Project Report:

Follow Up of a subject with Hemiparetic stroke

Abstract:

Hemiparetic is the most frequent neurological deficit after stroke. Hemiparetic stroke patients frequently present balance abnormalities. One of the biggest challenges to therapist is to make a real follow-up of the illness and document the improvement related with the treatment received for the subjects to be used for future reference.

Study of a Real Case for the Follow-Up:

We have a subject that had a Hemiparetic stroke.

Information about the Stroke Patient

- 37 year old female
- Hemiparetic Stroke
- First visit: February 2010
- Second visit: April 2010
- Symptoms: Right hemiparetic
- Treatment: Hydrotherapy

Actual problem:

On this case she presents problem to walk, to keep good balance for movement limitation on her right leg and problem to use her right arm and hand (Right hemiparetic)

Data:

She has been at the UTEP Human Lab twice with a different of 2 months and we got data on her Gait Human walk cycle using the Special Bertec treadmill that allow to walk on 2 different belts one for each leg to a different speed.

One the first visit (February 2010) she moves very slowly because of her limitations.

After two months (April 2010) of Hydrotherapy therapy she came back with a noticeable movement improvement but still limited to the stroke damage.

At this time the Medical Doctor and therapeutic made a visual inspection for evaluate follow-up after treatment or medication. We expect to define a methodology to do it using Interval Computation and obtain the result graphically and a range-relation-number that indicate the improvement or not of a subject.
“Tailoring efficient therapeutic approaches depends on appropriate evaluation of specific needs, but the best tools for balance evaluation in patients with stroke are still under debate .......

Volume 45 Number 8, 2008 Journal of Rehabilitation Research & Development

General Approach:
We need to do the subject follow-up and find the relation between the 2 visits analyzing all the data and getting the relation of improvement using intervals computations methods studied in class and compare with what we expect with reference of the healthy Human.

What is stroke and Hemiparesis?

**Stroke** is a sudden impairment in brain function. Usually, this is caused by the blockage, or the rupture, of a blood vessel.

**Hemiparesis** is muscle weakness on only one side of the body. When Hemiparesis happens as a result of a stroke, it commonly involves muscles in the face, arm, and leg. Hemiparesis is the most frequent neurological deficit after stroke.

Why is so important find a solution for follow-up of subject with Hemiparetic stroke

“Tailoring efficient therapeutic approaches depends on appropriate evaluation of specific needs, but the best tools for balance evaluation in patients with stroke are still under debate ........

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Figure 1 How do we get balance control
Understanding the Human Gait Cycle:
The human gait cycle is in two phases Stance and Swing.
The stance phase is divided in 5 sequences:
- Initial Contact, Loading Response, Mid-Stance, Terminal Stance and Preswing
The Swing Phase is divided in 3 sequences:
- Initial Swing, Midswing, and Terminal swing

How are we getting data for analysis?
We are using a treadmill for analysis, it’s a split-belt instrumented treadmill (Bertec Corp.) measuring the Ground Reaction Forces (GRFs) of the subject.
Data available:

We have data from 2 visits of the subject with Hemiparetic stroke they are shown in fig 5.

Specific Approach:

From the first visit of the subject on Feb 2, 2010 we have 1200 data captured

1) From the first visit of the subject on Feb 2, 2010 we have 1200 lectures. On that time the speed was very slow, only 4 cycles on 1200 unit time of .1 sec note: The subject came before any treatment.
a) We proposed to detect each cycle (stride) but first we shift our data to begin at the beginning of the cycle (Stride) and to diminish noise we defined a Threshold value of .05 Acceleration on Vertical axis.

b) We obtain the values for step at each cycle and chart the cycles together.
We get the Interval Computations Ranges minimum, maximum and $x_{med}$ of each unit of time.

![Figure 8](image1.png)

**Figure 8** cycles prepared to get Ranges of 1st visit

![Figure 9](image2.png)

**Figure 9** Ranges of the first visit
We can summarize the data of the first visit on the next figure 10:

2) From the second visit of the subject on Apr 28, 2010 we have another 1200 data captured. The subject received Hydrotherapy therapy and improve the speed and we get 7 cycle on 1200 unit time of .1 sec.
a) We proposed to detect each cycle (stride) but first we shift our data to begin at the beginning of the cycle (Stride) and to diminish noise we defined a Threshold value of .05 Acceleration on Vertical axis

![Data shift to the beginning of the cycle second visit](image)

b) We obtain the values for step at each cycle and chart the cycles together
Intervals Computation - Human Gait cycle Follow Up of a subject with Hemiparetic stroke  
Jorge Garza-Ulloa

Figure 13 cycles prepared to get Ranges of 2nd visit

c) We get the Interval Computations Ranges minimum, maximum and x_med of each unit of time

Figure 14 Ranges of the second visit

3) Chart the 2 interval computations range with the expected behavior and found a way to measure the improvement graphically.

