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作品名稱　**Potential Diagnosis of Cancerous Cells Through Utilising Optical Spectroscopy**

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關鍵詞　**Cancerous Cell, Optical Spectroscopy**

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Abstract

Cancer is responsible for an estimated 9.6 million deaths in 2018. Deaths from cancer worldwide are projected to reach over 13 million in 2030. Thus, developing a device that has the capability to solve today's toughest global challenge is crucial by utilizing a simple yet robust approach - "SEEING THE UNSEEABLE" through bold innovation. Although removing cancer is much more effective than either radiation or chemotherapy, when unseen residual cancer cells remain, they could grow back into tumour overtime. The reoccurrence of cancer contributes to a greater risk of death. Hence, launching a system that is able to distinguish between the cancerous cell and normal cell is ultimately essential to make sure no cancer is left behind during surgery. This robust optical system is established with quantitative approach by exploring the integration of an algorithm into the developed software. The end result of this device has the capability to provide users an accurate numerical pH value. The developed system is integrated with the smart IoT gateway capability whereby this powerful analytical device is incorporated with the real-time monitoring, data transformation and data analyzer. Harnessing the power of technology lets us fight cancer better. Each time a pathologist analyzes tissue after operation, it can take up 2 to 3 days because the tissue has to be frozen, thinly sliced, and stained so it can be viewed under the microscope during the process of biopsy. Thus, it is crucial to invent this Surgeons' VisionMetric device which has an IoT-based microcontroller that is capable of providing real-time numerical value on-site.

1.0 Introduction

1.1 Motivation

A nine-month-old girl whose tumour has regrow after the 1st surgery, travelled all the way from Malaysia to UK to remove a tumour from her mouth at London Hospital. Knowing that her condition was improving, her parents were relieved. Unfortunately, doctors mentioned that it requires them a month or even longer to monitor the girl as they want to make sure that the tumour doesn't grow back again.

It was such a disappointment to know that this child, who was an infant, is suffering from illness and even high risk of death. My greatest wish is to be able to reduce the pain that patients and their families may suffer in the treatment of cancer by make sure that all cancer cells or tumour are removed completely during the surgical process.

1.2 Problems Faced & Product Significance.

Although cancer survivors are considered in remission but the fear is there that it will come back. This is due to the fact that, when unseen residual cancer cell remain, they could grow back into tumour overtime. This reoccurrence of cancer cell may contribute to greater risk of death. Thus, launching a system that is able to distinguish between the cancerous and healthy cell is ultimately essential to make sure no cancer is left behind during surgery.

It is undeniable that cancer is responsible for an estimated 9.6 million deaths in 2018. These deaths from cancer worldwide are projected to reach over 13 million in 2030. Hence, developing a device that can solve today's toughest global challenge is crucial by utilizing a simple yet robust approach - "SEEING THE UNSEEABLE".

Complexity of spectroscopic data that can only be analyzed by trained personnel and the limitation of current methodology which unable to provide quantitative measurement, proves that

upcoming revolutionary system utilizes cloud based platform and applies Artificial intelligent technology to promptly identify RGB value of every pixels has to be invented.

2.0 Objectives

There are brilliant solutions for these problems quoted above. In order to ensure surgery are safer & more effective, I developed a novel portable optical spectroscopy device that empowers the surgeons with cancerous cell detection proficiency by shortening the time of accessing the cancerous cell which required removal by pathologists & surgeons during the operation. Moreover, it is truly crucial to establish a robust optical system with quantitative approach by exploring the integration of an Algorithm into the developed software that is capable of providing users an accurate numerical pH value. By integrating the developed system with the smart IoT gateway, this powerful analytical device is incorporated with the real-time monitoring, data transformation & data analyzer.

3.0 Design & Architecture

3.1 Conceptual Framework of Surgeons' VisionMetric (Surgeons' VM)

Surgeons' VM consists of 2 main frameworks: Non-invasive pH Sensing Analyser and Computational Imaging Recognition System (Figure 1).

