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Application of Computer Vision for Efficient Maintenance of Cleanliness and Order in Commercial Areas: An Invention Approach for Automated Management in Commercial Zones

Jesus David Villon Llacta
Wiler Yosef Hurtado Simeon
Jorge Martin Vega Rosales

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Autores:
1. Jesus David Villon Llacta – EAP. Ingeniería Empresarial
2. Wiler Yosef Hurtado Simeon – EAP. Ingeniería Empresarial
3. Jorge Martin Vega Rosales – EAP. Ingeniería Empresarial

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Application of Computer Vision for Efficient Maintenance of Cleanliness and Order in Commercial Areas: An Invention Approach for Automated Management in Commercial Zones

*Jesus David Villon Llacta
Facultad de Ingeniería
Universidad Continental
Huancayo Perú
70121476@continental.edu.pe

Wiler Yosef Hurtado Simeon
Facultad de Ingeniería
Universidad Continental
Huancayo Perú
71693881@continental.edu.pe

Jorge Martin Vega Rosales
Faculty of Engineering
Universidad Continental
Huancayo Perú
jvegar@continental.edu.pe

***Abstract*—This study explores the application of computer vision technology to improve the efficiency of maintaining cleanliness and order in high-traffic commercial areas. Given the growing importance of automation in managing commercial spaces, this paper proposes a technological model that utilizes strategically placed cameras and image processing algorithms to detect disorganized or dirty tables, sending real-time alerts to cleaning staff via a mobile application. The goal is to optimize resource use, reduce response times, and enhance customer experience. To validate the model, an experiment was conducted with a sample of 30 customers, measuring their satisfaction levels before and after the system's implementation. The results, analyzed through statistical tests, show a significant improvement in customer satisfaction. Additionally, the study discusses its limitations and proposes future research directions, including an evaluation of the costs associated with the automated system compared to traditional methods.**

Keywords—Computer vision, image processing, cleaning management, automation, commercial areas, detection algorithms, customer experience, operational efficiency.

I. Introduction

Customer satisfaction is crucial for organizations, as meeting the expectations and needs of their customers generates a perception of value in them [1]. This perception can lead customers to develop a preference for the organization and to promote its products or services within their social circle, resulting in greater economic benefits and a differentiated market position for the organization [2]. In fact, 55% of customers are willing to pay more for quality [3], which highlights the importance of this factor in ensuring customer satisfaction. Although quality can manifest in aspects such as price or the product itself, what really makes the difference is the service offered by the organization, especially in the retail sector, which is the focus of this research. In this context, quality service not only depends on good customer service but also on the efficiency with which tasks are performed and the environment in which customer service is provided. Considering these aspects allows for the creation of a satisfying customer experience [4]. In this sense, the incorporation of automation technologies is a convenient option, as it allows for task optimization and improves customer relations [5].

Corresponding author: Jesús David Villón Llacta (correo: 70121476@continental.edu.pe)

In an international context, Open Sky in Madrid, Spain, is a revolutionary shopping center that has integrated technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and Big Data to automate surveillance and security tasks. Additionally, they have improved the shopping experience by implementing augmented reality fitting rooms, allowing customers to visualize in real time how clothing and accessories would fit, facilitating their purchase decisions and personalizing their experience [6]. In Peru, shopping centers such as Larcomar, Jockey Plaza, Real Plaza, and Mall Aventura have implemented automations that include contactless payments and smart parking, providing users with real-time information on space availability. Furthermore, these shopping centers use data analytics to better understand customer shopping preferences, offering a more satisfying and personalized experience [7]. Therefore, it is clear that the adoption of automation technologies enables shopping centers to carry out their activities more efficiently and create an environment full of positive and trendy experiences for their customers, improving service quality and gaining customer preference.

Likewise, part of the positive experience a customer has in a shopping center depends on the cleanliness and order of the spaces. These aspects are considered crucial to the success of the design and infrastructure of shopping centers in Lima

Metropolitan and Callao [8]. Traditionally, order and cleanliness in a shopping center depend on manual inspections, which can sometimes be inefficient. However, as mentioned earlier, automation technologies can support the efficient development of these activities. In fact, recent studies predict a 15% growth by 2026 in the use of technologies to optimize cleaning services [9]. One of these technologies applicable to order and cleanliness tasks in shopping centers is computer vision, which is explored in this research. Computer vision is used to automatically capture, analyze, and understand images through processing algorithms [10]. This technology has applications in various fields such as security, medicine, autonomous navigation, and automatic inspection [11]. For example, in intelligent video surveillance systems for city

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