AC 2008-555: GRADUATE LEARNING THROUGH RESEARCH: HUMAN HAND TREMOR DETECTION AND ANALYSIS

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Abstract:

Human tremors can impair any daily activity, including something as simple as signing checks or eating food. Formally defined, human tremors are a rhythmic involuntary oscillatory movement of body parts with a relative and fixed frequency and amplitude; the range of frequencies for tremors is between 3 and 15 Hz [1], [2].

Many solutions exist to detect, acquire data on, and analyze human hand tremors. Hardware solutions, such as sensor networks, have been used with great success for motion detection. The type of sensor most commonly used was the accelerometer. These sensors were placed on the middle finger of each hand on a patient to detect motion [2], [3], [4]. Another device used 3 accelerometers and 3 gyroscopes, in conjunction with wireless data transmission [5]. Data acquisition was critical, but the fundamental issue was distinguishing voluntary motion from involuntary motion. Software based solutions, such as DSP-based algorithms, have had some success with this problem. The use of Higher Order Statistics (HOS), more specifically PSD and auto-correlation functions, were used for statistical signal processing [3]. Data analysis could also be accomplished using the Weighted Fourier Linear Combiner (WFLC), which is based on the Fourier Linear Combiner (FLC) [6]. The WFLC has the capability to extend the FLC to the case of an unknown fundamental frequency; essentially, the WFLC can essentially track the frequency and amplitude modulation of a time varying input signal [7].

This paper reports the progress of a graduate research project on human hand tremor detection and analysis. This project has two major aspects: hardware and software. The hardware was used to obtain simulated-tremor motion data and the software was used to analyze this data. The hardware consisted of the Analog Devices ADXL330 3-axis accelerometer, combined with the EVAL-ADXL330Z evaluation board for data collection. Data acquisition was accomplished using the National Instruments (NI) USB-

6008 DAQ and NI LabView. The tremor motion was simulated using a circuit designed to output 3 different frequencies to a vibration motor, resulting in motion in the range of human tremors. This project used two different data analysis methods: Hilbert-Huang Transforms (HHT) and Auto-Regressive (AR) process of order p. Each of these methods performed in a satisfactory manner.

From educational perspective, this project has provided invaluable graduate research experience. Student engagement is an important concept to the learning process, even as a graduate student [8]. The skills and self-efficacy gained from this project have helped prepare the author for his pursuit of higher education at Purdue University and his ensuing career in the engineering field.

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