

## Introduction

Parkinson's Disease is a degenerative disorder of the central nervous system that results from the death of dopamine cells in a region of the midbrain. Parkinson's disease is closely linked to genetics so most of the patients are fairly easy to target before the onset of the disease. The tremor is the most apparent symptom in which involuntary, rhythmic, oscillatory movements are produced by antagonist muscles (usually the hand and forearm is involved). Over 70% patients have tremors upon onset and most other patients develop it later on. There is no cure for Parkinson's disease, but medications, surgery and multidisciplinary management can provide relief from the symptoms [1]. Our project is based on detecting and monitoring these symptoms using programmed wireless technology.

## Purpose

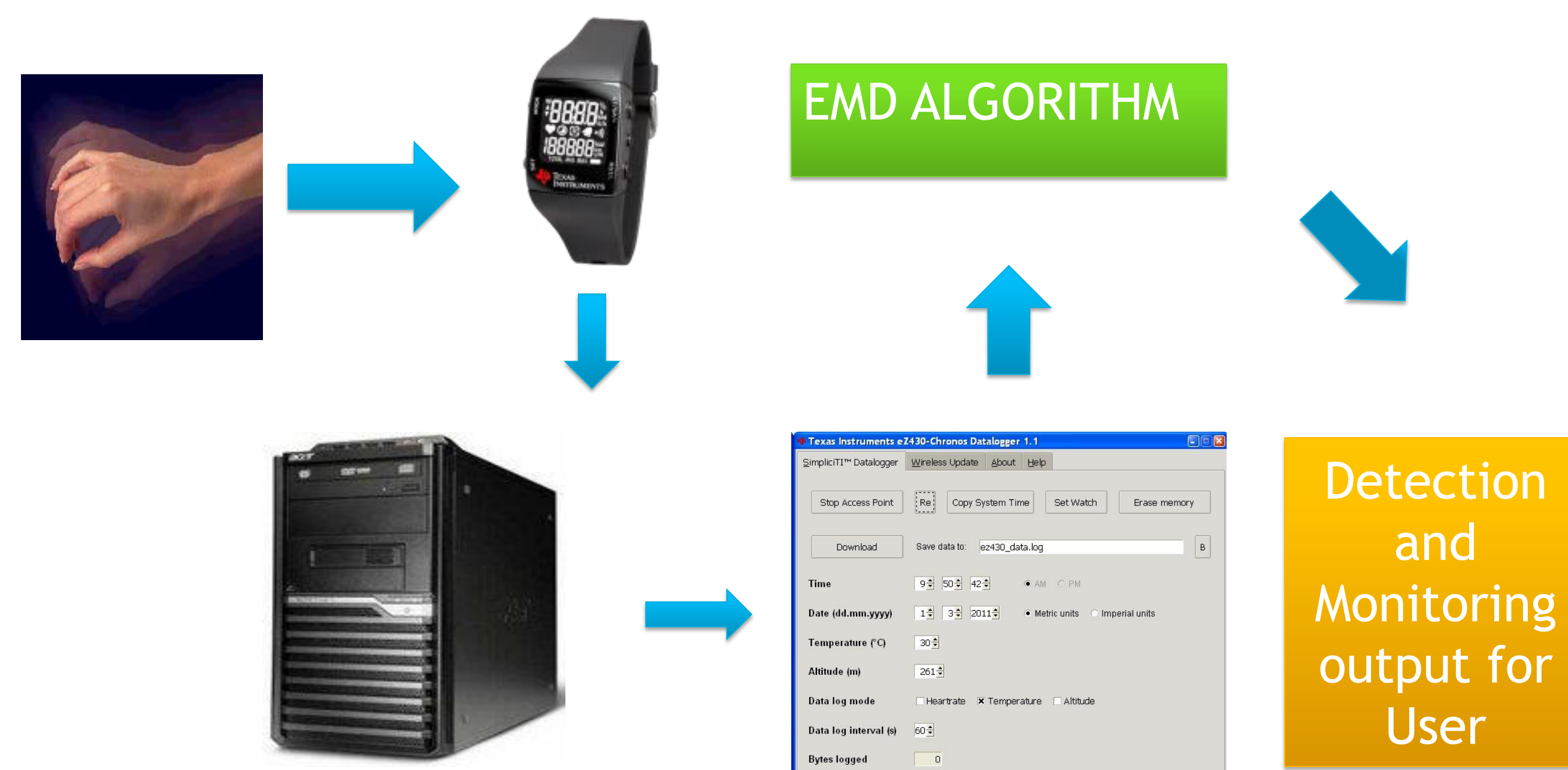
Many scientists have created smart phone applications that measure tremors and carefully monitor Parkinson's patients, however it is not very ideal to wear a phone on top of the wrist during the day in order measure the movements [4]. A medical application for aiding Parkinson's patients has never been developed for a watch which is in fact, more ideal for detecting arm and wrist movements. The ez430-Chronos is a highly integrated, wearable wireless development system that comes as a sports watch. It is mobile, non-intrusive and inexpensive and a Parkinson's detection program can provide many benefits for both known Parkinson's patients and possible Parkinson's risk groups. [2]



