Chapter 1

Introduction

1.1 Background

Antibiotic-resistant bacteria, or “superbug” are microorganisms that have developed the ability to survive and reproduce after exposure to one or more types of antibiotics that would normally kill or inhibit them (Chandrasekhar et al., 2023). The rapidly increasing cases of antibiotic resistant strains have become a major global public health concern due to the increased difficulty in treating such cases and increased morbidity and mortality of patients. One of the primary causes of antibiotic resistance is the increasing misuse and overuse of antibiotics in both clinical and non-clinical settings, which accelerates selective pressure on bacterial strains (Mittal et al., 2020). Typically, to determine the sensitivity of a bacterial isolate to an antibiotic, the Antibiotic Susceptibility Test (AST) is used (Chen & Hong, 2021). There are several different AST methods that are in use for the rapid testing of antibiotic resistance in a given sample; these methods include MALDI-TOF MS and Automated AST methods, such as VITEK 2 (Mitchell & Alby, 2017). However, conventional AST methods, specifically the Kirby-Bauer disc diffusion method, remain one of the most commonly employed approaches due to their low-cost, simple, and flexible method to assess the resistance of a bacterial isolate to antibiotic exposure (Welker & van Belkum, 2019). The Kirby-Bauer disc diffusion method works by placing antibiotic-impregnated paper disks onto the surface of a Mueller–Hinton agar plate that has been uniformly inoculated with the test microorganism (Emrah Gullu et al., 2024). As the antibiotic diffuses radially outward from the disk into the agar, it establishes a concentration gradient that inhibits bacterial growth in a circular region surrounding the disk, known as the inhibition zone (Emrah Gullu et al., 2024). The radius of this zone is measured and interpreted according to CLSI guidelines to classify the microorganism as susceptible, intermediate, or resistant to the tested antibiotic.

However, despite its simplicity, low cost, and widespread use, the Kirby-Bauer method can be challenging to implement when testing a large number of bacterial samples. In laboratories with a high volume of samples, manually identifying, measuring, and interpreting the inhibition zones of large numbers of Petri dishes can be time-consuming and labor-intensive (Emrah Gullu et al., 2024). Furthermore, the manual nature of the processes is susceptible to variables such as human error, particularly in cases where inhibition zone boundaries are unclear or when measurements are done inconsistently. Thus, such limitations can compromise the result and accuracy of the AST and reduce overall laboratory efficiency. To address these challenges, this project focuses on the development of an automated algorithm that is capable of identifying, measuring, and analyzing inhibition zones on petri dishes used in the AST assay. The project is going to utilize computer vision-based detection by training a YOLO (You Only Look Once)-based artificial intelligence (AI) to detect and analyze inhibition zones from user-provided images of petri dish results. By automating the detection and analysis process, the project aims to reduce manual workload and improve accuracy and consistency to minimize the likelihood of false or subjective interpretations.

1.2 Objective

To create an AI-based object detection algorithm by training an image detection AI model, YOLO26, using a database of AST obtained from clinical trials that utilizes the Kirby-Bauer method. Evaluate the model's performance by evaluating its confusion matrix, recall metrics, and F1 score to determine the model’s accuracy and reliability.

1.3 Hypothesis

It is hypothesized that the trained YOLO26 AI model would be able to reliably and accurately identify and measure the radius of inhibition zones found in images of the Kirby-Bauer test method with a mean error of below 2 millimeters.