Laser speckle imaging system for evaluation of antimicrobial resistance

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Bacterial resistance due to widespread of use of antibiotics is a serious problem for modern medicine as common bacterial species have become insensitive to traditionally used antibiotics. In case of infection, the appropriate treatment must be determined as quickly as possible. This can be achieved by testing the specific pathogen for susceptibility to several antibiotics at the same time in a laboratory. Recently, this issue has become relevant in the treatment approach of COVID-19 patients as severity of disease is strongly related to presence of bacterial coinfection [1]. Finding the effective antibiotic treatment quickly is crucial to reduce mortality of patients and to avoid the formation of new antibiotic-resistant bacteria due to preventative antibiotic use. Currently utilized “golden standard” methods, namely, disk diffusion and E-test require 16-24 hours to conduct [2]. In severe cases such as in case of sepsis these hours may be of great importance in the course of disease and risk of mortality.

Laser speckle imaging is a method that applies reflected laser light, creating a speckle image when it is reflected off a surface. The changes of the speckle image can be tracked to determine movement of very small objects on the surface such as cells and bacteria. It has also been demonstrated that laser speckle imaging is an improved method of bacterial growth measurement over traditional laboratory methods [3].

However, a specific device design must be developed to make the method compatible with the laboratory setting in which antibacterial resistance is tested. Our proposed device contains a laser diode for illumination, a low cost 10 MPix camera, embedded processor and an objective lens. The wavelength of the laser diode will be chosen depending on the light sensitivity of the specific bacterial species to avoid photobiological interaction between the laser light and the bacterium. The device will be compatible to use with standard Petri dishes used in the local bacterial testing laboratories. The CMOS camera is used for continuous video recording of the laser speckle image. The captured video will be analyzed in real-time to detect growth of the bacterium, if it is resistant to the tested antibiotic. Analysis is conducted using previously developed image processing algorithms.

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