

# Problem Statement, CS 461

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## Abstract

This assignment, the Problem Statement, contains details about my capstone project, *A Kinect based virtual physical therapy solution*. My project partner Louis Leon and I had a meeting with our client, Mehmet Kilinc, to introduce ourselves and gain more insight into the existing project and the details of the problem we are trying to solve. Using the information we learned from this meeting, I created a problem statement containing three topics. The first is a definition and description of the problem; this is the overall purpose for the project, and it is the main problem we will be developing a solution for. The next part is the proposed solution; this is our general plan to complete the project as of now. The final part is the performance metrics; this will be what determines the completeness of our project.

## I. DEFINITION AND DESCRIPTION OF PROBLEM

We are working with Mehmet Serdar Kilinc, a research associate, and Jose Castro, a PhD student, who conduct research at the OSU Healthcare Systems Engineering Lab. Their motivation for this project is a use case involving people suffering from Parkinsons Disease who use physical therapy to control and delay PD-related symptoms. The problem is those suffering from this have a difficult time accessing physical therapy clinics due to their physical disability that inhibits travel. The goal of the project is to develop a sensor-based solution, using the Xbox Kinect, that brings physical therapy sessions to the patients. This has the potential to reduce the number of in-person visits and long-distance travel that burdens PD patients. There is also an opportunity to provide more objective frequent motor symptom monitoring.

This virtual therapy solution will guide patients through exercises by giving spoken and written instructions and sense whether they are doing the motions correctly. It will collect the data of the exercises and send them to a physical therapist. The physical therapist will be able to prescribe and customize exercises in the software for the patients. Like any other prescription, the patient may have to do certain exercises a specified number of times correctly.

The research that Mehmet and Jose are involved in would like to develop this software in order to evaluate the usefulness of such a tool for the target demographic of PD patients. If this tool is useful, it could be distributed and used as an alternative to in-person physical therapy sessions. Another possible future development is the analysis of patient data using artificial intelligence. If the data is accurate to patients abilities, the software can then make judgements and predictions about the patients progress. The collected data will then have more meaningful results to the physical therapists.

## II. PROPOSED SOLUTION

The Kinect system uses 20-25 nodes to track human movements. Each node, at each moment in time, has a 3D coordinate. The coordinates of each node will be recorded specified intervals of time. Using this data, we can determine how accurate the patients movements are to the given exercise they follow. This will be done by comparing the node positions of the patients recorded data to the node positions of the pre-defined exercises. To create the user interface, start and stop parameters, and exercises, we will be using the Kinect SDK. To create the pre-defined exercises, we will be consulting physical therapists from Dixon Recreational Center and/or the Samaritan Physical Rehabilitation Clinic. By learning the important conditions of a proper physical movement from the physical therapists, we will then be able to define these movements in the software using node coordinates. This may also require the physical therapists to do several example movements in front of the sensor to get an idea of the node positions of a correct movement. The other component of this project is data collection. The data collected from each node throughout a session will be saved to an excel file in which each column is a node containing its position, and each row is a point in time. In addition to the raw position data in the excel file, we will also include meta data such as the timestamp of recorded data and duration of recorded data.

## III. PERFORMANCE METRICS

Since this is primarily a research project, Mehmet and Jose had some trouble coming up with metrics to define a complete project. In general, they both agreed that the outcome of a research project is unpredictable. Unlike a project like developing a specific product for industry, research projects have no definite timeline or answers. With this in mind, we concluded that our project is complete if it has the following minimum features:

- **Setting the duration of a data collection period.** This will trim the data in a way that shows us windows of activity to assess, which is more manageable and easier to comprehend than the constant raw influx of data.
- **Start and stop rules.** These are the conditions, when met, that determine when to start an exercise and when to stop. The software needs to know when to start and stop paying attention to how the user is moving compared to the pre-defined correct movements. This is also part of the user experience. The start and stop rules need to be somewhat intuitive to the user and easy enough to do. This could be based on distance/position from the sensor, movement, or pose.

- **Timestamps of saved data.** The data that is collected will need timestamps as a way to keep track of patients progress. Data is taken multiple times a second, but there needs to be a way to view intervals such as exercise sessions.
- **Setting the time and frequency of data saving.** This allows the user and/or the physical therapist to choose how often the patients data will be saved, and when the data should be saved.

In addition to these minimum data collection features, we would like to have at least one or two pre-defined exercises completed to be able to demo at the expo.