## Methodology

### Accelerometer Logger program:

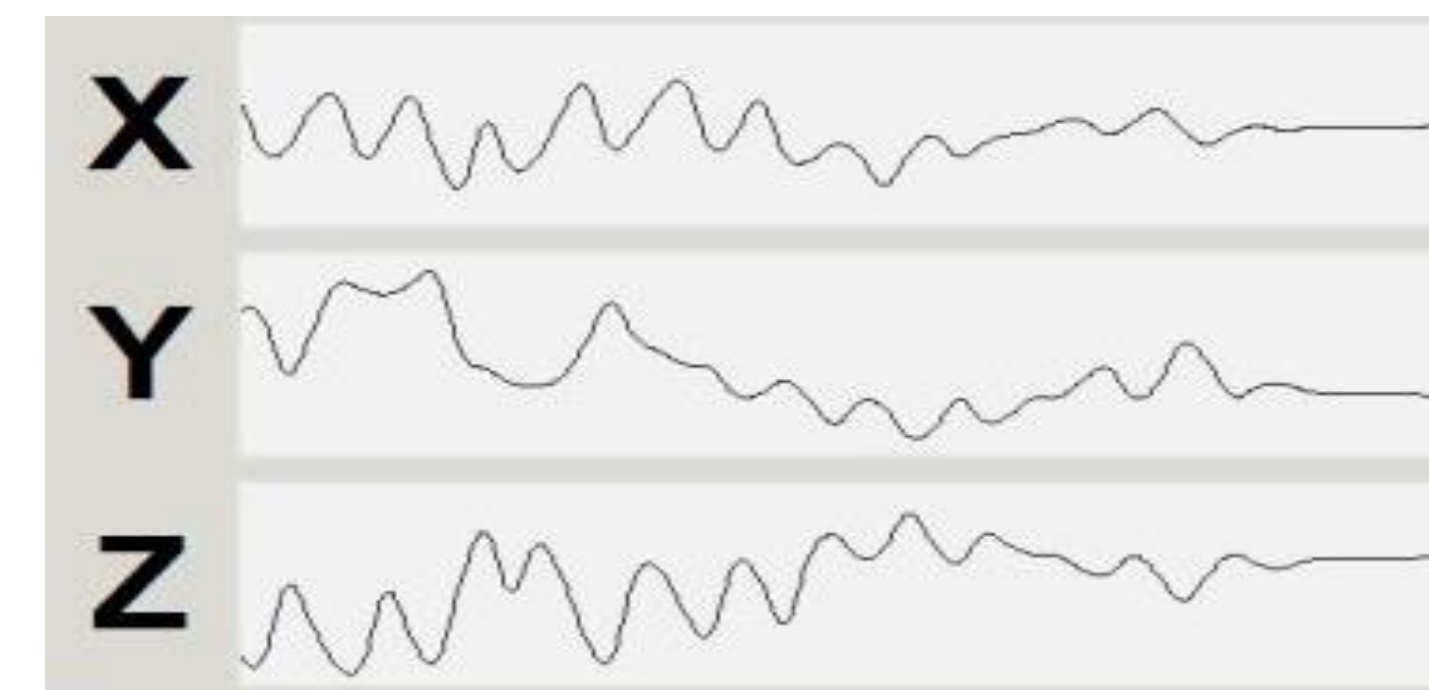
- Code to collect accelerometer data at 100 ms sampling rate in X, Y, Z directions
- Collected data is then analyzed to capture specific frequency range using EMD algorithm