How can we compare the next charts for Follow up if they have different speed?
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Figure 15 how compare 3 chart with different speed on the Human Gait cycle for a follow-up

It is important to mention the a Healthy Subject has a Delta very small and the subject with stroke has a big delta

<table>
<thead>
<tr>
<th></th>
<th>Average of Delta=X_max -X_med</th>
<th>Max_Delta</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Visit _Subject</td>
<td>0.032746</td>
<td>.212285</td>
</tr>
<tr>
<td>Second Visit_ Subject</td>
<td>0.0188</td>
<td>0.1027</td>
</tr>
<tr>
<td>Normal Health Subject</td>
<td>0.007027</td>
<td>0.039825</td>
</tr>
</tbody>
</table>

Figure 16 Table of Delta from Ranges

The normal Human Gait Cycle is form.9 to 1.2 sec.

A Human Being with mobility related impairment really cares about speed for walking?

Answer: the subject with mobility impairment doesn’t care about it because simply it cannot do it!

Then we need to define a new term On Human Gait Cycle:

**GRC (Gait Relative Coefficient)** = actual speed/Expected speed of the subject

<table>
<thead>
<tr>
<th></th>
<th>Speed ( m/s )</th>
<th>GRC (Gait Relative Coefficient )</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Visit _Subject</td>
<td>0.25</td>
<td>0.2632</td>
</tr>
<tr>
<td>Second Visit_ Subject</td>
<td>0.5</td>
<td>0.5263</td>
</tr>
<tr>
<td>Normal Healthy Subject</td>
<td>.95</td>
<td>1</td>
</tr>
</tbody>
</table>

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Nov 10, 2010
The GRC must be applied on the Unit Time

Figure 17 Table of Gait Relative Coefficient

Using the GRC calculated we chart them:

![Graph showing the comparison of gait cycles for different visits against expected behavior.]

Fig. 18 Show the 2 visits compare with the expected behavior

How can we differentiate when a subject is doing a good Gait cycle independent of speed?

**Answer:** Expected Rate Cycle (ERC) of the Healthy Subject = 60/40 (60 stance 40 swing)

Based on this we need a Coefficient Factor (CF)

\[
CF = \frac{ARC}{ERC}
\]

Where ERC is the Expected Rate Cycle and ARC the Actual coefficient Cycle

<table>
<thead>
<tr>
<th></th>
<th>Coefficient Factor (CF) using X_Med</th>
<th>Coefficient Factor (CF) Ranges</th>
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</thead>
<tbody>
<tr>
<td>First Visit _Subject</td>
<td>3</td>
<td>[2.96, 3.04]</td>
</tr>
<tr>
<td>Second Visit _Subject</td>
<td>2</td>
<td>[1.97, 2.03]</td>
</tr>
</tbody>
</table>

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Nov 10, 2010
With this analysis we find a methodology for easy follow-up deducting a relation that indicates in a range how was sick the subject before and after treatment and/or medication related with the expected cycle of a healthy subject. The result of this methodology is based on the result of three parameters:

Coefficient Factor (CF), GRC (Gait Relative Coefficient) and Max_Delta

These factors are summarized in the next table:

| Normal Healthy Subject | 1 | [0.99, 1.01] |

*Figure 19 Table of Coefficient Factor*
We have 3 parameters to measure the follow-up of a subject using his Gait Human Cycle:

**Coefficient Factor (CF),**

**GRC (Gait Relative Coefficient)**

**Max_Delta of Ranges**

<table>
<thead>
<tr>
<th></th>
<th>CF (Coefficient Factor of X_med)</th>
<th>GRC (Gait Relative Coefficient)</th>
<th>Max_Delta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Healthy Subject</td>
<td>1.0</td>
<td>1.0</td>
<td>0.039825</td>
</tr>
<tr>
<td>Second Visit Subject</td>
<td>2.0</td>
<td>0.5263</td>
<td>0.1027</td>
</tr>
<tr>
<td>First Visit Subject</td>
<td>3.0</td>
<td>0.2632</td>
<td>0.212285</td>
</tr>
</tbody>
</table>

Figure 20 Table showing the three coefficients for follow-up

**Discussion:**

The result indicates a big improvement in all the coefficients analyzed from the first visit to the second visit proving the treatment is getting good results. This methodology covers the 3 main factors than can affect the Gait Cycle:

- Deviations on strides (Cycle Human Gait) that is reflected on the Max_delta value obtained from the variations on ranges
- For a good equilibrium the standard of the main phases of walking 60% stance and 40% swing are covered by Coefficient Factor (CF) that is obtained from dividing the Actual Rate Cycle by Expected Rate Cycle (CF=ARC/ERC)
- The common speed of walking from .95 to 1.2 m/s is covered by the Gait Relative Coefficient (GRC) that is obtained dividing the actual speed of the subject by the Expected speed

It is important to mention that the max amount of Ground Reaction force to walk is not so important to the follow-up that is a special characteristic of each human being.
Conclusions:

This methodology is ease of use for a good follow-up and can be used for therapeutic and doctor or exercise lab as feedback after each test to verify that the medication and/or the treatment is helping or not to the health of the subject. The results can be used for future references of the same subject and/or others with the same illness and treatment. We are doing at this time follow-up of different subjects using this methodology and so far the results are according with this Coefficient ranges.

References

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