The Novel Contactless Spectroscopy is a conceptual framework of Surgeons' VM which is adhered to distinguish & monitoring configuration as well as providing reproducible & quantitative results. On the other hand, the Biomedical Visual System is coupled with acquisition & analysis of the RGB value principle.

When 2 systems are joined together, this synthesize an ultimate, robust Surgeons' VM that has capability of utilizing cloud-based informatics platforms to present a practical way to handle big data,

using the cloud to allow essentially unlimited data storage and sharing. Surgeons' VM is developed using machine learning (ML) approaches, and it is likely that major developments in personalized treatments will come from taking data stored in cloud-based platforms and applying artificial intelligence (AI) technology to quickly identify patterns and trends.

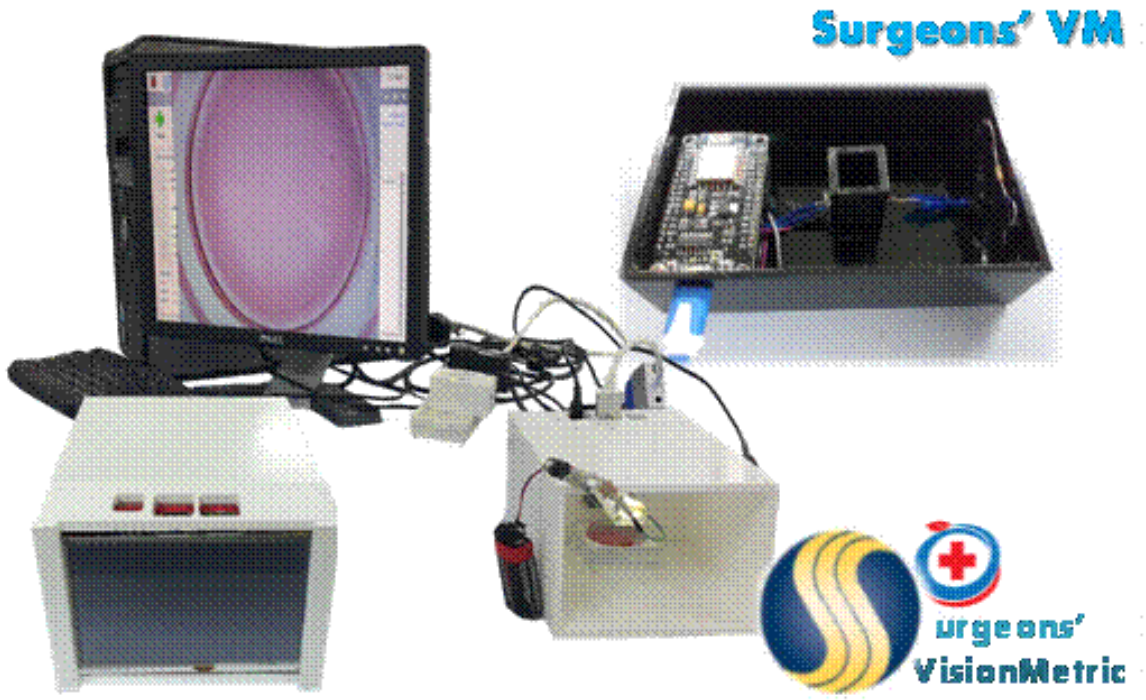

Figure 1: Conceptual Framework Surgeons' VisionMetric

Python is the platform that was used to computerize the system to be able to create Red, Green and Blue colour bands of the Image. This Biomedical Imaging Recognition is computed and able to plot the RGB colour band Histogram through the algorithm implemented in our Computational Imaging and Vision System.

In the algorithm, we have to subtract & divide the Red segment from the Green segment picture to remove the blue segments in the picture. With these data, the system will profile the range of RGB value and determine the type of pH value of the cancerous cells in the solution.

