Prognostic Identification of Issues in Textile Manufacturing Machines Using the Digital Twin Technology

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Abstract: **The term 'digital twin' was first coined in product lifecycle management in 2003, when digital representations of physical products were still in their infancy. With the advance of computing power and the Internet of Things, digital twins are now gaining traction across industries, including Textiles. They were recently named one of the top ten strategic technology trends in 2018 by Gartner. It is a dynamic virtual representation of a device, which is continuously fed with data from embedded sensors and software and it gives an accurate real-time status of the physical device. The goal of this paper is to summaries the implementation of Digital Twin Technology in Textile industries to identify the defects of machines used to convert a yarn to a fabric.**

Keywords: **Digital Twin, IoT, IAI, Design Manufacturing, Sensory Visual**.

I. INTRODUCTION

Technologies today like the Internet of things, machine learning and other forms of IAI(Industrial Artificial Intelligence) are converging and being leveraged to change how data is to be collected and analyzed. Technology has come a long way since 1970. Analogue models have been replaced by digital models, enabling NASA to monitor and modify systems in real time with ever more precision. But the underlying notion is still the same: a model of a physical object – a 'twin'– enables to monitor its status, diagnose issues and test solutions remotely. A digital twin is a digital replica of a living or non-living physical entity like devices, people, places and systems that can be used for various purposes. By bridging the physical and the virtual world, data is transmitted seamlessly allowing the virtual entity to exist simultaneously with the physical entity. The digital representation provides both the elements and the dynamics of how an Internet of things device operates and lives throughout its life cycle.

II. THE DIGITAL TWIN: A VIRTUAL REPRESENTATION OF A DEVICE

When adding the power of computational technologies such as artificial intelligence (AI), can potential problems are identified before they arise, allowing for timely repair or replacement of critical components. For example, smart analysis of data transmitted from sensors in a jet engine during flight can provide 15 to 30 days' advance notice of potential failures. It is not hard to see how Textile operations could benefit from the same kind of prognostics.

III. PRODUCTION PROCESSES AND PRODUCT PERFORMANCE OF JERSEY KNITTING MACHINE

With the advent of IoT, a digital twin can collect data continuously from sensors and mutually pass information with the physical counterpart throughout the system's life-cycle. Everything from manufacturing processes to sensor input, to external management software, can be fed into, and organized inside, the digital twin.

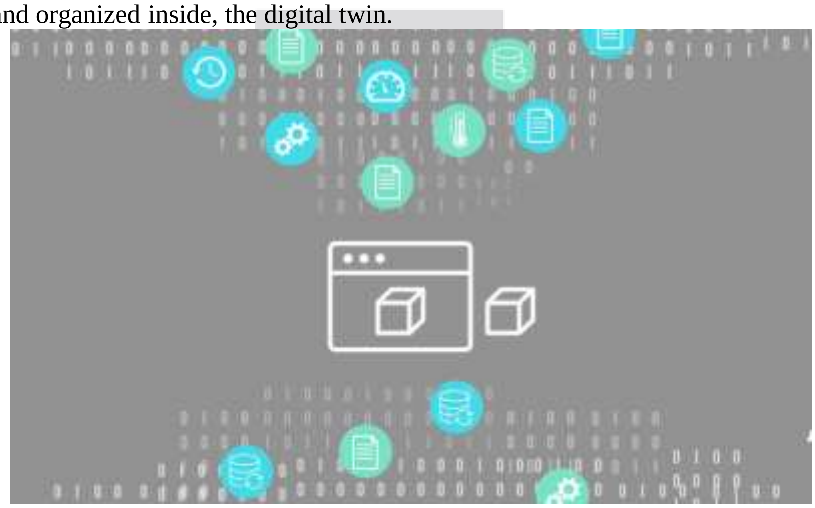

Fig 1: Digital Twin aggregate data, making it easy to identify patterns and optimizes line processes.

A fabric manufacturing plant produces a billion dollars worth of products per year. Each line contains highly specialized and expensive machines with high ended raw materials and machine settings used to produce the end product. Now imagine a digital copy of the production lines in the factory, including sensor data collected from production line machines (typically stored in a data historian), ERP data of the raw materials, production orders, formulas and QA. The manufacturer needs to continually optimize production yield by reducing unplanned machine downtime, reducing the amount of wastages produced in each production run, and minimizing costly production quality faults.

Normally, the team starts by looking at the mountains of data and slowly narrowing down which information can help them. Only after an far-reaching research, the corrections are noticed that can be helpful to optimize this complex system of assets and instructions.

IV. IMPLEMENTING THE DIGITAL TWIN WITH THE ASSET

Good digital twin software will ingest data from relevant IT and OT sources and display it on a virtual copy of the plant line. Process engineers, QA teams and others can understand the data in the context of the machines, the raw materials, and the entire production line environment. If the digital twin system is coupled with root cause analysis tools, it will even point out which variables need urgent attention, speeding up root cause investigations and optimization processes.

Fig 2: Digital Twin of Textile Machinery.

Digital twins are first and foremost the EKG monitors of manufacturing and it can they visualize and track pulse of production line. Skilled operators can notice something wrong with a machine just by touching its surface. The digital twin takes that intuition a step further by showing how the problem is reflected through data, helping investigation teams identify problems in assets more quickly and even mitigate the same problem in the future. In addition, all of this insight is available remotely. Engineers can troubleshoot equipment remotely via the digital twin, reducing incident resolution times more quickly and accurately than through viewing the data on historians, MES or quality management software alone.

V. USING DIGITAL TWINS TO UNDERSTAND DATA IN CONTEXT

Production line data is stored in different systems like some data is saved in data historians, some in ERP, MES and quality systems, some stored manually, and some processed automatically. When data isn't aggregated and organized in a digestible way, it's useless for reaching accurate and actionable insights. For Example, production line yields 10,000 fabric per batch but produces 1.5% scrap at the end of the process. Over time, each batch produces more waste and smaller yields. To identify the source of the issue, an engineer first needs to pinpoint the step of the process where they are losing throughput by monitoring machine downtime.

But reviewing downtime data from different sources is time-consuming and makes it difficult to spot correlating indicators. A digital twin gives a more integrated view of environmental factors, individual machines, and how they interact to affect the operational quality and asset performance. Viewing downtime on a digital twin, can quickly and accurately pinpoint the root cause of the problem (e.g. low temperature in an oven) and the chain of events that lead to scrap.

VI. CONCLUSION

Digital Twin use cases are as varied as manufacturers are innovative. As AI, image recognition and other technologies advance, digital twins will adapt to them and develop exciting new applications for industrial manufacturing. By implementing the Digital Twin Technology, the asset or a product can be digitalized and the problems which will occur in future will be identified and trouble shouted to avoid a bigger expenses.

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