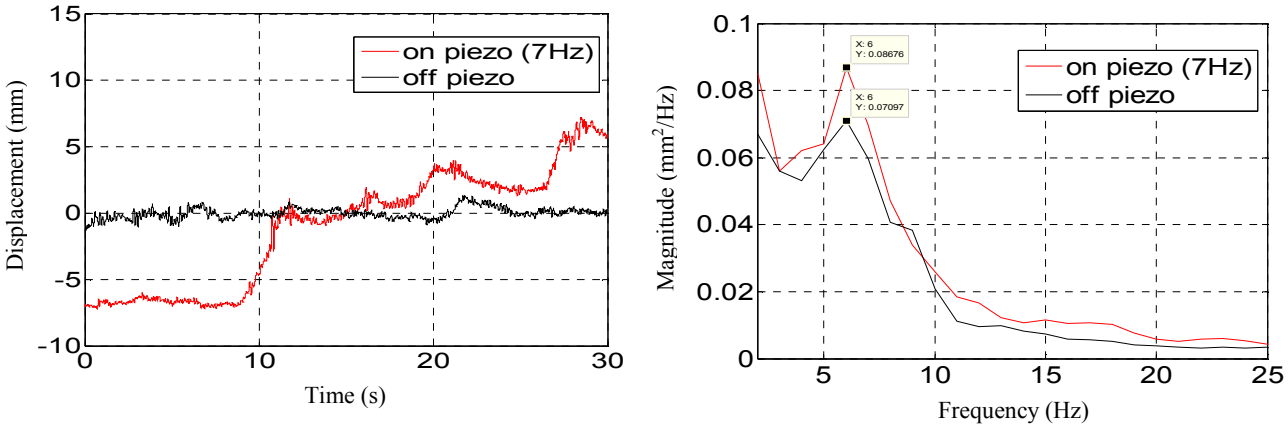
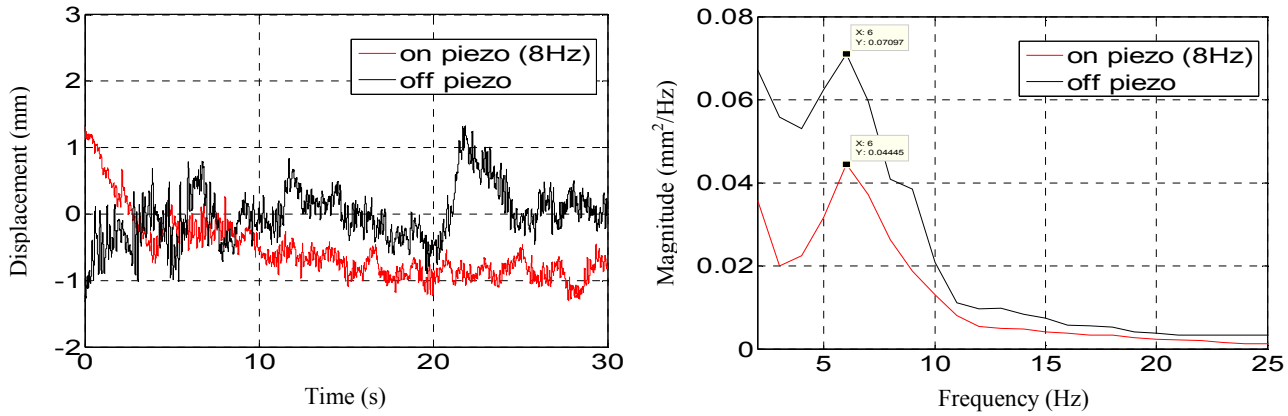
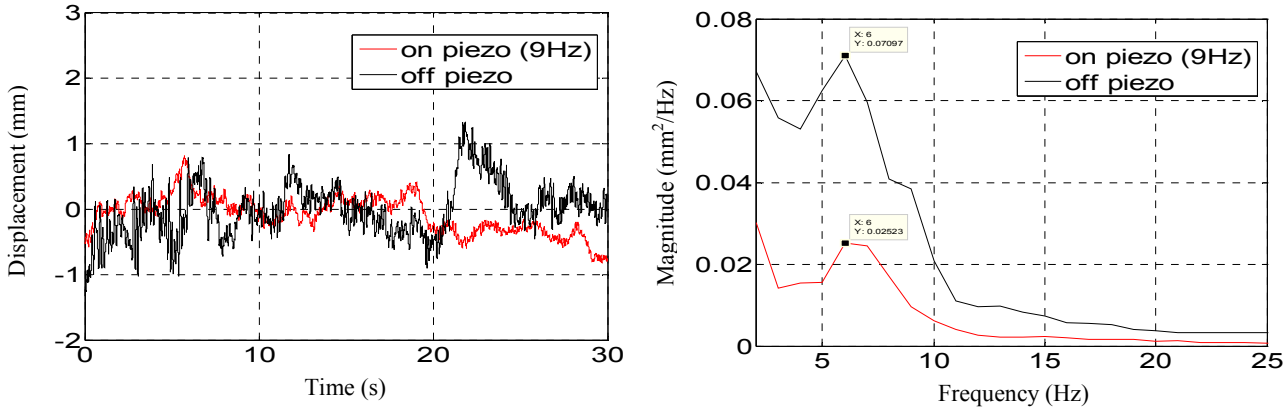


