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DEVELOPMENT OF OPEN-SOURCE ROBOTIC COMPUTER-BASED SYSTEM FOR AUTOMATIC COUNTING OF LACTIC ACID BACTERIAL COLONIES

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Abstract

Counting bacterial colonies is an important step in performing a variety of biotechnological analyses. There are several approaches to counting bacterial colonies according to the types of growing medium and all of them can be classified into three main groups - manual, semi-automatic, and automatic. Manual approaches to counting bacterial colonies are time-consuming and subjective. This method requires manually labeling and counting each colony using a marker on the Petri dish. Semi-automatic methods are faster because a specially developed device is used which uses a digital pointer and a special touch display to mark each colony and count it automatically. Although counting error is minimized with this method, manual marking of each colony remains a time-consuming operation. This research aims to develop an open-source robotic computer-based system that provides techniques for automatic positioning of Petri dishes using a robotic arm, scanning the surface of each Petri dish, and counting bacterial colonies based on object recognition methods.

For this research, an open-source Selective Compliance Assembly Robot Arm (SCARA) with 4 degrees of freedom is used and several sets of Petri dishes with fully grown lactic acid bacterial colonies are analyzed using digital image processing methods implemented in a specially developed standalone software with graphical user interface. The body of the robotic arm is printed using a 3D printer and assembled with all mechanical and electrical parts. The control and training of the robotic arm are conducted using Arduino Uno microcontroller and open-source software with GUI. To test the efficiency of the proposed system the time required for performing the two approaches - manual counting and automatic counting is measured. In addition, the accuracy of counting bacterial colonies of both approaches is examined.

A set of agar plates is analyzed using two approaches - an automatic computer-based with a robotic arm and a manual one. Each agar plate contains a different number of colonies with varying sizes. The results show a significant improvement in the time needed to count the bacterial colonies using the developed automatic system. In addition, an absolute error ΔA is calculated, and after processing the data a relative error is calculated too. The results show that the errors calculated after performing the automatic counting process are close to the ones obtained with manual counting.

In conclusion, an open-source robotic computer-based system for the automatic counting of bacterial colonies has been developed. The proposed system shortens the time required for colony counting and improves efficiency in performing biotechnological analyses.

***Key words**: Robotics, Digital image processing, Colony counting, SCARA robot.*