FDGA Project Final Report

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This report presents the outcomes of my FDGA sponsored wearable technology garment creation project entitled "Cycle of a Hope: A wearable bicycle riding outfit incorporating Electroluminescent (EL) tapes and a LED ring light". This project is accepted by the Journal of Sustainability's special issue on the topic of "Sport, Tourism, and Hospitality for SDGs (United Nation's Sustainable Development Goals)" to be published by fall this year. To fit the journal's topic, the created garment was designed to address three goals in SDGs: Climate action, Gender equality, and Sustainable cities and communities. The garment is aimed to encourage people to become bicycle commuters, instead of using fossil fuel consuming transportation modes. Based on previous studies addressing women's stronger concerns on bicycle's road safety than men, the garment was designed to enhance wearers' visibility at night with two embedded EL tapes and a LED ring light on the garment. The styling concepts and silhouette of the garment were inspired by the contributions of 1890's Victorian rational dress reform and the emergence of bicycle to the women's access to opportunities. Today, bicycles donated by international charities such as the World Bicycle Relief provide new opportunities for people, especially students living in developing countries. To express passion and hope of people growing their dreams on a bicycle, red and orange colors were used in the garment design. These colors also increase bicycle riders' visibility on the road. Overall, the presented wearable garment attempts to illustrate SDGs' purposes for making more inclusive, safe, and sustainable cities and society for humans.

The main medium of the garment is a mulberry paper-based textile called *Hanji*, produced by using Korean traditional paper making methods and techniques. Rather than using 100% *Hanji* with a stiff surface texture, silk blended *Hanji* (70% Mulberry Paper, 30% Silk) was selected for a soft texture of the garment. The used fabrics were created by one of the sustainable textile companies specialized in the novel natural cellulose fabric development based out of South Korea. To construct the garment, high-functional materials such as stretch mesh fabric and 3M™ sew-on reflective tape were combined with *Hanji*. For the wearable devices incorporated into the garments, the EL tape lights that can be stitched on fabric, glow from both top and bottom sides, and are more flexible, were selected. To lit and control flash rate and brightness of the EL tapes, a 9-volt rechargeable battery and 12 volt EL parallel inverter are connected to the tapes. Two EL tapes linked with JST 2 pin connectors are stitched inside of the garment's shoulder frills. To decorate the belt of the garment, a 2-inch LED ring, consisting of 40 individually addressable lights capable of producing many different colors, was used. The LED ring is connected to a Python-based micro-controller incorporating external buttons, switches, a USB drive, and other interfaces to interact with the lights. Adafruit's Circuit Python programming language was used to program the colors of lights and flash rate for the micro-controller. To power and turn on/off the LED lights, a push-button switch and micro-sized (approximately 1.5 inches in width) 110mAh 3.7 volt lithium-ion polymer battery for e-textile were integrated to the micro-controller. To match with the garment's color scheme and the EL tape colors, the LED ring lights are programmed to lit in orange color.

