INTRODUCTION

The symptoms of patients suffering from Tardive Dyskinesia (TD) include pathological gait, involuntary motions, and trouble with sit to stand and other activities of daily living. TD is a condition that may develop in patients who use metoclopramide [1], a drug sold under brand names such as Reglan in the United States, and prescribed for psychosis and occasionally gastrointestinal issues, particularly in infants. Prolonged use of dopamine receptor blocking prescription drugs such as this, often in high dosages, can result in involuntary, repetitive tic-like movements, primarily in the facial muscles or, less commonly, the limbs, fingers, and toes. The hips and torso may also be affected [2]. The current method of testing for TD is using the Abnormal Involuntary Movement Scale (AIMS), which is a 12 item anchored scale [3]. Though administered by trained clinicians, this method of testing is susceptible to human error and can vary from doctor to doctor. Moreover, it requires doctor/patient time and is costly and time-consuming. As a result, tests are often administered less frequently than is recommended. The best treatment for TD appears to be prevention, either by lowering the dosage of a medication known to cause this condition or switching the patient to a different drug [4]. Thus, decreased reliability and frequency of the test impairs prevention tactics, which is dangerous and costly. Being able to conduct this test more accurately and from the patient’s home would significantly improve the accuracy, comfort, and cost of these tests.

By using the inexpensive 3D capabilities of a commercial camera like the Microsoft Kinect to track the coronal, transverse, and sagittal planes of the body, the Kinect Abnormal Motion Assessment System (KAMAS) can conduct this test simply and easily sending the results as electronic medical records for doctors to use.

METHODS

The AIMS scale has five categories of parameters to rate: facial and oral movements, extremity movements, trunk movements, global judgement, and dental status, for a total of 12 parameters. Each of the parameters in the first four categories are judged from 0 (none) to 4 (severe) and the fifth category response is yes or no. Of the nine parameters in the AIMS scale that address physical progress, seven can be tracked using the inexpensive 3D abilities of the Kinect camera (steps 4, 5, 8, 9, 10, 11, and 12). The Kinect can track 16 parts of the human skeleton (head, shoulders, elbows, wrists, torso, hips, knees, ankles) in all three anatomical planes with precision to the millimeter at 30 frames/s [5] (Figure 1). This theoretically provides more precise analysis of the five possible prognoses in the AIMS scale.

Initially, five female control subjects (27.6 +/- 2 years old, 176.8 +/- 12.7 cm tall, 67.91 +/- 15 kg body mass) with no history of musculoskeletal problems participated in the feasibility testing. Their participation was voluntary, and written informed consent was obtained prior to testing.

To assess the feasibility of using KAMAS to test TD patients, the control subjects went through an additional testing session where they were told to voluntarily exhibit some of the behaviors that KAMAS is designed to detect. Through studying AIMS instructional videos, the control subjects were able to mimic the performance of moderate
(scoring of three) symptoms in TD for steps four and five of the AIMS scale.

RESULTS AND DISCUSSION

The Kinect was able to correctly identify the joints of the subjects (Figure 1). The control subjects each scored a value of zero on the KAMAS testing, as expected.

![Figure 1: Depth image from the Kinect showing joints in red and limb segments in black](image)

In the subsequent test, the control subjects were able to mimic moderate symptoms, indicated by scores of three using KAMAS (see initial posture for parameter 4 in Figure 2).

![Figure 2: KAMAS demonstration of initial posture for evaluation of step four of twelve](image)

Based on initial testing, the Kinect’s 3D capabilities can reliably detect the involuntary movement necessary to objectively evaluate TD patients. Out of the relevant nine parameters of the AIMS scale, the Kinect was able to detect seven control levels and two mimicked TD levels. This feasibility study was conducted in advance of TD patient trials that will commence in June 2012 with Dr. Daniel Karlin, MD, PhD at Tufts University. Over the course of one month, four doctors will conduct the AIMS test both visually and electronically (using KAMAS) and compare consistency and reliability between the two. Following testing, statistical analysis will be performed to determine if there are any significant differences between evaluation of TD patients with the AIMS scale both subjectively by clinicians and objectively through KAMAS. Inter-rater reliability will also be performed to confirm the strength of this method. Additionally, two other components of the AIMS scale that rely on facial tracking software, currently in development, will be implemented in the next testing phase if the Kinect tracking proves reliable.

REFERENCES