The Utilization of Sensors for Tracking and Identifying Usage Phases of Textile Articles: An Initial Step Towards Lifespan Prediction

Mohammed Jayat, Romain Benkirane, Cédric Cochrane, Sebastien Thomassey

P-8

The Utilization of Sensors for Tracking and Identifying Usage Phases of Textile Articles: An Initial Step Towards Lifespan Prediction

Mohammed Jayat[1], Romain Benkirane[1], Cédric Cochrane[1], Sébastien Thomassey[1]
[1]Univ. Lille, ENSAIT, ULR 2461 - GEMTEX - Génie et Matériaux Textiles, F-59000 Lille, France
*cedric.cochrane@ensait.fr

Context: The lifespan of clothing is a critical factor in the circular economy and in assessing environmental impacts. Estimating clothing lifespan is complex due to various factors including product characteristics, manufacturing processes, usage, and maintenance. Research at the GEMTEX laboratory has demonstrated the potential to predict product lifespan, but this method relies on extensive experimental data obtained from standardized textile tests.

Objective: In response, this study aims to develop an innovative approach utilizing advancements in textile sensors. These sensors record the stresses and wear experienced by garments during use. Acquiring such data will facilitate the development of predictive models based on artificial intelligence to estimate garment lifespan. This article focuses on a specific segment of the project, detailing a preliminary experiment involving the monitoring of a garment through sensor instrumentation. The primary objective of this phase is to capture and analyze data generated by sensors during different usage phases of the garment to recognize these phases. Subsequently, machine learning techniques will be used to predict these phases based on the collected data.

Methods: The method developed in this work consists of several stages: (1) garment instrumentation, (2) data collection, analysis, and preparation, and (3) prediction of different usage phases. Initially, the garment is equipped with a multifunctional MSR 145 sensor. This sensor records timestamped data on acceleration along three axes (ACC x, ACC y, ACC z), ambient humidity (RH), pressure (P), and temperature (T RH). The sensor is precisely positioned vertically along the accelerometer z-axis (ACC z) in the fifth pocket of a pair of jeans, chosen for its stability and isolation to minimize interference and spurious movements. Data collection is performed over various durations and by different users, with measurements taken every second. The usage phases were defined and recorded into six categories: walking, sitting, standing, storage (garment not worn), washing, and drying. These phases were rigorously matched with corresponding datasets through manual labeling. For predicting the different usage phases, a Random Forest model [1] was chosen for its recognized capabilities in predicting human activities due to its robustness and excellent ability to handle complex and noisy data. The model was trained using data collected by the MSR145 sensor, selected for its high precision and ability to simultaneously record multiple types of data. The data were split into two sets: eight different days were used for cross-validation across five folds, and four other days were used for testing. Additionally, a grid search was employed to optimize the model's hyperparameters.

key findings: This experimental phase shows that clothing instrumentation enables the recognition of usage phases. The next step aims to improve the training and testing datasets by integrating real-world constraints and specific textile standardized tests. These findings could support further studies on consumer behavior analysis and the environmental impact of clothing durability.

Keywords: Clothing lifespan; Clothing usage prediction; Textile sensor; Machine learning

[1] L. Gioanni et al., "Opportunistic Human Activity Recognition: a study on Opportunity dataset", 13th Annual International Conference on Mobile and Ubiquitous Systems, Hiroshima, Japan, november 2016.