Development of a backpack-based wearable proximity detection system

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Wearable devices go beyond space constraints to read data about a user's state, behavior, or surrounding environment and provide feedback according to the user's needs. Wearable devices are used in diverse fields with various forms and functions such as health care, medical purposes, and machine interfaces. Especially, such devices allow monitoring individuals' biological and behavioral data on a daily basis for health communication (Song, Kim, & Kim, 2020). Recently, there has been a study to detect shoulder injuries common in space flight training by creating suits that incorporate wearable proximity sensor technology (Loflin, Cluff, Griffith, & Mohammed, 2020).

Wearable devices can be of great help to people with physical disabilities. Research has been conducted to perform tasks such as real-time transcription, real-time transformation, and alert management based on wearable technology for people with difficulty hearing sounds (Alkhalifa, & Al-Razgan, 2018). Further, wearable terminal devices have been developed that detect surrounding sounds in real-time and convert them into visual and tactile data to inform deaf people of the type and direction of sounds to help them cope with potentially dangerous situations (Park, Ahn, Kim, Ha, & Park, 2006). People with hearing loss or visual impairment have difficulties recognizing when someone is approaching and can feel threatened in crowded streets. An inconsistent approach to such technologies can cause dangerous incidents such as bumping into someone. Therefore, it is important to alarm users of approaching objects in advance, as well as develop devices that function with such alarm systems.

In this study, we develop a backpack-based wearable detection system that includes a commercial IR (infrared) proximity sensor, LEDs, and a microcontroller unit. This backpack system helps users recognize when someone is approaching from behind through visual and tactile notification, even if the user has difficulties hearing sounds or seeing surrounding objects. Furthermore, this device can play an important role in preventing accidents for general users, including those with hearing loss and visual impairment.

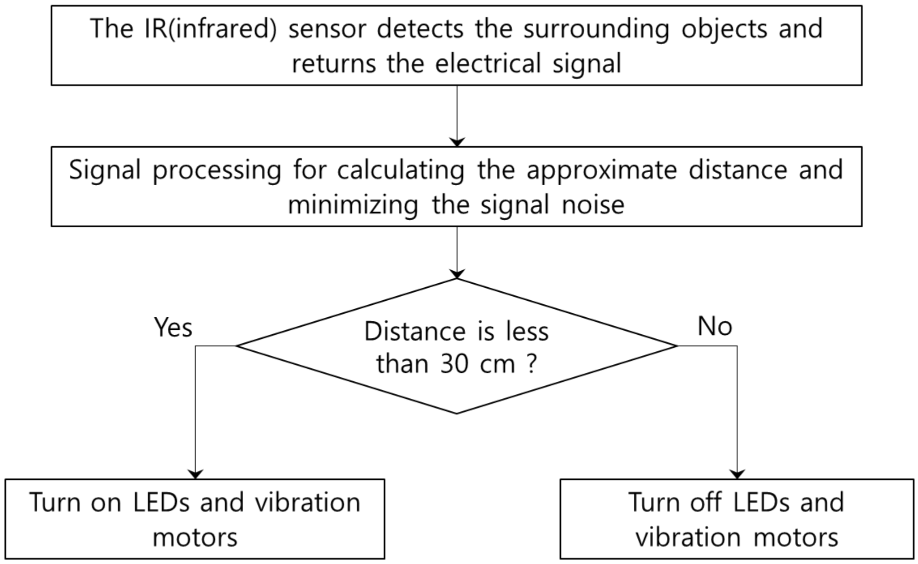

Figure 1. Operation process of the proximity sensor, LEDs and vibration motors.

Figure 1 shows the operation procedure for the proposed detection system. First, a proximity sensor is used to detect the distance of approaching objects from behind users. Second, the measured electrical signals are used to the approximate distances and minimize noise. Lastly, if the distance is within 30 cm, then an array of LEDs and two vibration motors are activated within the alarming system. A vibration motor located on the bag strap will alert users when the proximity sensor detects any object within a certain distance range. The system also provides a warning message to the stranger in question via the LED lights and warns them to be aware of their proximity to the user. To program the Lilypad Arduino microcontroller in our system, we took advantage of the Arduino software (IDE) and implemented add-on components of the LEDs and vibration motors for e-textiles electronics on the backpack. For the proximity sensor, the Sharp IR sensor (GP2Y0A21YK0F) was used, and we evaluated the changes in electrical signal based on the different distances. We expect that our device could help prevent street accidents for people with hearing loss and visual impairment, as well as those that are not sensitive to the movements around them, such as those using earphones with noise-canceling technology.

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