(a) Displacement response when piezoelectric actuator vibrates at 7Hz



(b) Displacement response when piezoelectric actuator vibrates at 8 Hz



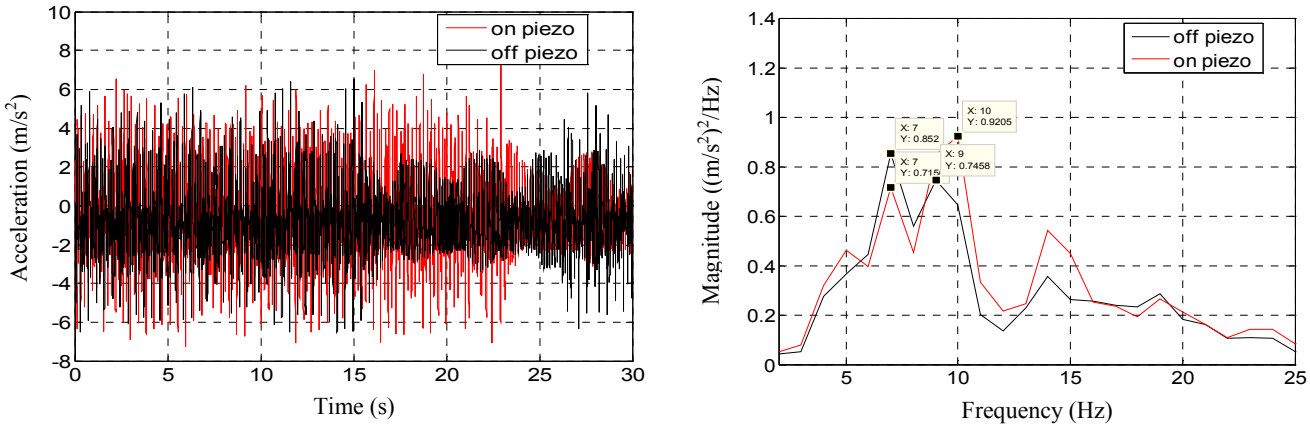
(c) Displacement response when piezoelectric actuator vibrates at 9 Hz

