

## **STUDENT RESEARCH EXHIBITIONS**

**Table 1: Machine Learning “Pennie” / Telehealth: James Frazier, Raj Desai**

The Pennie Rocks iOS application’s goal is to be a fun, easy to use telehealth program for patients and end-users. The application is named after Pennie, the humanoid robot that greets you once the application launches. Users interact with Pennie to activate and observe the many functions she is capable of conducting. The iPhone is equipped with numerous sensors such as the accelerometer, gyroscope, global positioning system, barometer, and etc. Pennie is able to enable the sensors, collect the data, and save it for later medical analysis. Pennie can listen to your speech and, utilizing the power of IBM’s Watson, transcribe it to text. You can tell Pennie how you are feeling, and with your permission can crowd source this information and your location to [chot.psu.edu](http://chot.psu.edu) for population health analysis. Pennie is equipped with computer vision technology, as well. Apple recently announced Core Machine Learning and Vision Frameworks for iOS. Using these technologies and existing models, Pennie is able to utilize iPhone’s cameras to identify numerous objects

Pennie’s companion website, [Pennie.rocks](http://Pennie.rocks), works in harmony with Pennie and provides further medical analysis. It displays trends in the data collected by Pennie. All of the data is updated in real-time and can be downloaded from the website for further analysis. Along with the visualization of patient’s data, [Pennie.rocks](http://Pennie.rocks) allows patients to video call their doctor directly from their native browser. This allows patients in rural areas to connect with their doctor without any additional costs.

Pennie is already baked with these function, and in the future, Pennie will be able to train its own model to identify medical related objects on the go and allow the patients to call their doctor directly from their iOS device which will make telehealth better and more efficient.

**Table 2: Population Health Data Mining: Sunghoon Lim, Chongnan Lee, Vishnupriya Bakthisaran**

CHOT Real Time Social Media Map is the map interface that visualizes population-health-related information using real time tweets. The time slice feature at the top shows the research objectives of Penn State CHOT: From analyzing population health to providing personal medicine. Users can see different objectives with different scope of the map interface.

The map interface provides clustered view of the tweets from different geo locations and users can zoom-in to see the individual plots. General information about each tweet including user id and publish time is shown along with the textual message. Density view indicates concentrated geolocations with multiple data. IBM Watson’s API that converts audio to text is used in the ios application developed by our machine learning team (James, Raj) and the map interface separately collects those converted messages that is published from the application. Search bar on the top left allows the users to view filtered tweets that contain a specific keyword.

Streaming data is collected through a channel provided by PubNub. This dynamic data set generated on a continual basis is processed under Mapbox API to provide user-friendly service where clients can analyze and visualize the real time data.

An unsupervised machine learning algorithm, developed by Sunghoon Lim (Ph.D. Candidate and a CHOT scholar), is referenced to filter out non-health-related tweets. The filtering process includes sentimental analysis and unsupervised learning method based on disease-related terminologies. The messages having positive sentiments, which are considered non-disease-related messages, are filtered out. Symptom-related body-part-related, and pain-location-related terminology lists from WebMD, Mayo Clinic, and MedlinePlus are also used as sources to discover the disease-related messages from the dataset

**Table 3: Drone Search and Rescue: Andy Lam, Sen Lu**

We use [3DR SOLO drone](#) and a mobile phone application (currently only available on Android platform) to track the face of a human. In addition to the normal operations of the drone’s control such as route planning and video recording, the application can recognize human faces through the GoPro Hero 4 camera installed on the 3DR SOLO drone. The camera follows the detected face and automatically adjusts its rotation accordingly through our application. Currently the

drone's flight has limited stability. However, when the drone (in flight) is fully tested, it can find and follow a specific person. Such capabilities are of high value in search and rescue operations such as natural disasters and other health related applications.

**Table 4: Dynamic Heart rate Measurement: Sakthi Kumar, Arul Prakash Prottay Protivash**

This booth utilizes the principle of remote photo-plethysmography (rPPG) to dynamically predict the heart rate of a person in real time. The ability to predict the heart rate of people is allowing researchers to get a better understanding about their physiological and emotional states, which can in turn be used in wide ranging applications such as medical monitoring, affective computing, human computer/robot interactions and many more.

