An Overview of 5G Wireless 3D Printer Monitoring

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Abstract—The 3D printer is a new manufacturing technique that becoming popular in the fields of industry. However, the rapid development of 3D printing technology needs monitoring during the printing process. In this paper, we surveyed papers with different methods for monitoring using the fifth-generation (5G); 5G will improve the standard of the monitoring system to prevent faults during the printing process of the 3D printer. In this paper, we describe and compare many methods of monitoring through a table.

Index Terms—3D printer, fifth-generation (5G), 3D printer monitoring

I. INTRODUCTION

Additive manufacturing or 3D printing is one of the most useful technology in medical, industrial, manufacturing, and even other areas [1]. The widely use of 3D printing technology requires intelligent approaches to produce a more efficient health management system. Aside from that, 3D printers are prone to failure due to its severe operating environment. Such failures can cause a poor quality printed product or even short-term and long-term damages on the printer itself. Hence, several researchers exert efforts on 3D printer monitoring systems. 3D printer monitoring system aids in the 3D printing process and maintains a good quality printed product. 3D printer monitoring involves continuous checking or observation of the printer’s actual output as compared with the printer’s expected output. In line with this, several techniques are available in the literature. 3D printer monitoring can be performed wired or wirelessly. Due to the advancement in the wireless technology, several researchers focuses on the development of wireless monitoring techniques. Wireless monitoring involves the integration of wireless communication modules to the 3D printer system. Such wireless communication modules are based on wireless technologies such as: Wi-Fi, long term evolution, 5G technology and etc.

5G technology is expected to give an outstanding improvements to deliver higher data speeds, ultra-low latency, more reliability, increased availability, and massive network capacity, which will make the wireless Internet of Things better and reality. In addition of the improvements of 5G, there are many areas that can benefit from this technology. It is a certainty that technology can play an important role to enhance the several fields that requires a monitoring system [2]. For 3D printer monitoring, 5G technology can be utilized to enable real-time streaming of camera frames wirelessly. The use of 5G technology enables high speed and reliability communication between the 3D printer system and a wireless remote server. Moreover, it also enables access to multiple users. In line with this, a survey of several related literature that features 5G technology for monitoring systems. Moreover, an overview of the proposed 5G technology-based 3D monitoring system is presented and discussed in details.

II. LITERATURE SURVEY

The authors in [3], focused on improving the latency, spectrum, and throughput of the 5G network by implementing a hybrid detection technique based on the QR decomposition and the M algorithm-maximum likelihood detection (QRM-MLD) and beam-forming for massive multiple-input multiple-output and non-orthogonal multiple access system. The proposed hybrid detection technique improved the throughput of the system and reduces the computational complexity as compared to the conventional QRM-MLD algorithm, conventional BF and zero-forcing techniques on the platform of several parameters.

[4] designed a Mobile Edge Computing enabled 5G health monitoring system for Internet of Medical Things (IoMT). The objective of the formulated optimization problem is to minimize the system-wide cost, which depends on the medical criticality, Age of Information, and energy consumption of health monitoring packets. The IoMT can be divided into two sub-networks, i.e., intra-WBANs and beyond-WBANs. For intra-WBANs, gateways regulate the transmission rates of body sensors by bandwidth allocation to minimize the cost. While for beyond-WBANs, patients can make choices between analyzing the medical information from monitored packets by local devices and that by edge servers.

[5] conceptualizes AI-powered scalable air quality monitoring and presents two systems of calibrating low-cost air quality sensors and the image processing f pictures captured by hyperspectral cameras to better detect air quality. They developed and deployed different AI algorithms in these system on a 5G edge test bed and perform a detailed analytic regarding to 1) the performance of AI algorithms and 2) the required communication and computation resources.

[6] proposed a continuous home telemonitoring system for chronic respiratory patients using 5G connectivity. The system features a wearable repertory and activity monitor, an environmental sensor and a pulse oximeter sending the data through a 5G router to a Multi-Edge Computing server, where they are stored and accessible for visualization. In particular, activity, respiratory and environmental data are continuously streamed and collected.


TABLE I: Comparison Table

<table>
<thead>
<tr>
<th>Reference</th>
<th>Year</th>
<th>Approach</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>[5]</td>
<td>2021</td>
<td>Intelligent and Scalable Air Quality Monitoring with 5G Edge</td>
<td>AI-powered scalable real-time air pollution monitoring by developing a sensing architecture with different air quality sensing devices.</td>
</tr>
<tr>
<td>[8]</td>
<td>2021</td>
<td>Service Chains and Virtual Monitoring Functions with Minimal Cost in Softwarized 5G Networks</td>
<td>Explore latency-aware and reliable SFC placement to meet the requirements of users and enhance the reliability of SFCs from VNF failures.</td>
</tr>
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</table>

[7] discusses the implementation and validation of an Health service. The new application makes use of the characteristics of 5G, enabling dynamic instantiation of services at the edge, a federation of domains and execution of real on-the-field augmented reality. The major outcome of this work is a real-life proof-of-concept of the system, which can reduce the time required to respond to an emergency in minutes and perform more efficient triage, increasing the chances of saving lives.

Paper [8], explored latency-aware and reliable SFC placement to meet the requirements of users and enhance the reliability of SFCs from VNF failures. Also, they focused on reliable placement of virtual monitoring functions at proximal locations of VNFS in order to identify and mitigate service degradation and security-related issues in the network. They formulate the problems as Integer Linear Programming problems to minimize the total deployment cost, and show that they are NP-hard.

III. RESEARCH DIRECTION

In this paper, we surveyed monitoring techniques using 5G network as shown in Table I. The surveyed papers show that 5G network is applicable for monitoring the health care and industrial fields. Going forward, in a research future intention to use 5G module for real-time monitoring in the 3D printer to detect the fault during the printing process. Fig. 1 shows the model diagram of 3D printer monitoring. In our experiment, we will use a Raspberry Pi and a camera to capture the printing process of the 3D printer, after getting the frames from the camera, the 5G module will transfer the data from the Raspberry Pi and send to the server. After the data transmission the system will monitor if there is fault in the printing process and will give a command when the faults occur.

IV. CONCLUSION

We reviewed various papers for monitoring using 5G in health care and industrial fields in detecting, tracking, classification, and identification has been studied. 3D printing is an inspiring technology and considered to be a machine with great advantages and development in emerging communication systems. For our future work, we will conduct a 3D printing monitoring using 5G communication to detect the faults in 3D printer.

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REFERENCES