It is clear that the more data obtained from the researches, the more capable and intelligent the system is able to distinguish between cancerous cells and normal cells.

Data is what fuels this research, which is why it is pledged to use big data to its fullest to develop Surgeons' VM. NodeMCU was utilized in the system to act as a communication protocol to upload all collected data as JSON into the Firebase Cloud which synchronized in real-time to every connected client. The developed App has potential for real-time monitoring of pH value, storing data as well as no limitation acquiring patients' historical measurements from the database.

4.0 Research Methodology

4.1 Proof of Concept: Quantifying the pH level of Phenol Red

A series of research & development were done to invent Surgeons' VM. The absorbance spectroscopy measurement of cultured normal and cancerous cell lines was conducted using a QE65000 spectrometer in the visible and near-infrared region. Fibre optic cables were used as an optical interface to find the correlation between the absorption of Phenol red & wavelength of Tungsten Halogen light source (HL 2000) using Ocean Optic Software. Other custom setup prior to the experiment includes integration time = 35 ms, scan to average = 10 and boxcar width = 1.

With the regression analysis of interconnection between the pH level of Phenol Red solution, the absorption of light proves that primary investigation of visible absorption spectroscopy is established.

4.2 Design ,Device fabrication & Circuit Development

Through the analysis of the pH level of Phenol Red, the most competent wavelength which is 557nm is discovered. Surgeons' VM is constructed with TSL12s photodiode as a detector which has the capability of detecting the light that penetrates through the Phenol Red solution & Green photo emitter

with the wavelength of 560nm as a light source. The resistor within 33K ohm is explored to aid in changing the light intensity whereas sensors are constructed and localised by referring to the absorbance method (Beer Lambert Law)

4.3 Establishment of a Mathematical Algorithm

The preparation of samples with different pH buffer in cuvette is needed for establishment of algorithm which relates the pH value & reflective index of Phenol Red. After the first experiment, reproducibility test is conducted thereafter. The final Mathematical Algorithm is integrated into the developed software in order to collect raw data which processed according to the algorithm for accuracy & quantitative pH value validation.

4.4 Formulate an Analytical Approach to Distinguish Cancerous Cell & Healthy Cell

In order to establish an analytical approach to differentiate the cancerous & normal cell , series of contemplated experiment is designed by cultivating cancer cells in the Phenol red which contains a medium for it to grow. The extraction of the Phenol red from the cancer cell is then place in the cuvette for validation tests that are accomplished by deploying the invented system to perform quantitative analysis of a set of difference of pH value between cancerous cell and normal cell.

5.0 Experimental results

5.1 Visible Absorbance Spectra of Phenol Red

Since the colour change of phenolphthalein medium is within red colour visible light ranging from 635nm - 700nm, it is very obvious that there is a significant peak absorbance of 557nm wavelength (Figure 2).