### Noise Cancellation and Filters:

-Constant offset: add or subtract from all values to make the constant the new zero value  
 -Zero Acceleration: In order to compute the data, the stationary data points need to be removed. A filter was created to delete all acceleration values between 5 and -5

## Methodology



### Implemented Algorithm - Adaptive Empirical Mode Decomposition and Hilbert-Huang Transformation [5]:

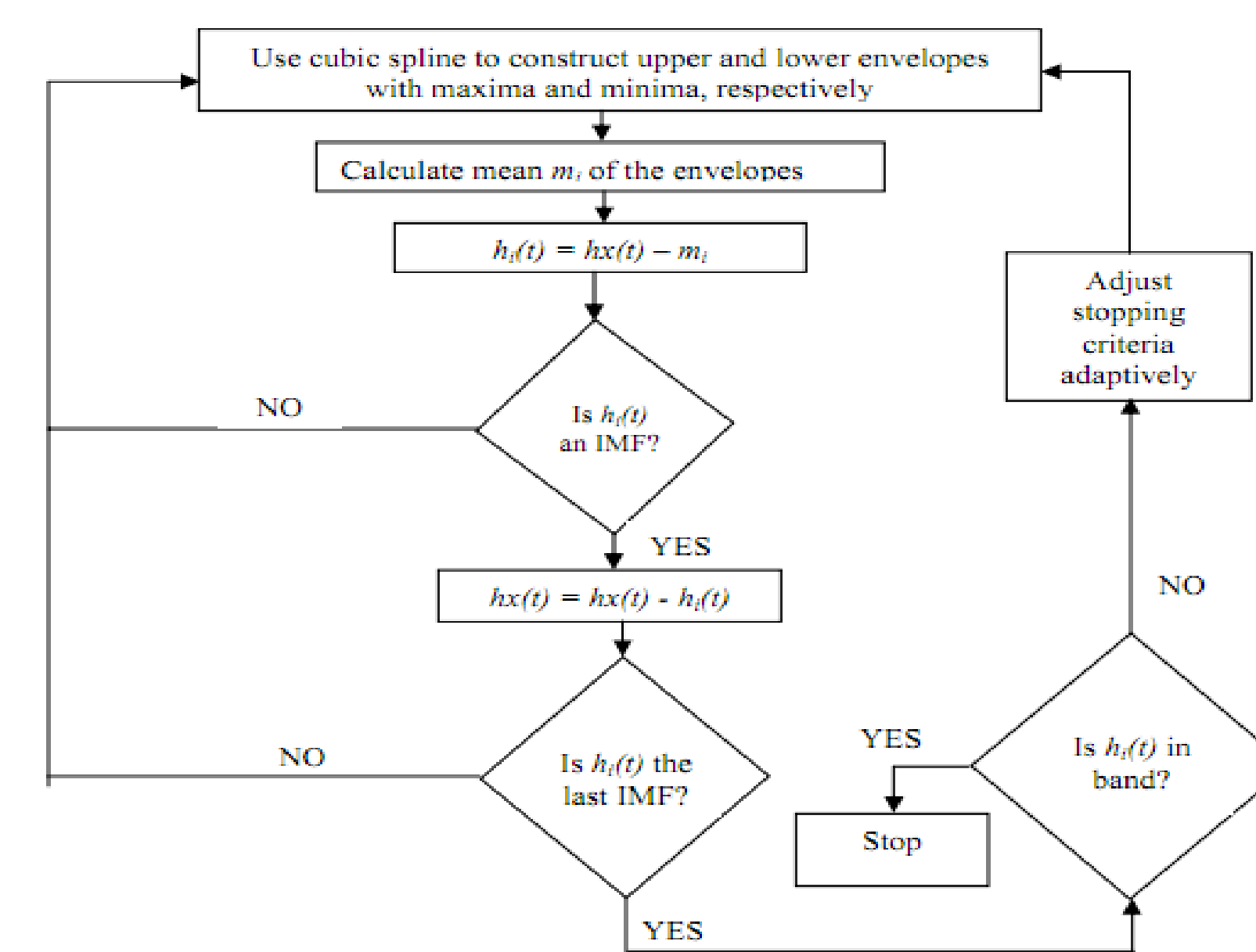
-Tremors are regarded as a nonlinear and non-stationary process and therefore we need amplitude and frequency information of a tremor at a specified time for accurate and real-time examination