Fig.6 Displacement responses for the human hand tremor with glove

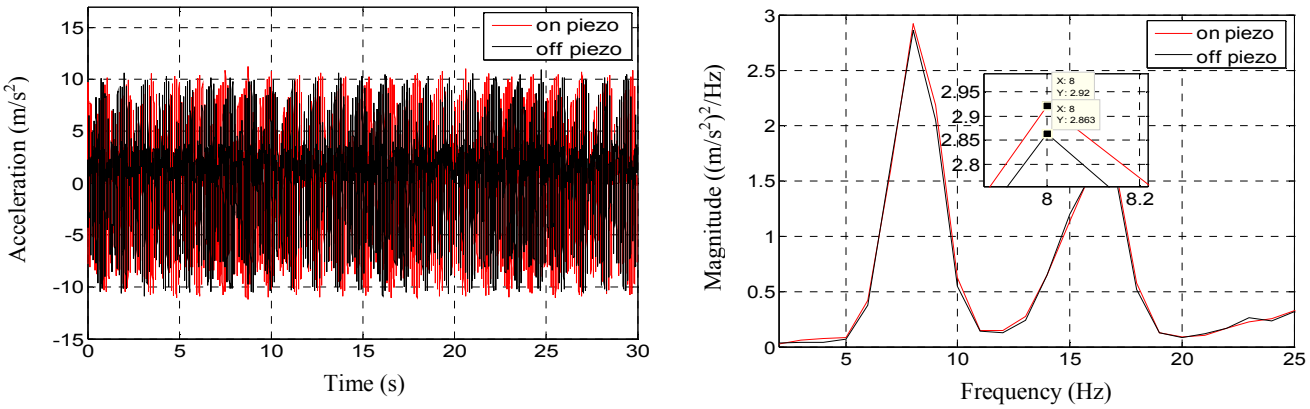
the piezo condition.

Figure 8 shows the precise vibration displacement signals of IVTA, after wearing the second glove. As shown in Figure 8(a), the amplitude is within the range of -0.65 mm to 0.75 mm (off piezo) and -0.85 mm to 0.85 mm (on piezo). Meanwhile in the frequency domain, it is observed at 7 Hz with the magnitude peak at 0.1525mm^2/Hz (off piezo) and 0.1745 mm^2/Hz (on piezo).

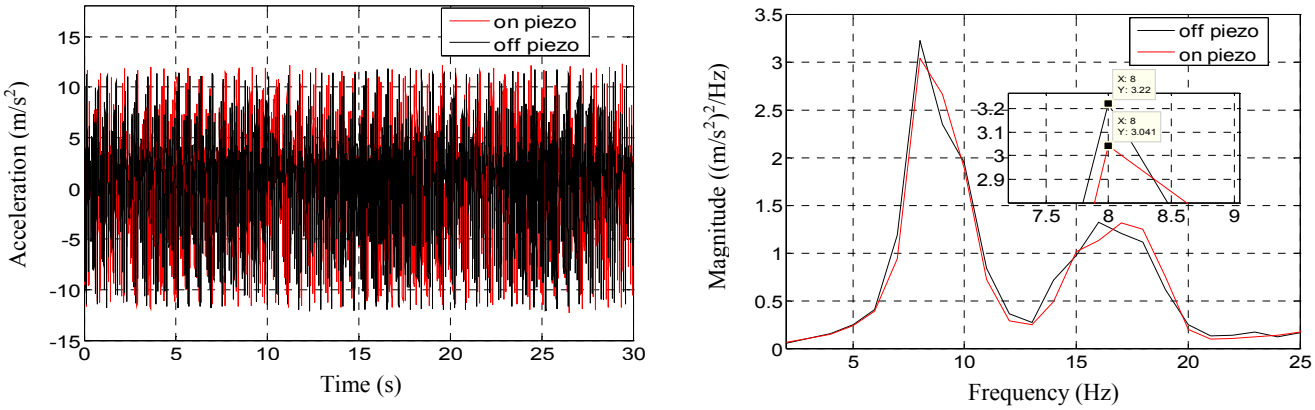
In Figure 8(b), the IV Training Arm oscillated between -1.1 mm and 1.1 mm without piezoelectric effect. With the piezoelectric actuator, the acceleration signal is not in uniform distribution as the amplitude is within the range of -1.2 mm and 1.2 mm. This is due to the noise of the displacement signal while taking the measurement. Nevertheless, the frequency domain revealed the actual vibration reading at 8Hz and without the effect of piezoelectric, the magnitude is 0.3168 mm^2/Hz but with the piezoelectric, the magnitude is reduce a is reduces a little bit to 0.3162 mm ^{2}/Hz. Lastly, Figure 8(c) shows the high displacement range between -1.15 mm and 1.2 mm when disable piezoelectric effect while with piezoelectric it is between -1.3 mm and 1.35 mm respectively. In frequency domain, without piezoelectric actuator effect, the frequency was observed at 9 Hz with magnitude peak at 0.3903 mm ^{2}/Hz. By applying piezoelectric actuator, the frequency occurred at 8 Hz with magnitude at 0.3219 mm ^{2}/Hz. From the glove results, by referring to the time and frequency domains, it shows that the acceleration of the IVTA is reduced when the DC motor rotates the unbalanced mass at 77.80 Hz with 5.59% reduction. Meanwhile for the displacement signal, the glove is able to reduce tremor when the natural frequency of the DC motor is also at 70.68 Hz with 0.19% and at 77.80 Hz with 17.52%. Thus, it clearly shows more effectiveness of the glove in reducing IVTA tremor when the natural frequency of DC motor is at 77.80 Hz.