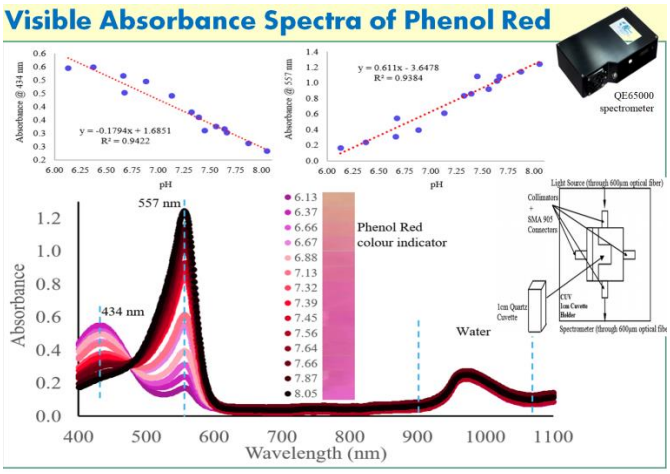

Figure 2: Visible Absorbance Spectra of Phenol Red

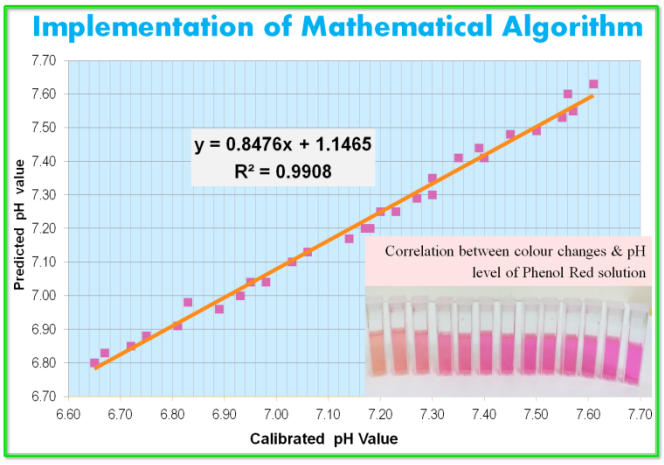

Figure 3: Establishment and Implementation of Mathematical Algorithm

5.2 Establishment and Implementation of Mathematical Algorithm

In order to establish the calibration algorithm, we did a few experiment to find the equation for relation between pH value & ADC value of photodiode as well as embed it into the code. We then implement the Mathematical Algorithm and compared the system data output of pH level with calibrated pH level. The result seems to show the preciseness of our developed system algorithm (Figure 3). The coefficient of determination R2 & slope of regression are used as distinctive spectral signature to differentiate between cancerous, healthy cell & phenolphthalein medium.

5.3 One way ANOVA: ADC Value (Volt) vs. pH value (calibrated)

Utilizing Anova analysis technique, proves the stability of our concept and ensure that system is reliable. From the analysis, I can infer that Surgeons' VM had the confidence level of 95% and has the potential capability to undergo non-invasive determination of pH value in the solution utilising near-infrared spectroscopy technique (Figure 4).