Figure 1: The completed wearable garment without lights on

Figure 2: The completed wearable garment with lights on

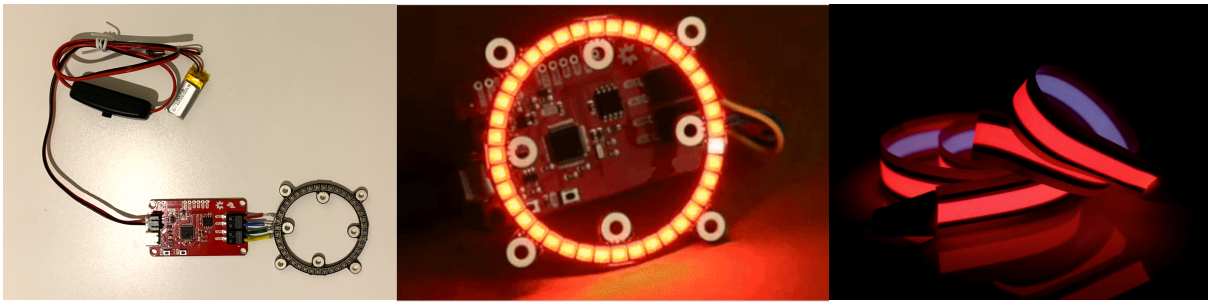
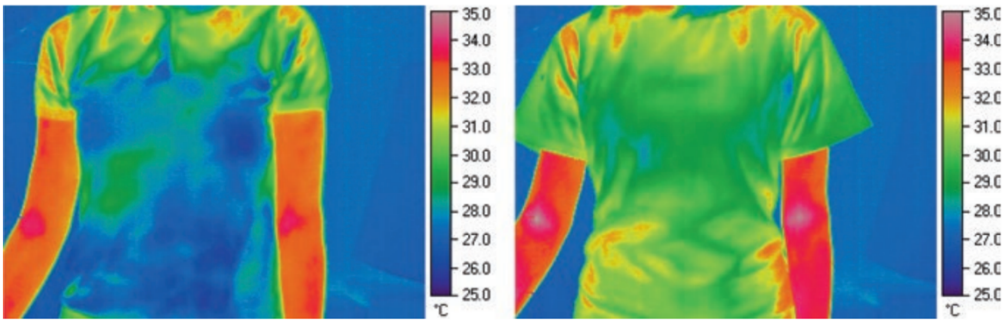
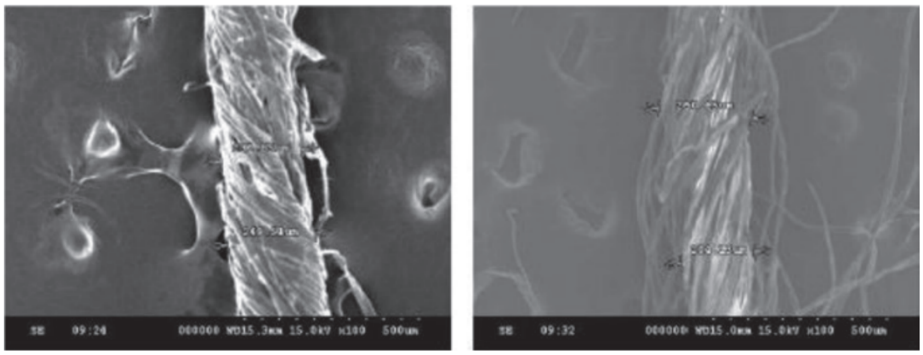


Figure 3: The wearable device components incorporated into the garment

The Korea Institute of Convergence Textile (South Korea) specialized in research and development of *Hanji* textiles collaborated with this research. The institute provided the lab testing results that the used *Hanji* fabrics' natural cooling capability can lower a wearer's body temperature by 3 degrees in Celsius than cotton. The *Hanji* fabric's yarn has lower weights and narrower widths compared to cotton. These yarn characteristics result in finer yarns for better textile quality. The *Hanji* yarn's fibers are agglomerated, whereas cotton yarn has a dispersed fiber structure. The *Hanji* yarn's fiber agglomeration creates a high elastic resilience. They also provided the information that *Hanji* have a better moisture control and anti-bacterial capabilities in warm humid weather than cotton.



Hanji Fabric Cotton Fabric



Hanji 20s Cotton 30s

Figure 4: The Korea Institute of Convergence Textile's lab testing results

After the completion of the project, my achieved outcomes include the enhancement of my wearable design research capacity and pedagogical skills to teach innovative and sustainable product development methods for students. I plan to submit the abstract of this research to the FIT's Sustainable Design and Business Conference and SUNY IITG Conference in 2021. My experiences and knowledge gained from this FDGA sponsored project are enormous. I would like to express my special thanks to professor Elaine Maldonado and Celia Baez at the Center for Excellence in Teaching for helping me this research project possible.