

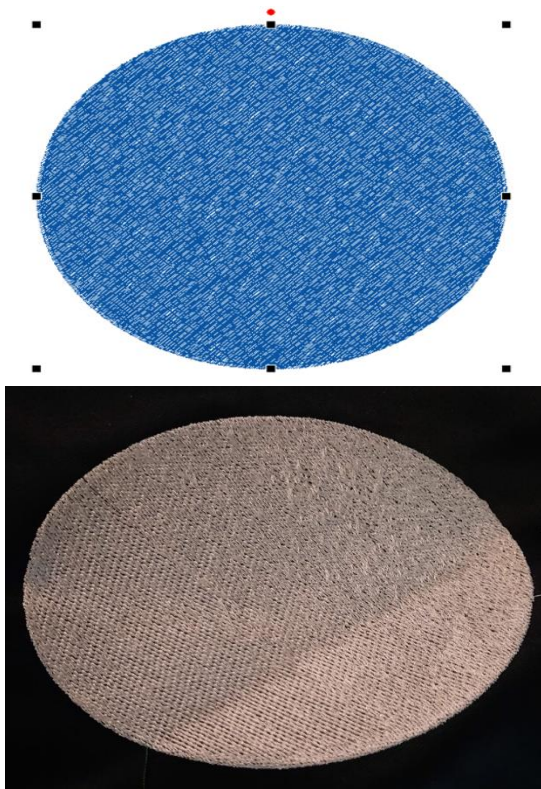
A hybrid 3D printed embroidery TENG for energy harvesting

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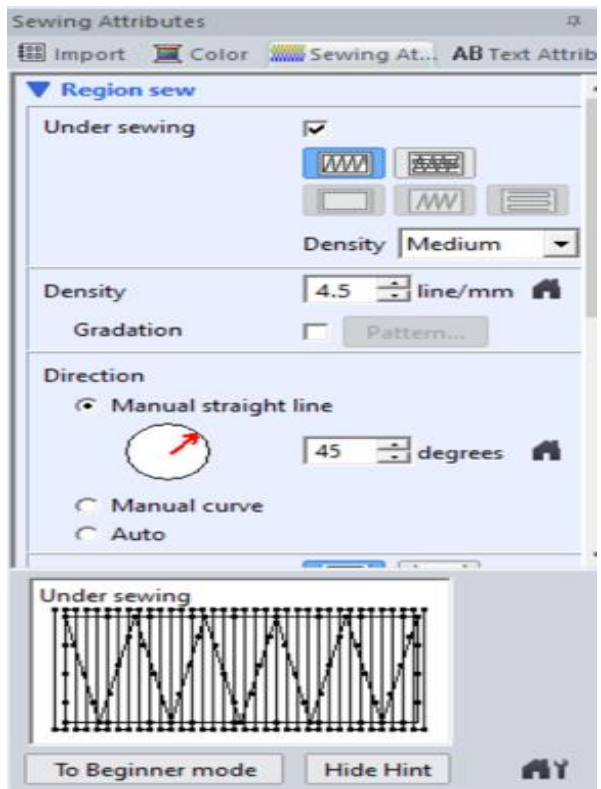
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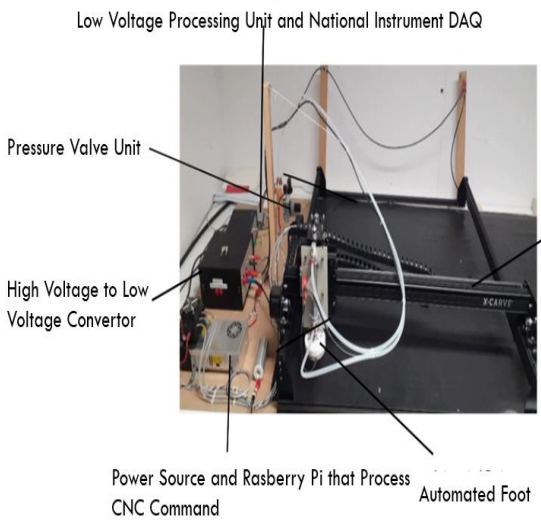
Textile based triboelectric Nano generator (TENG) is the energy harvesting flexible and light weight device that convert the mechanical energy to electrical. In this work, we present a novel hybrid 3D printed embroidery TENG for energy harvesting. The digital embroidery part is done on Brother Embroidery Machine PR670E with Polyester multifilament conductive hybrid thread (CleverTex), that have a linear resistances of thread $280 \Omega /m$. This embroidery thread is fully compatible with standard textile embroidery process. This thread is very suitable for embroidery due to its very good mechanical property and having no loop formation during embroidery. These features of this thread especially suitable for high production quality. It could be used as upper and lower bobbin. For the preparation of embroidery part, Polyester multifilament conductive hybrid thread is used as upper bobbin with 100% polyester Madeira thread as lower bobbin thread. These thread having non-toxic, no skin irritation properties make them suitable for smart wearable energy harvesting applications. These threads are coated with silicone-paraffin emulsions that improve their running during embroidery process. Figure 1 a) shows the simulated embroidery sample and the actual developed embroidery sample. Among the possible stitch types (satin, Fill, Prog. Fill, Piping, Motif, Cross, Concentric Circle, Radial, Spiral, Flexible Spiral, Stippling, Net Fill, Zigzag Net Fill, Decorative Fill), Fill stitch with medium stitch density and 4.5 line per mm has been used to develop this energy harvesting sample. Figure 1 b) shows sewing attributes of the embroidery sample. The 3D printing part of energy harvesting TENG is done with flexible Filaflex materials on textile substrate. To characterize the energy harvesting, the tapping and lateral sliding devices are used as shown in Figure 1 c) and Figure 1 d).



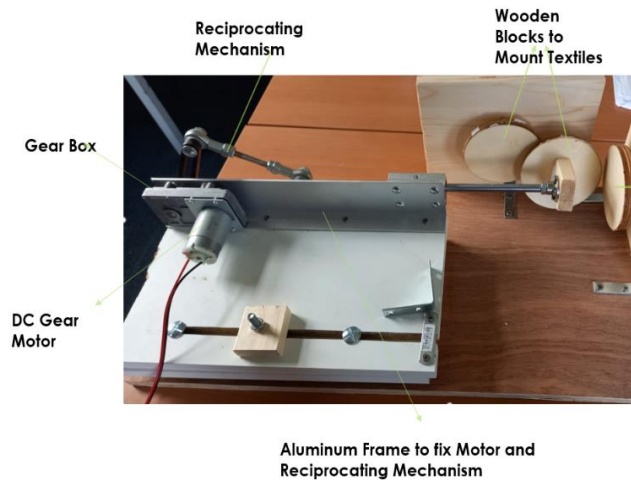
a)



b)



c)



d)

Figure 1. Shows the Energy harvesting TENG with characterization devices a) Simulated and actual embroidery TENG with Polyester multifilament conductive hybrid thread (CleverTex) as upper bobbin and 100 % polyester Madeira as lower bobbin thread. b) Sewing attributes for embroidery c) Tapping characterization device for TENG d) Lateral sliding characterization device for TENG