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# Real-Time Monitoring of Knitting Machine Performance Using IoT and Machine Learning: Innovations and Applications ⋆

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**Abstract**

Textile technologies are revolutionising with Industry 4.0. This research aims to introduce a novel real-time monitoring system in the knitting sector using the Internet of Things and machine learning technologies to measure and display productivity precisely through an interactive dashboard. Sensors were integrated into a circular knitting machine to track productivity and performance. A comparative statistical analysis through three processing phases demonstrates the high accuracy and precision of the current system, as evidenced by minimum variance and error values. The t-test results validate a non-significant difference between actual and device-measured production. Thus, it enables real-time monitoring, preventive maintenance, and cost-effective quality in knitting machines.

*Keywords*: Internet of Things; machine learning; system accuracy; real-time monitoring; knitting machine

## 1 Introduction

In recent years, the way professionals approach problem-solving has undergone a few modest changes due to the Industry 4.0 revolution, which is currently taking place globally. The Internet of Things (IoT), Machine Learning (ML), Artificial Intelligence (AI), Smart Manufacturing, Cloud computing, and Cyber-Physical Systems (CPS), among other Industry 4.0 innovative components, have already started to focus their study on textiles and fashion [1]. Kevin Ashton claims that the Internet of Things (IoT) is a technological development that ushers in a new era of pervasive

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connectivity, processing, and communication [2]. The "Internet of Things" refers to networked sensors and actuators connected to computing systems [3]. Moreover, IoT builds a network by connecting various data-generating devices [4]. Machine-to-machine (M2M) connection and the Internet of Things (IoT) will close the gaps between the industrial and telecom sectors. A huge number of sensors, actuators, and various smart devices networked with one another via a ubiquitous, high-performance, and highly reliable communication network are the key building blocks of an effective and broad IoT [5].

IoT is revolutionising the textile sector by promoting sustainability, quality, and efficiency. It enables a data-centric approach that optimises several aspects of the textile production process. Rathore et al. [6] declared that IoT applications in textiles include inventory management, real-time process monitoring, quality control, and predictive maintenance for machines. These applications enable textile companies to make informed decisions, adapt to market dynamics, and enhance product quality. There are several IoT applications in the textile industry, such as fashion, E-textiles, spinning, weaving, knitting, and clothing production. Implementing IoT in spinning, weaving, knitting, and clothing mills may greatly improve process optimisation, and reduce failures. From fibre manufacturing to the final fabric, IoT is used in various industrial processes [7].

Examples of Internet of Things applications in the spinning industry include Rieter's introduction of SPIDERweb modular, which allows any number of components to be connected. This system was used to monitor a spinning machine. Modules can be easily added at any time in the future. Additional sensors and Reiter-supplied proprietary equipment are needed to maximise the system's capabilities. Therefore, the Rieter spinning mills will adopt Industry 4.0 [8]. Manglani et al. [9] reported that a case study for the spinning industry is being carried out to aid in assessing its IoT solutions and to determine how other textile industry sectors may profit from their application. The case study summarised IoT technologies from ITMA 2011 to 2019 in the spinning industry. IoT provides specialised solutions at each level of the textile production process. In spinning, IoT maximises energy usage, anticipates and avoids malfunctions, and guarantees that gear operates at peak efficiency [10].

For IoT applications in the weaving industry, IoT is being used in several ways. For example, Pacific Textiles uses real-time data analytics to achieve the ideal fabric colour, improve company procedures, and facilitate future expansion. Predictive data and analysis, which lower equipment downtime, boost equipment efficiency, and meet daily production targets, are made feasible by integrating sensors into textile manufacturing equipment. It also allows textile businesses to take back market share [11]. In addition, IoT automates loom functions and keeps an eye on cloth quality while weaving. IoT-enabled knitting machines increase accuracy and reduce errors [12]. Furthermore, the Industry 4.0 solution axisWEAVE4.0 provides online analytics and monitoring for various weaving machines, including rapier, waterjet, and air-jet looms. Providing computerised dashboards and reports to weaving machines significantly enhances quality, productivity, and profitability [13].

Some applications of IoT in the fashion industry include, for instance, Liu et al. [14], who studied the obstacles of digital technology deployment in the fashion business, discussing ways to improve supply chain models using lean and agile methodologies using virtual networks, standardised information, and big data technologies. As a result, online monitoring can give real-time data for optimal strategy execution. Liu and Yuan investigated the fashion business and the growth of virtual fashion [15]. Collaborations with video games, mobile applications, virtual icons, virtual