Appendix (3 Segments):

1) Figures of Prototype Feasibility/Market Research Results:

The first parameter we analyzed was defined as "Step Length". This is the distance between the left ankle and the right ankle when the person is walking perpendicular to the line of sight of the Kinect. To test the proof of concept of using Kinect along with data analysis to determine statistical differences between Parkinson's patients and controls, we had two members of our team walk with 5 trials each. In addition, we had two members of our team conduct 5 test runs each imitating Parkinson's disease as instructed by neurologist Dr. Litvan. This gave a sample of 20 total trials to run statistical analysis on the step length; results are shown in table 1. The step lengths are shown to be statistically different based on a two-sample t-test.

	Mean	Standard Deviation
Control Step Length	**0.627 m**	**0.091 m**
PD Step Length	**0.295 m**	**0.068 m**
Control Step Time	0.38 s	0.53 s
PD Step Time	0.33 s	0.42 s

Table 1: Mean and standard deviations step length and step time parameters of control group and Parkinson's disease patients

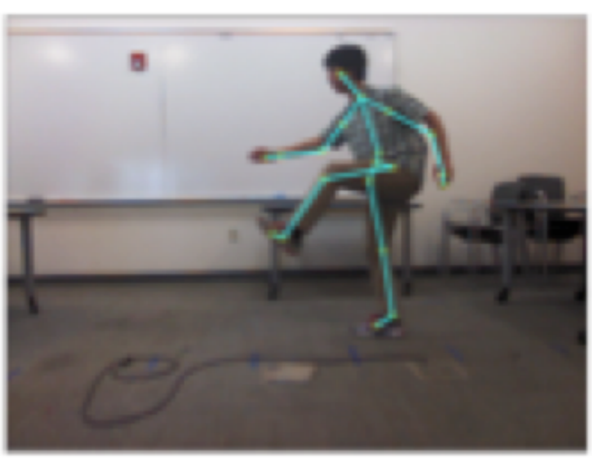

Figure 1: Data acquisition software components of image processing that display a) the virtual skeleton overlaid on the original image and b) the isolated virtual skeleton used to obtain 3D coordinate data

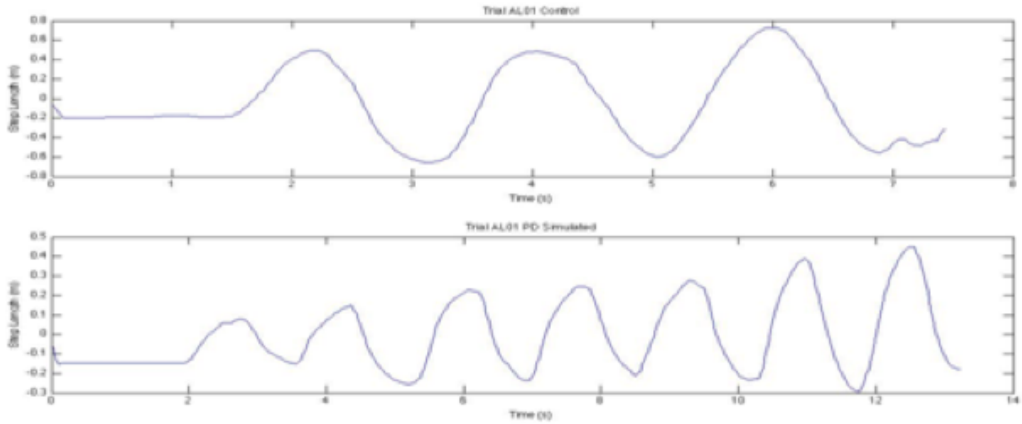

Figure 2: Sample filtered sinusoidal curves from data generated from a normal individual (top) and a simulated run of an individual with Parkinson's disease (bottom).

The following is a link to our video that shows the project design:
https://www.youtube.com/watch?v=Ot-w8IeGpXw

	Neurocom	Motek Medical	Reflexion Health	Rem Park	BioMetrics (OUR DESIGN)
PD Specific	✗	✗	✗	✓	✓
Full Body	✓	✓	✓	✗	✓
Space Efficient	✗	✗	✓	✓	✓
Physician-Friendly	✗	✗	✓	✗	✓

Figure 3: Competitive matrix that compares our product vs. other companies that seek to analyze movement problems, or neurological disorders. This illustrates our competitive advantage.

Figure 4. Contribution of cost components to total direct medical cost per patient with Parkinson disease (PD) annually.