This is an advancement over existing methods that require a static, controlled environment for heart rate detection, making them impractical for real-world scenarios. The proposed algorithm works to eliminate motion artifacts such as blurring and noise by i) employing blur identification and denoising for each frame and ii) employing a bounded Kalman filter technique for motion estimation and feature tracking by modelling the prediction of feature points for every frame using the trajectory of history points.

The program predicts heart rate by analyzing the temporal hue variations in the regions of interest, followed by motion estimation of the tracking features using the proposed method. The objective of this demonstration is to enable a real-time measurement of heart rate across different lighting conditions and motion categories.

**Table 5: Machine Learning- Medical Text Transcription: Sahil Mishra**

The goal of our project is to use Deep Learning to accurately summarize and transcribe complex medical documents into easy-to-understand language. Our prototype application can currently classify medical terms in a document and search for their lucid translation. The application then replaces the medical term with the translation and constructs a coherent new sentence. We use a Recurrent Neural Network trained to differentiate common English words from complex medical terms. The RNN model is currently trained with a dataset containing 5000 medical terms and 20000 common English terms. The accuracy of the model is limited by the miniscule size of the dataset. We will be able to increase the accuracy of the model by increasing the size of the dataset. In order to successfully summarize a verbose Medical document, we propose to use a deep learning technique called sequence-to-sequence learning. We propose to collect data, similar to the Gigaword dataset (a dataset use to train news article summarizers), specifically used to train medical text summarizers.

**Table 6: Virtual Reality Medical Training: Austin Hedden, Alexis Prichard**

This booth utilizes the Novint Falcon and the Unity game engine to provide a unique learning environment for medical professionals. The Novint Falcon is a haptic device that gives force feedback to users through their hands. The device monitors movement in the virtual space and exerts realistic forces to the user based on these movements. The Unity game engine provides us with a simulation environment. Unity has a 3D graphics system as well as a built in physics system that lets us simulate realistic forces on objects in the virtual space. By using an open source library, FalconUnity, we can use the Novint Falcon to control a physics object in the Unity environment.

The demo puts the user in a virtual operating room in which they can practice drilling into a patient with a medical drill. In this demo, the Novint Falcon exerts a constant downward force, equivalent to Earth's gravity applied to a medical drill with a mass of 4 kg. The user can move the drill in 3 degrees of freedom (up and down, left and right, forward and back). By pressing the lightning bolt button, the drill will turn on. Once the drill is on the user can drill into the arm of the virtual patient. The Novint Falcon will exert kickback forces at an interval equivalent to the rpm of a real medical drill.

The overall purpose of this demo is to showcase the ability to teach medical procedures to medical students in a risk-free environment. In the future, the demo could be adapted to include multiple medical devices to interact with, and allow users to have more detailed interactions with the virtual patient.

### **Table 7: Quantitative Walking: Yi Dong**

The project is to integrate sensors into comfortable and attractive clothing for human gait monitoring. The prototype utilizes fabric circuit technology and inertia measurement unit (IMU) sensors to build up a wearable sensing system. The fabric circuit utilizes Arduino LilyPad as the main control board, a Xbee wireless modulus for data transmission and two IMU sensors. All the conductive threads are made with fabric material so that the circuit can be integrated into clothing. The data are transmitted to the laptop through the Xbee modulus under a 30 Hz sampling rate. The laptop uses MATLAB for data processing and visualization. The processing algorithm uses quaternion calculation and Madgwick AHRS algorithm to provide an accurate orientation quaternion of the sensor in real time.

The demo enables the users to try on the wearable sensing system prototype and see the real-time modeling of their legs. The upper part of the prototype should be fixed around the knee and the bottom part should be fixed around the ankle. The two IMU sensors should be located at the side of the knee and the ankle respectively. After putting on the prototype, the user may be asked to walk for a distance or simply swing their leg. The movement of the leg will be visualized on a real time MATLAB plotting.

The overall purpose of the demo is to showcase the ability to capture the human gait data with a circuit built on fabric and the ability to process and visualize the sensor fusion. In the future, this project will compare the quality of the data with the gait data collected from trustable unwearable sensing system. After that, this project will try to mine the sensor fusion and learn the pattern of walk from the data. There is opportunity for collaborating with textile industry partners to develop the knitted circuits for textile top and leggings.

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