1 day</td>
<td>2/1/2008</td>
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<tr>
<td>All team members: write weekly reports/update timeline</td>
<td>2 days</td>
<td>1/31/2008</td>
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**Hours Worked**

15 hrs