-The Empirical Mode Decomposition (EMD) method allows us to decompose a complicated signal into Intrinsic Mode Functions (IMF) after multiple iterations. IMFs consist of:

- One clear signal obtained from the original set of data-the mean value defined by the local maxima graph and local minima graph is zero

The iterative EMD process is as follows [5]:

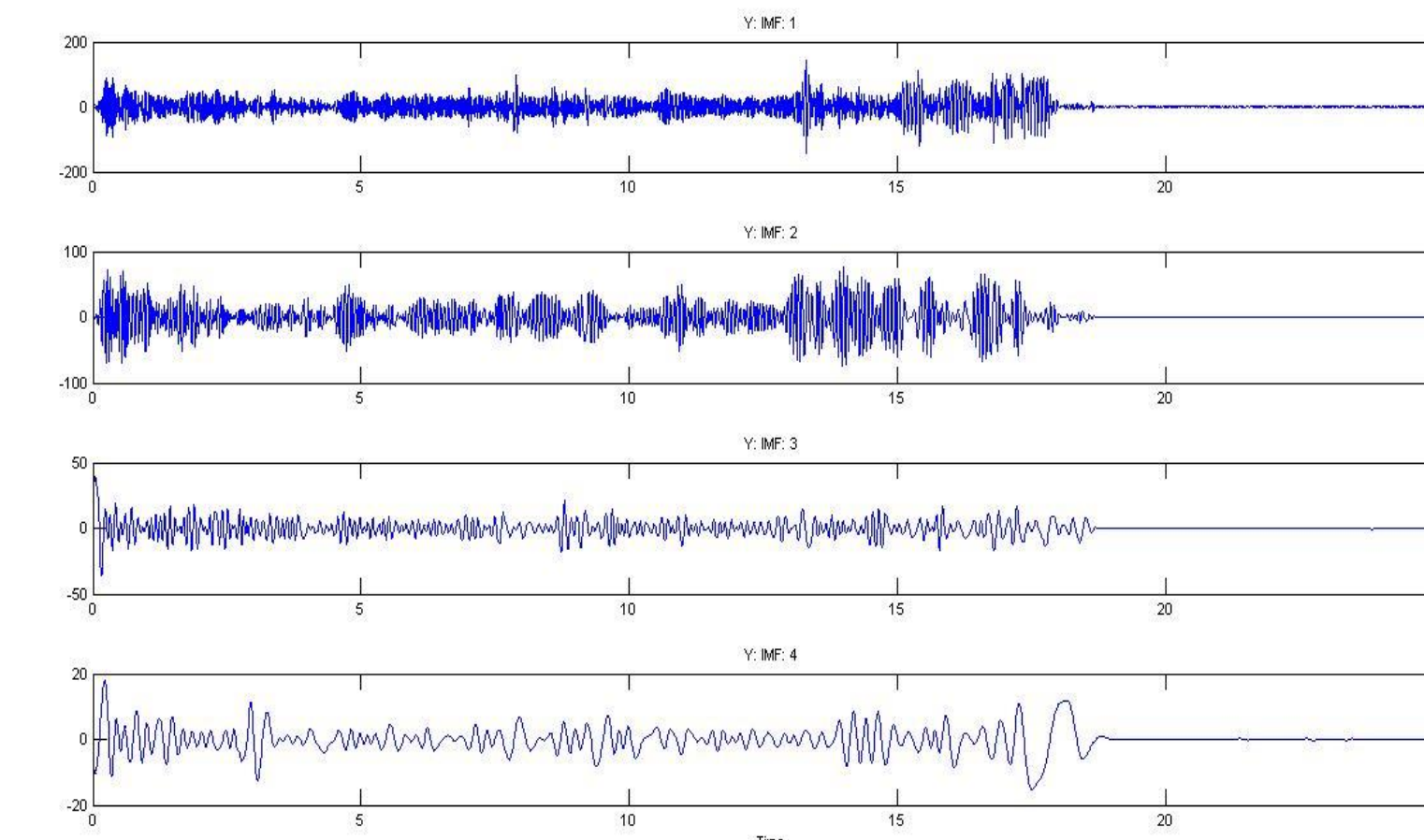
1. Create a graph by connecting all the local maxima data points and create another graph by connecting all the local minima
2. Take the mean of the graphs,  $m$ , and subtract it from  $hx(t)$ , the original set of combined signals to obtain  $n(t)$
3. Determine if  $n(t)$  is an IMF using the criteria above
4. If  $n(t)$  is an IMF, leave the graph unchanged so that it can be analyzed. Then, subtract it from the original graph and follow the above steps, going through multiple iteration until another IMF is obtained
5. If  $n(t)$  is not an IMF, progress through the iterations until the signal becomes an IMF. 6. When the last IMF is obtained, convert all the IMF signals from the into frequency data using the Hilbert-Huang Transform program. These frequency signals can now be properly analyzed for Parkinson's [5]