(a) Vibration induced by the DC Motor at 67.91 Hz

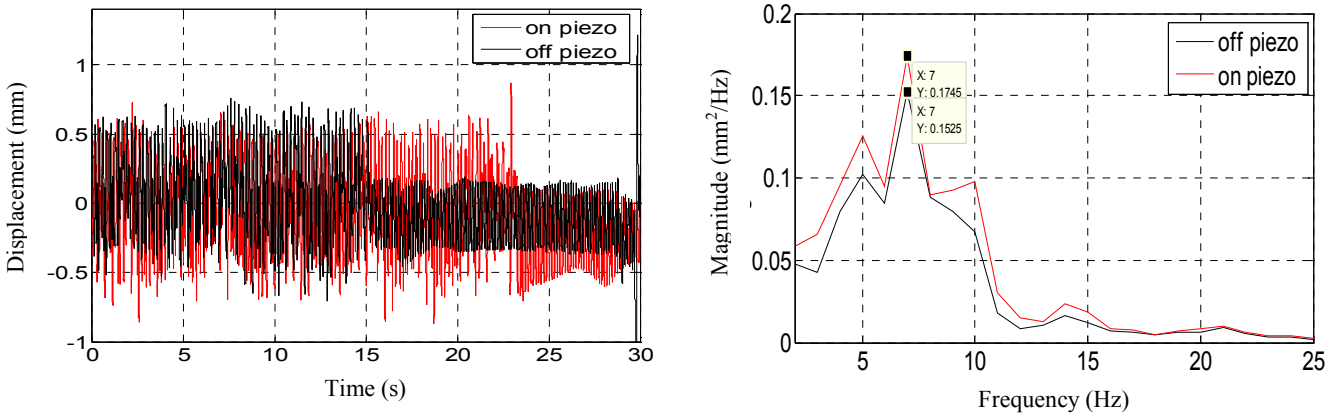


(b) Vibration induced by the DC Motor at 70.68 Hz

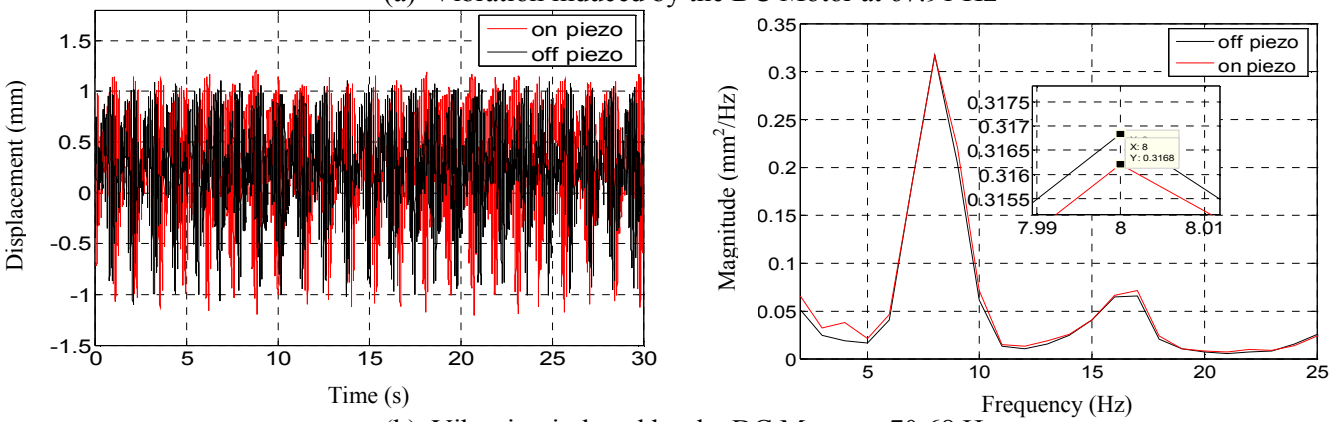


(c) Vibration induced by the DC Motor at 77.80 Hz

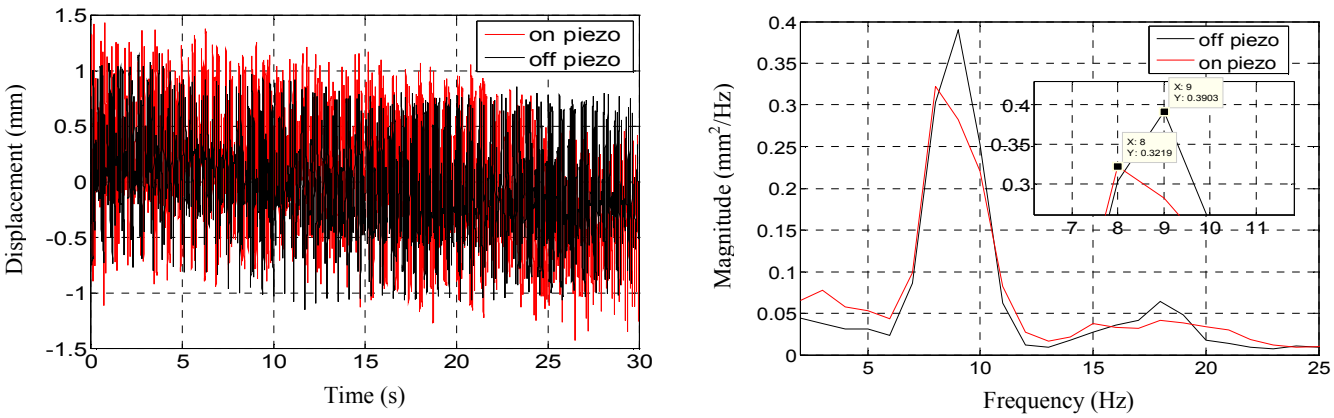
Fig.7 Acceleration responses of IVTA with glove



(a) Vibration induced by the DC Motor at 67.91 Hz



(b) Vibration induced by the DC Motor at 70.68 Hz



(c) Vibration I induced by the DC Motor at 77.80 Hz

Fig.8 Displacement responses of IVTA with glove

6 Conclusion

The tremor suppression is made possible through the use of glove with piezoelectric actuator embedded. It is clear that the actuator acts as a tremor resist element by providing the pre-emptive force to the hand and/or IVTA model. For human hand tremor, the glove is much better in reducing the tremor because it is able to give high percentage of magnitude reduction for both acceleration and displacement signals. For the IVTA tremor, the glove shows good responses, when the natural frequencies of the artificial exciter through the DC motor were operated at 67.91 Hz and 77.80 Hz. It was also found that three selected frequencies of the artificial exciter can provide vibration almost similar to the human hand tremor at 67.91 Hz, 70.68 Hz and 77.80 Hz, thereby implying that the model can be acceptably used for emulating the actual hand tremor.

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