INTRODUCTION

Quantifying the number of bacteria in a sample is critical in biomedical research, clinical diagnosis, food and drug safety testing, environmental monitoring, and public health (Liu et al., 2004). In this type of test, a liquid sample containing bacteria is poured onto an agar plate, and the surviving microbes are incubated for culturing to increase the number of germs on the agar surface to form colonies (also known as colony forming units, or CFU). The survival rate of the microbes in the sample is checked during evaluation. Colony counters are used to count the number of viable bacteria in a colony to check the results of bacterial culture.

The use of high technology in medical devices has not been evenly distributed, especially laboratory equipment. Therefore, many laboratories still count the number of bacterial colonies manually. Manual counting is an error-prone process because the results tend to have a more subjective interpretation and the detailed results obtained will take a long time (Ihsan, 2016) and are laborious work because there are hundreds or even thousands of colonies that need to be counted (Kaur & Sethi, 2012). The manual counting process usually carried out by health analysts will only count a quarter of the number of colonies in the petri dish (Azizah & Soesetyaningsih, 2020). This is due to the large number of bacterial colonies that appear on the petri dish so as to minimize time in the counting process, this technique is carried out. However, this has a big effect on the final result of the analysis.

Based on research conducted by Haris (2016), the input system was designed as a mechanical sensor in the form of a limit switch and based on the Atmega16 microcontroller. In this study, only the number of bacterial colonies seen in Petri dishes was counted and the results of the enumeration were displayed on the LCD (Liquid Crystal Display) included in the colony counter, so that the final results of the enumeration had to be processed again with this tool to determine the number of bacteria. The system only uses a mechanical sensor in the form of a limit switch located under the Petri dish and a stylus to make an enumerator mark and the pressure of the Petri dish to ensure high logic on the Atmega16 so that the counting starts then the count value is displayed on the LCD screen.

In research conducted by Hamdani (2019), this research improved the colony counter by adding dilution factor parameters and data recording, which can be displayed and stored on a computer by sending data via USB to the TTL PL2303 module. The colony enumerator work system in this tool still uses the observer's eye sensor and the enumeration is still done manually with an electric pen.

In research conducted by Ateş and Gerek (2009), this study aims to detect the number of bacterial colonies that develop in microbiology laboratory Petri dishes. The visible colonies represent the original bacterial population in an aqueous environment. The computer system includes shape-based segmentation and classification algorithms. Colonies (overlapping with amorphous irregularities) are treated as disks and classified into bacterial groups according to their compactness ratio. The system was implemented in Matlab and tested using evidence obtained from the Department of Environmental Engineering, Microbiology Laboratory of Anadolu University, Turkey. This research still has shortcomings because it can only be used to count one type of bacterial colony that is round and circular. The implementation of the tool under study still needs development, such as adding a graphical user interface (GUI), so that it can be used easily by health analysts in the laboratory.

In research conducted by Kis et al. (2019), this study aims to detect and count bacterial colonies. In the medical plasma laboratory of Izmir Katip Celebi University, three types of hospital-acquired infection-causing bacteria, namely *Escherichia coli*, *Pseudomonas aeruginosa*, and *Enterococcus faecalis*, were cultured and examined properly, then detected and counted using Circular Hough Transform (CHT) in MATLAB. To be able to obtain a more practical use, a Graphical User Interface (GUI) was designed. However, this research still has shortcomings due to the use of MATLAB which is propietary and paid. MATLAB is also heavy and inefficient in the use of memory and storage space. Looping operations run

very slowly, even slower than Python, so for high performance you have to directly use matrix/tensor multiplication operations which are abstractly difficult to understand.

In the experiments that have been carried out, it can be concluded that the Colony Counter tool that has been made by previous researchers still has many shortcomings using observer vision sensors and proprietary applications. So, from the shortcomings that exist in the tools that have been made by previous researchers, the author intends to make an Automatic Colony Counter tool with a digital image processing method with a work system based on image processing of bacterial colonies through a program that has been made. Digital image processing is done to improve the quality of human and computer interpretation in medical imaging systems, especially patient diagnosis (Jumadi et al., 2021). Medical imaging analysis is commonly used in the field of radiology, but it is less developed in other fields, especially laboratory equipment. Moreover, digital image processing technology in laboratory equipment can only be found in high-level laboratories or healthcare facilities that have a large budget. This is precisely the space to develop technology through digital image processing on laboratory equipment. This digital image processing method can be applied to the automation of bacterial colony counting. The goal of this research is to create a real-time, automated method for counting bacterial colonies based on artificial intelligence and computer vision.