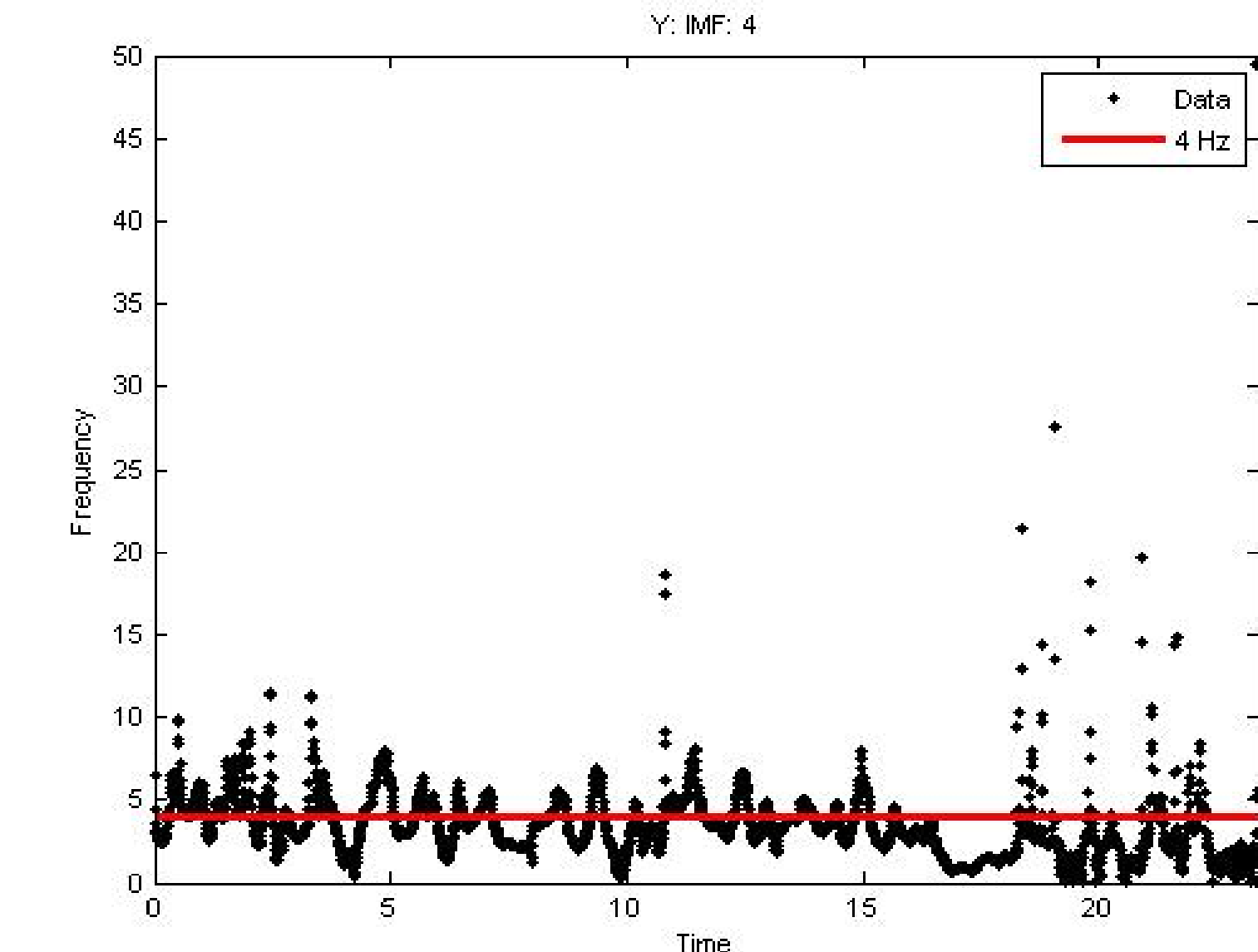
### Detecting Parkinson's and Aiding the patient Program:

- Obtain mean of all IMF frequency data roommate
- If the mean is between 4-6 Hz it is considered a tremor [4]
- Outputs the detection graph and its severity

## Results



## Results



- Empirical Mode Decomposition allows for examining noisy, combined signals and isolating each signal so they can be interpreted individually which makes real time tremor detection possible
- Intrinsic Mode Functions provide clear signals without unwanted fluctuations so that the frequency can be analyzed for detecting Parkinson's disease
- The detection program detects the tremors in Parkinson's patients

## Conclusions and Next Steps

The implementation of a Parkinson's detecting program in the ez430 Chronos watch supplies a wide variety of applications. For the possible Parkinson's risk group users, this mobile and non-intrusive watch can provide constant monitors for early detection. For Parkinson's patients, the programmed watch can be used for drug studies, to examine progression of the disease, and for personal monitoring.

To further develop this project, more accurate noise cancellation filters such as average value method can be employed and data collection routines can be improved to eliminate the noise and non-deterministic variations due to serial communication with the USB access point. Our current experiments are based on artificial(!) data and we plan to extend our studies by collecting data from actual Parkinson's patients.

## References

[1] Barnhart, B.L., and Eichinger, W.E., "Analysis of Sunspot Variability using the Hilbert-Huang Transform" *Sol. Phys.* (2011), **269**, 2, 439-449.  
 [2] Husain, MD, Ilfat. "iMedical Apps." *Researchers use iPhone accelerometer to diagnose Parkinson's disease tremor, test remote diagnosis potential.* *iMedicalApps*, 07 02 2011. Web. 9 Aug 2011. <<http://www.imedicalapps.com/2011/02/iphone-accelerometer-diagnose-parkinsons-disease-tremor/>>.  
 [3] Jankovic J (April 2008). "Parkinson's disease: clinical features and diagnosis". *J. Neurol. Neurosurg. Psychiatr.* **79** (4): 368-76. doi:10.1136/jnnp.2007.131045  
 [4] Norden Huang, Nii O. Attoh-Okin, "The Hilbert-Huang transform in engineering," *Taylor & Francis*, 2005.  
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