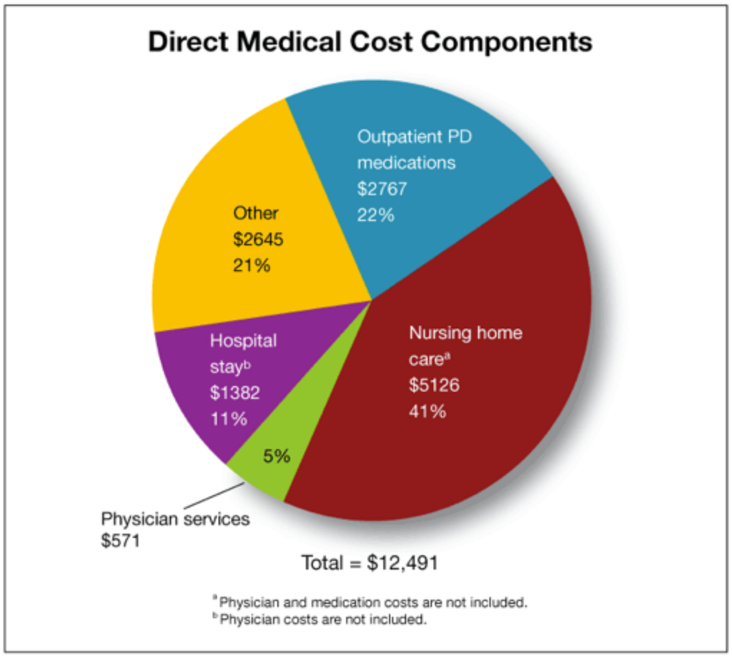

Figure 4: Illustrate annual medical costs associated with Parkinson's Disease. Obtained from http://www.psychiatrictimes.com.

Example of Price Estimation Based On Figure 4:
We know that current medical costs for patients average ~$12,500/year (Figure 4). If we can provide a higher quality of care for patients that lower the amount of time spent in the clinic, then insurance companies will reimburse our system. Based on that, a hypothetical sales price could be based off the reduction in hospital visits, or an improvement in patient lifestyle. Assuming the healthcare industry moves into a value based purchasing model, a reduction in hospital visits would be beneficial for both the patient, as well as the doctor because they are incentivized to keep patients out of the clinic. If we can reduce the medication visits, we can lower the costs of PD up to $5000/year based on data on average cost/visit. We can therefore have a sales price of $4000/year for each system we license.

2) Customer Interviews:

I. Hypothesis and Approach:

a. Description of questions we asked
    i. Is there a need for a motion tracking tool or aid for a physician to better diagnose Parkinson's Disease and other movement disorders with superior accuracy?
    ii. What are the challenges in implementing our solution in the clinic?
    iii. Is this scope for this to be a research aid for investigators who want to utilize motion tracking in conjunction with other modalities to better understand medical problems?
b. Description of solution

i. The Microsoft Kinect will capture the motion of a patient with PD walking perpendicular to the line of sight. The parameters will then be processed using our algorithms to deliver information of walking velocity, posture, length of step, arm swing velocity.
ii. A demonstration of the software was conducted to show the output of PD metrics.

II. Customers and Responses

a. Names of customers, companies, provide company website links if applicable
   i. Dr. Howard Poizner, PhD - Institute of Neural Computation
   ii. Dr. Joe Snider, PhD – Institute of Neural Computation
   iii. Dr. David Song, MD, PhD, Dept. of Neuroscience, UCSD
   iv. Dr. David Barba, MD, Dept. of Neurosurgery, UCSD
   v. Dr. Leah Levi, MD. Director of Neuro-opthamology, Scripps
   vi. David Wing – EPARC Gait Lab, Calit2
b. Summarize what your customers said in response to your questions
   i. Dr. Poizner and Dr. Joe Snider sees the approach we are taking **as promising**. Such a device and analytical process could be commercially viable if it could be turn-key and automated. This innovation would reduce physician time. This device could be useful when coupled with the EEG research that Dr. Poizner is conducted for Parkinson's Disease.
   ii. Dr. Song states that our proposition does fulfill a need but patients also want extra face time with the doctor. The challenge is to understand the medication cycle because it affects the gait parameters. Therefore it is difficult to compare the same patient because medication has different effects. In addition, different patients have different problems such as moving too little, or too much tremor, or freezing of gait. The ability to track and provide physicians with the tools to **help differentiate these subsets of the disease will be helpful.**
   iii. Dr. Barba states that such motion analytics device would have **promise in fine tuning** deep brain stimulation therapy (DBS) both in clinical practice and clinical research. Since different patients need different levels of voltage, pulse frequency, etc. such a device is highly useful.
   iv. Dr. Levi states that utilizing motion tracking would really **help distinguish different movement disorders**, especially if such a device was coupled with some sort of eye-tracking device. There is definite clinical need for this kind of device, but it has to function within the parameters of a typical clinic and it has to be automated. The challenge would be to automate so the learning curve is small.

v. Overall, our product has high potential to help researchers and doctors to detect and diagnose Parkinson's disease if we can differentiate between PD and similar movement disorders. We can expand the scope of our market from merely researchers and specialists if we can persuade general practitioners of the use of our product. By assessing quantitatively the severity of movements, our product can assist a GP in the decision to send a patient to a movement disorder specialist. Our method is a promising one with low cost and continuous observation and recording of symptoms, which is more objective than UPDRS.

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