Predicting moving disorders using non verbals Webinar
Presenter: Dr. Conrad Tucker.
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Dr. Tomaszewski:
Welcome to the Center of Health Organization Transformation steep dive webinar series today's webinar will be on predicting moving disorders using non verbals. The presenter for today's webinar is Dr. Conrad Tucker.

Dr. Conrad Tucker:

Welcome everyone. Today we are going to be looking at some novel ways to predict moving disorders using non-verbal sensors. As part of this overall chain research domain, it ties into the concept of systems emergence. So do systems and in this case a patient exhibit certain characteristics that make that patient distinguishable from a normal individual in the population, and so the question is why do we want to look at body movement data as a characteristic of predicting movement disorder. There is a famous piece of work that shows that when you look at human communication as a whole more than 55% pertains to non-verbal communication. Specifically relating to Parkinson's disease which would be the focus of today's talk, there are over a million people affected with Parkinson's disease just in the United States with approximately 60,000 new cases each year. Now there is medication/therapy to slow down disease but there is no cure yet.

So why is predicting early stages of Parkinson's disease relevant to society and transforming health care?, well it cost on average $25,000 per year per patient to treat this disease so the sooner that we can identify the deficiencies as you can see here at the top graph where you see what actually happens and so there is a decrease in the doping levels in an individual Parkinson disease. By identifying this disease earlier medication can be prescribed to medicate the harmful effects of the doping loss. The hypothesis that is jested in this research is that there is statistically significant difference in the gait patterns between Parkinson's disease (pd) patients when they are off and when they are on their medication. Knowledge gained from testing this hypothesis would lead to novel ways of determining whether or not a patient is being adhered to a specific medication protocol.

One of the challenges that come to patients improving over time is actually constantly taking their medication which is a significant problem in the health domain as a whole. The question is how do we plan on doing this? Well there are two domains of sensing, you can think of wearables where you have devices attached to a particular patient and you can then monitor their bio markers or bio behaviors in real time. In terms of literature there are benefits due to the precisions of the systems. However, some of the challenges are scalability; If you want to measure how someone walks for example you have to attach multiple sensors of different areas of the body. There are cost constraints, each of these (inaudible) can be cost prohibitory to implement on a national scale of a million Parkinson disease patients.

What we wanted to investigate is non wearable approaches to capturing similar types of data in a less invasive manner and the way to do this is employing machine vision techniques while capturing the data coupled with machine learning algorithms for making sense of data and testing the hypothesis. This is an example here of what commercially available off the shelf sensing system can do, so the individual on the left as you it can see there is a skeletal ovulate on their body and each of those red

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The open research methodology is to first acquire the sensor data which you see here in step one, the patient walks towards the sensor and as they walks the sensor captures 20 joint locationsranging from the head to the (Inaudible) nodes which are then next to step 2, which is taking the wall xyz coordinate data for each of those nodes and we then developing a data mining model using both data from when a patient was on their medication and when a patient was off their medication, and so this becomes a binary classification problem where we are trying to determine whether or not there are certain features such as the position, and velocity of the hand that are indicators of when someone was on their medication vs off . It's difficult, as you can see on the left what would be certain to a health care decision maker where a patient is potentially (inaudible) or be non-inherit to their medication from which point the health care decision maker can make decisions moving forward. This is an example close up of the specific nodes that are acquired and each of these nodes is considered a feature and each of these nodes has a xyz data point attached to that feature. When you look at all these features for the position, velocity, acceleration and also ratios over a thousand features for each patient this becomes a high dimensional interspace and also depending on the number of (inaudible) patients can also be a high dimensional problem. If you have over a million individuals It would inherently become a big data problem where you have constant streaming data coming in, and we want to then capture the two pull variations in this data. The individual's data comes in and we employ data mind techniques to then generate a model that we can then use as a decision support system to determine what characteristics would inform or help individuals predict when someone is off or on their medication.

This is a snapshot of the results for example you can see a decision result if the elbow position is less than 1.2 meters relative to the data In the case the data is a sensor and the elbow position is x position is less than -.29; Then they are actually on their medication vs if its greater

than .29 and if the elbow Left Y position is greater than 1.4, then they are off their medication so with a decision model such as this researchers can understand when a patient is on vs off their medication. So, preliminary results we just published a journal paper where we were able to successfully classify certain patients better than others and here it is, just showing the best performance and the worst performance for two different patients; Patient 162 using several different algorithms and different ways that they walk, for example if they are walking front, towards away, to the right, or to the left. What are the accuracies in informing decision makers of whether or not that is indeed characteristics of them being on or off their medications for the lowest performing subject? This is also interesting because they are on their medications when they come in they are taken off their medication and the reduced performance perhaps could be contributed to the impact of that medication on that patient so if it's very difficult to decide for when a patient is on vs off their medication.

A hypothesis that we explore further is well maybe the effect of the medication doesn't really change their gait behavior when they are on or off as much as patient 162 for example. There are many different hypothesis moving forwards that we would like to investigate further but these are just preliminary results testing the validity of the hypothesis and the accuracy of different data mind algorithms. These are some of the references, a complete set of references can be found in the paper.We would like to acknowledge funding from the NSF CHOT and this is a larger initiative enforce with my colleagues Dr. Harriet Nembhard here in IE at Penn state, Dr. Xuemei Huang who is department of neurology at Hershey medical center, Dr. Mechelle Lewis also Hershey medical center, and graduate students that work on this paper are Isha Behoora at university port, and Nicholas Sterling. I would like to thank you for listening to our talk and if you have any further questions please visit our website link which is at the bottom of these slides which is engr.psu.edu.

Thank you.