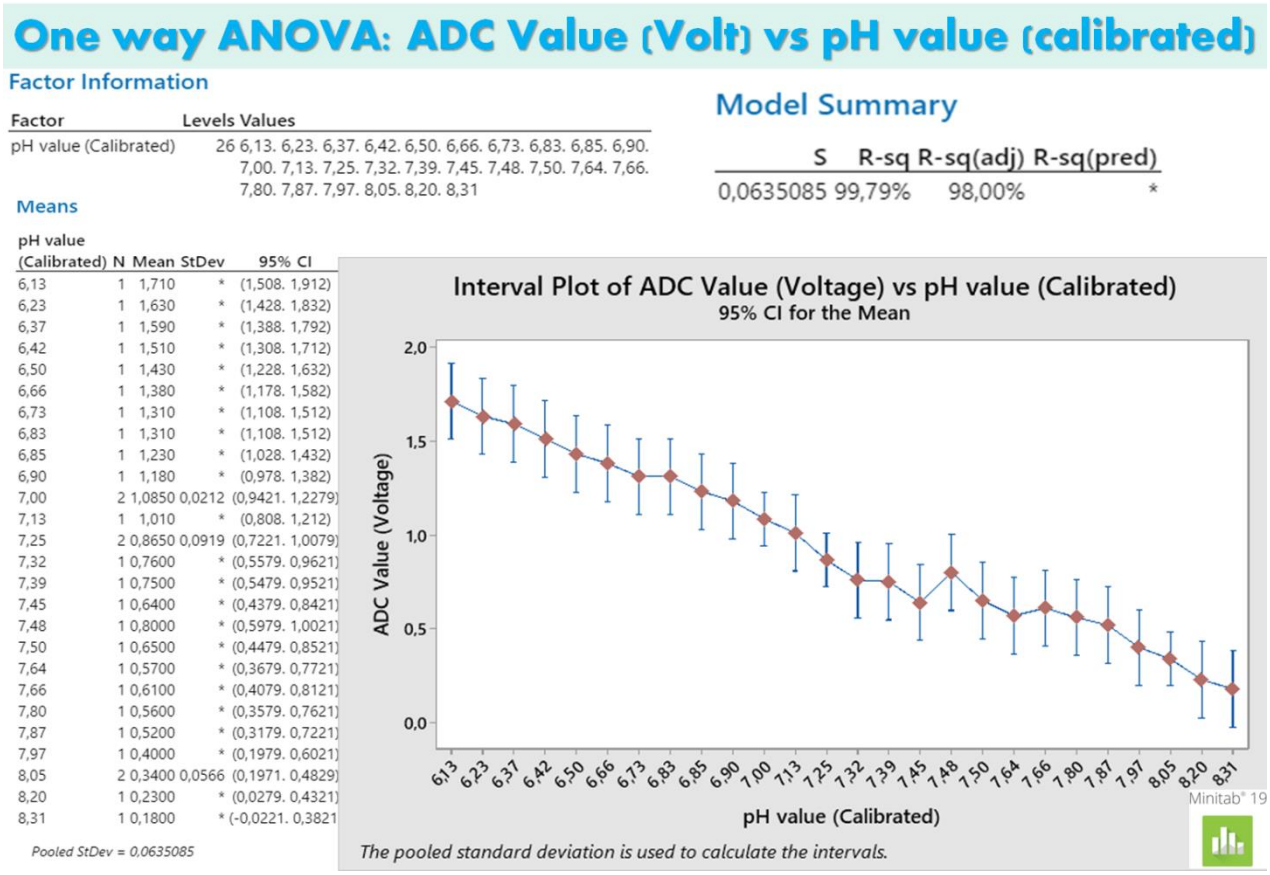

Figure 4: One way ANOVA: ADC Value (Volt) vs pH value (calibrated)

5.4 Analysis of Cell Population Density

Minitab is used to plot histogram in order to obtain a significant difference is RGB values of each pixel in different cell lines. From these graphs, we can infer that there is a huge gap between RGB values of each particular cell lines which reflects the population density of the cells (Figure 5).

