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Entitled

ENHANCED LABEL FREE NORMAL AND CANCER CELLS CLASSIFICATION USING COMBINED PARAMETRIC MODELING AND OPTICAL TECHNIQUES

by

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Date & Venue

11:00 AM

Thursday, 30 January 2020

Room 2022, F1 Building

Abstract

Development of label-free methods for cell classifications has been driven by the importance of early detection and identification of cancer disease. The future point-of-care (POC) treatment methods require rapid and real-time cancer screening techniques. As the labelled methods of cell classification are time-consuming process and require large amount of sample preparation along with skilled persons, they do not appear to be suitable for POC treatment methods. This necessitates the importance of such development. The label-free methods incorporate the biophysical properties of cells instead of biomarkers. The optical properties of cells have been frequently utilized for cell classification. This is due to their capability to interact with light. This interaction depends strongly on intrinsic properties and composition of cells. Cells from different tissues as well as normal and cancerous of same tissue exhibit different optical profiles. Therefore, the objective of this work is to combine the optical techniques with numerical methods to enhance the accuracy in classifying different type of cells. The variation in light interactions with different type of cells is studied and the observations are further analyzed using numerical methods. Prony and autoregressive (AR) techniques are used to extract set of parameters such as poles and coefficients, to enable cell classifications. For demonstration, six types of cells: lung normal, lung cancer, liver normal, liver cancer, kidney normal, and cervical cancer cells are considered in this work. Their corresponding optical signals have been measured. The measured signals are then estimated and approximated using Prony and AR models. It is shown that the variation in the extracted poles and coefficients for different type of cells form a vital tool in cell classification enhancement. Statistical tool such as analysis of variance (ANOVA) helps in determining the significant AR coefficients. The results revealed that the poles obtained through the prony method for different cells differ in their magnitude and location. A figure of merit (FOM) is developed and adapted here which correlates the magnitude and location of poles. It is found that the distribution of FOM in complex z-plane is closer to the center of the unit circle for normal cell lines than for cancer cell lines taken from the same tissue. Furthermore, the AR model of same order for different types of cells exhibit different coefficient and pole values. To reduce redundancy and to arrive with a concise AR model (order optimization), ANOVA analysis has been used to determine the significance in the AR coefficients. After that, the dominant poles have been determined. With optimizing the order, the differences in the pole values of normal and cancer cell increases, enabling cell classification enhancement. This shows the role of statistical tools is a further enhancement for better accuracy of classification. The findings of this work form the foundation stage in the domain of cell classification for early detection of diseases like cancer.

Keywords: Analysis of variance (ANOVA), autoregressive (AR), cancer, cell classification, figure of merit (FOM), optical, prony.