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Development of an IoT based automated colony counter

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Microorganisms are small-sized organisms that cannot be seen without a microscope. They grow on solid media as colonies. A colony is defined as the visible mass of microorganisms originating from a single mother cell. Recent studies have shown that temperature, humidity, time, and many other factors affect the growth of microorganisms. Scientists use incubators which are insulated enclosures to regulate humidity, temperature, and other environmental conditions at optimal levels for the growth and reproduction of microorganisms. When considering microbiological research, most depend on an accurate count of bacterial and fungal colonies. Colony forming unit (CFU) is indispensable in estimating microbial content, measuring cytotoxicity, and functions of specific genes. Therefore, researchers have to enumerate these colonies manually. Traditional manual methods are time-consuming, tedious, and error prone. A colony counter is an instrument used to count microbial colonies on a petri dish. Some automated colony counters based on image processing techniques are already available in the market. Not only that, some researchers have developed algorithms and methods to enumerate the microbial colonies count. However, in all these colony counters, researchers have to move the petri dish to the colony counter from the incubator to count the colonies. When researchers want to enumerate colony counting several times, it is subjective, and the changing environmental conditions have highly affected the growth of microorganisms and the final result of research. Therefore, this paper introduced an IoT-based automated colony counter that can place inside the incubator as well as enumerate and upload colony counting data to a web server (Google Drive API and Google Sheet API) in real-time using an IoT-based (WIFI) ESP32 camera module and video processing (OPEN-CV Python), with interfaces (PyQt5) using the laptop-computer to evade the problems mentioned above. The 3-D model of the counter was designed using CAD software and printed using the 3-D printer with PLA material. This device is the world's first real-time updating IoT-based automated microbial colony counter that can be placed inside the incubator with a dedicated application for distanced monitoring. The accuracy of the novel colony counter was above 95% in identifying and counting colonies and it is more accurate compared with the manual colony counters.

Keywords: Colony counter; IoT; IoT-based automated microbial colony counter; OPEN-CV; Video processing