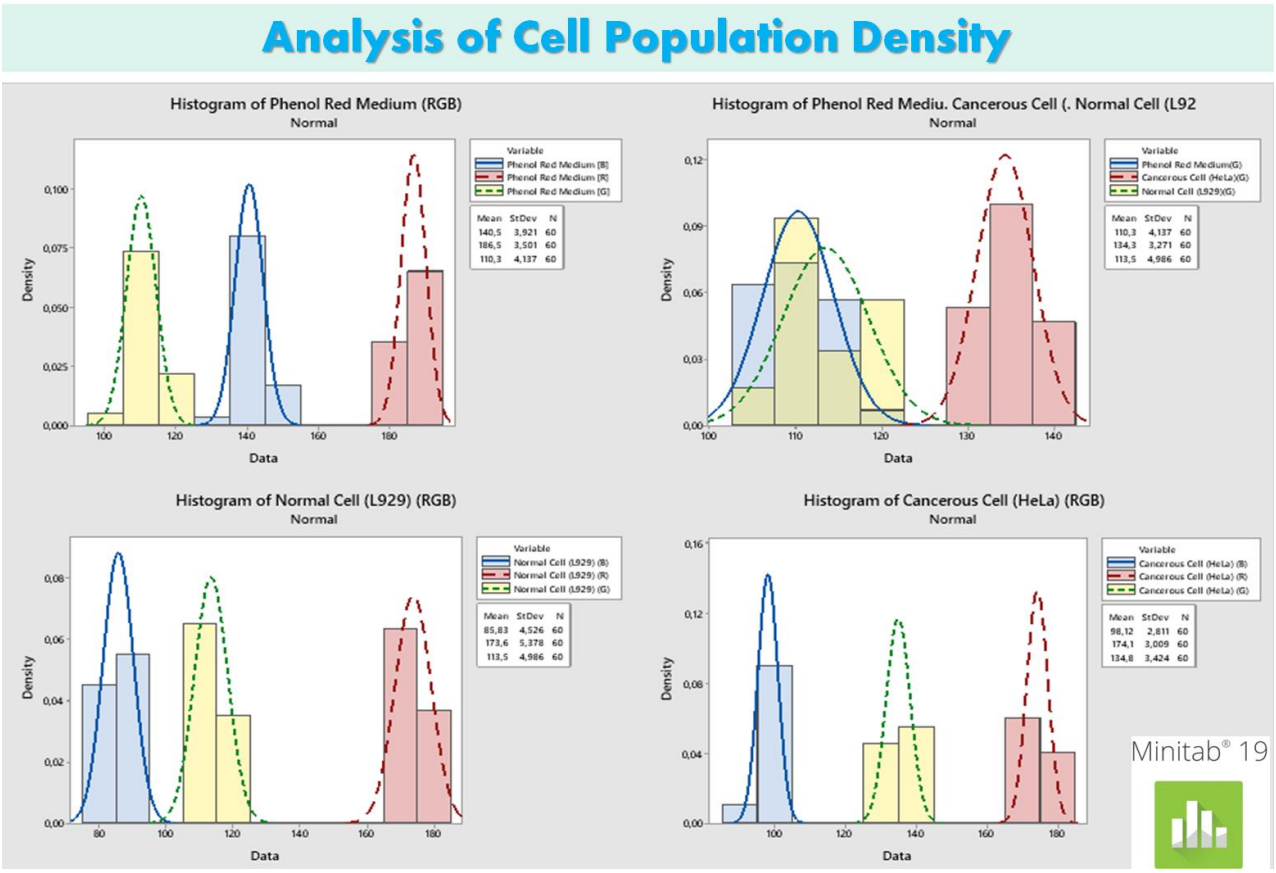

Figure 5: Analysis of Cell Population Density

5.5 Subtraction & Normalization of R & G value

Subtraction and normalization of R and G value will allow us to get more accurate RGB value and increase the drastic difference in the value. From the graph, the sequences of types of cells actually tally with the arrangement in pH value. Cancer cell which is in red colour reflects the acidic ph value, whereas the normal cell is between neutral and alkaline pH range (Figure 6).

