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Short Message

Wearable Smart Sensor Ring to Monitor the Severity of Hand Tremor

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Abstract: Tremor is a small, rhythmic shaking movement that occurs in a back-and-forth pattern. Everyone has a small, sometimes undetectable, shake when they move their hands. Fatigue, stress, feelings of anger or fear, caffeine, and smoking can make this normal shaking more obvious. Hand tremor can occur at any age but most commonly occurs in middle-aged and older men and women. In the present investigation, a light-weight ring using polyvinylidene fluoride (PVDF) thick films as piezoelectric transducer, were fabricated and tested for monitoring Hand Tremors under voluntary human tremor modes.

Keywords: PVDF, Piezo-ring, Hand tremor.

1. Introduction

Tremor is defined as an involuntary, rhythmic to greater extent, oscillatory movement of a body part. Hand tremor is an involuntary muscle movement, trembling, or shaking of the hands. Short-term tremors that disappear quickly can be due to an anxiety attack or stress; whereas chronic tremors that come and go over a longer period of time can be due to the essential tremor (ET). Essential tremor is a neurological condition that causes your hand to shake rhythmically. However, any type of hand tremor, even if it is temporary, needs to be evaluated, as it can be due to serious, ongoing diseases, such as Parkinson's disease and multiple sclerosis. In particular, a hand tremor on one side of the body can be indicative of brain damage from a tumor or stroke. The amplitude of tremor is often small, such that it can only be measured with a highly responsive and sensitive sensors. Tremor can be further be divided into two very basic groups: physiological and pathological. Physiological tremor is ubiquitous, asymptomatic (normal) shaking that affects everyone and results from activity in individual motor units. It is generally a low amplitude (<0.5 mm peak-to-peak), high frequency movement (between 8 and 12 Hz) that is barely visible such as writing or holding a cup. In certain cases, such as fear or excitement, the tremor might increase in amplitude to such a degree that it interferes with simple actions such as writing or holding something steady, such as holding a coffee cup, writing, etc.

2. Materials and Methods

Pathological tremors, on the other hand, arise because of a disease or disorder, usually of central or peripheral nervous system. These tremors always

involve rhythmical contractions of muscle groups which manifest in a periodic, that is, roughly sinusoidal, movement about an axis. The rhythmic nature of tremor suggests characterization by amplitude, waveform, or frequency. There are several types of abnormal tremor, viz., Resting or Static tremor (frequency: 3 to 6 Hz) occurs in up to 75% of individual with Parkinson disease (PD) patients; Action tremor (3 to 6 Hz) occurs in more than 25% of PD patients; Postural tremor (4 to 12 HZ) occurs in around 60% of PD patients; Task-specific tremor (3 to 10Hz); and isometric tremor (medium frequency). An objective evaluation of tremor severity is needed to record the course of disease and the usefulness of treatment for on-time interventions in clinical trials. Various transducer-based methodologies, such as accelerometry, electro-myography, gyroscopy, electromagnetic tracking, actigraphy, and digitizing tablets are being currently used [1-6]. Due to their size, weight, potential high costs, time consuming measurements and their complexity, most devices are only used in electro-physiological laboratories and are not yet applicable for daily clinical or home monitoring. To mitigate above cited present cumbersome characteristics, we propose a concept of low-cost, light-weight ring with cantilevered piezoelectric sensors as depicted in Fig. 1.

We investigated our prototype piezo-ring's functionality by (a) voluntary rhythmic tremor and (b) random tremor as seen in Fig. 2 (a) and Fig. 2 (b) respectively. From the waveform, one can extract amplitude, frequency, and waveform. Furthermore, Frequency spectra can be used to extract amplitude and signal energy as a parameter for tremor severity.

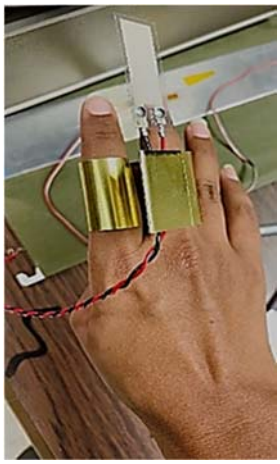
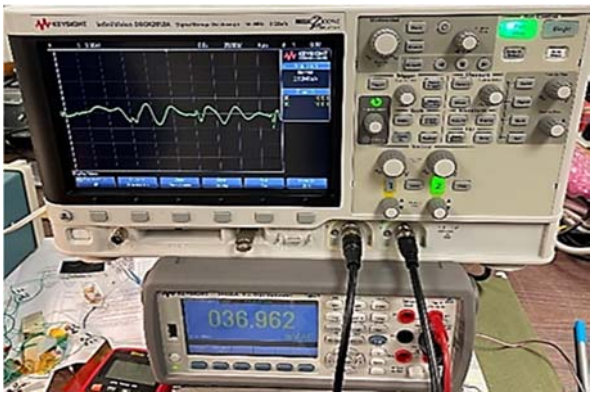
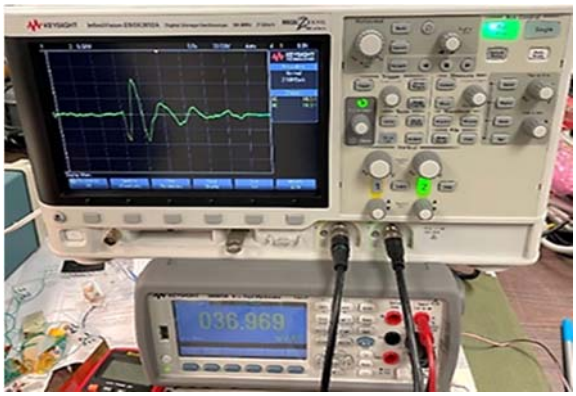


Fig. 1. Light weight metal ring with PVDF type piezo transducer.



(a)



(b)

Fig. 2. Waveform obtained for rhythmic tremor (a), for random tremor (b).

3. Technical Summary of the Proof-of-concept

PVDF can be used as power harvester as well producing power and that can be utilized to power the small associated electronics [7]. Furthermore, results obtained can be correlated with clinical scales. This is a technical, and clinical proof-of-concept device under test (DUT) for its demonstration. Further clinical investigations along with algorithmic wave analysis will demonstrate if tremors can be recorded and analyzed in home-environment and additionally, if it is possible to achieve a home-monitoring system, like blood-pressure measurements.

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