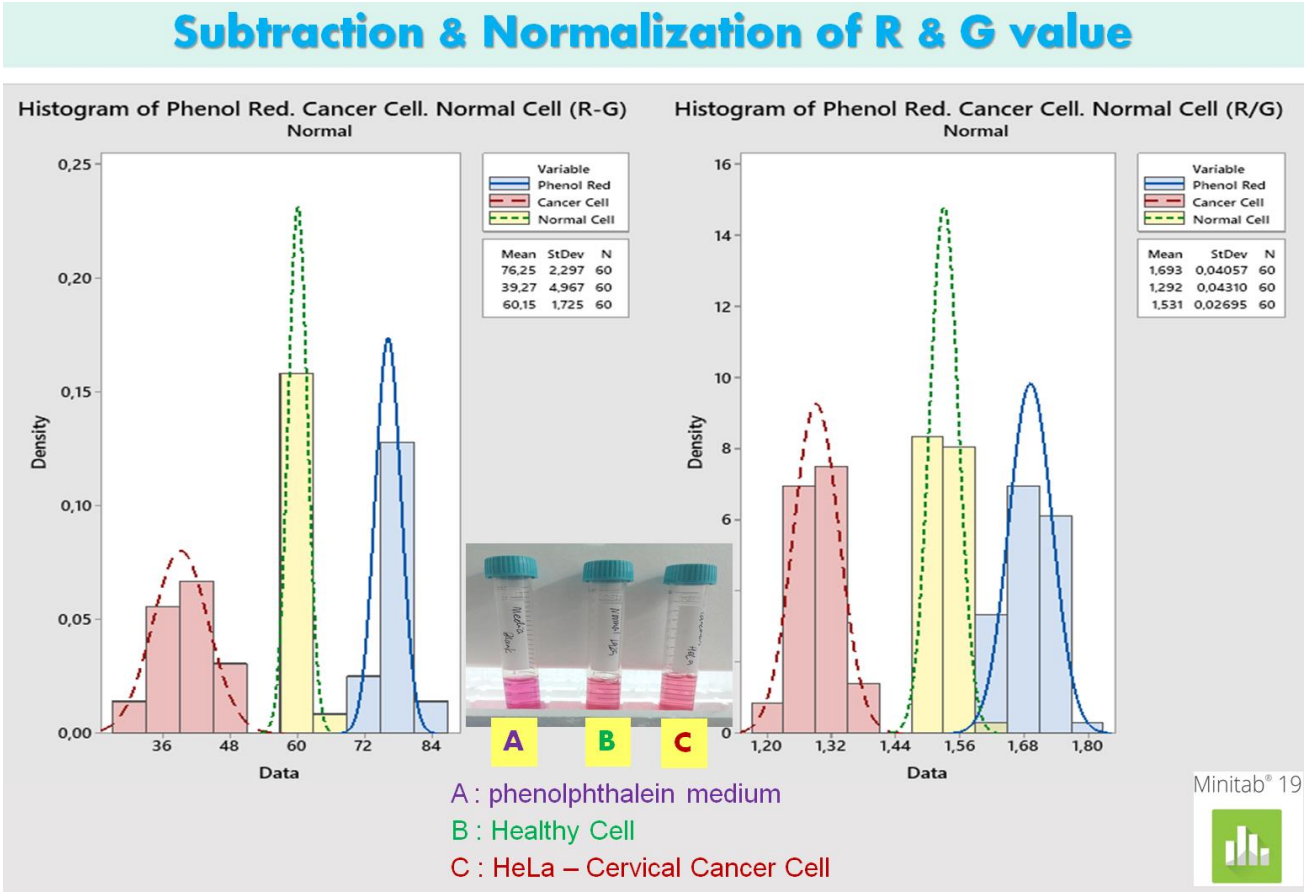

Figure 6: Subtraction & Normalization of R & G value

6.0 Product Marketability

6.1 Impact of Surgeons' VM Towards the Society

It is ascertain that this upcoming new product will possess tremendous marketability and its product commercialisation opportunity will have stupendous growth globally.

This device is able to facilitate the surgeons with cancerous cell distinguishment competency, ease researchers during experimental study by providing quantitative result & ensure that swimming pool maintenance no longer require technical team to justify the pH level based on visual comparison of colour scheme. Instead, numerical output and real time triggering of the maintenance period will be made available.

7.0 Conclusion

Research and development have been conducted to invent Surgeons' VM. It has proven that Surgeons' VM is the 1st Revolutionary optical device that has Web application based on Iot programming competency yet cost effective. To stress out more, the capital intensive, limitation and complexity of ordinary instrument has shown that this portable, standalone system which is feasible to utillize the device on-site is crucial. Surgeon's VM is also the 1st Invention with the cancerous cell detection proficiency by providing quantitative & reproducibility result.

【評語】090030

The author aimed to establish a novel portable optical spectroscopy device to distinguish cancerous cell from normal cell. Moreover, the authors also establish a robust optical system with quantitative approach by exploring the integration of an Algorithm into the developed software that is capable of providing users an accurate numerical pH value.

1. It is very difficult to distinguish cancer from normal cells by PH since the PH value depends on many other factors.
2. It is better to select the cancer markers to distinguish of cancer from normal cells.