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Research Report

TUBERCULOSIS COUNTER (TC) AS THE EQUIPMENT TO MEASURE THE LEVEL OF TB IN SPUTUM

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ABSTRACT

Tuberculosis (TB) is an infectious disease caused by Mycobacterium tuberculosis. This disease is the third killer disease after cardiovascular diseases and respiratory diseases, and is also he number one killer disease in a group of infectious diseases. This is partly due to the late handling and a non real time detection, both of which will inhibit the therapy which yields a large number of microorganisms in the body, and will eventually complicate the recovery. Based on this phenomenon, we offered an alternative solution for detecting the sum of microorganism using Tuberculosis Counter, a tool used to count the number of Tuberculosis bacteria in the patient's sputum. Technically, the patient's sputum preparat was screened using the TCS230 color sensor that was able to filter the color of the preparat. Tuberculosis bacteria in the stained sputum Ziehl-Niellsen preparat was colored red, while the other was colored blue. By utilizing these optical phenomena, the TCS230 color sensor was supposed to filter the red color in the preparat. By using regression equation measurement, we gained the equation which then correlated the bit value as an output of the sensor with the number of Tuberculosis bacteria. Then, the digitalization process yielded the real time and accurate data of Tuberculosis bacteria.

Keywords: *Tuberculosis, Ziehl-Nellsen staining, TCS230 color sensor, counter of bacteria, sputum*

ABSTRAK

Latar Belakang: *Tuberkulosis (TB) adalah penyakit menular yang disebabkan oleh Mycobacterium tuberculosis. Penyakit ini adalah penyakit pembunuh ketiga setelah penyakit kardiovaskuler dan penyakit pernafasan, serta nomor satu penyakit pembunuh dalam kelompok penyakit menular. Hal ini disebabkan sebagian karena penanganan yang terlambat dan tidak mampu mendeteksi masa inkubasi secara tepat Hal tersebut dapat menghambat terapi, sehingga jumlah mikroorganisme dalam tubuh tinggi sehingga mengakibatkan sulitnya pemulihan.* ***Tujuan;*** *Menciptakan alat untuk menghitung jumlah bakteri TBC dalam dahak penderita.* ***Metode:*** *Secara teknis, para preparat dahak penderita akan diputar dengan menggunakan sensor warna TCS230 yang mampu menyaring warna preparat tersebut. Tuberkulosis bakteri dalam preparat Ziehl-Niellsen dahak bernoda akan berwarna merah, sementara yang lain berwarna biru. Dengan memanfaatkan fenomena optik, sensor warna TCS230 akan disaring merah dalam preparat menggunakan gejala optik TCS230 sensor warna akan menyaring warna merah di preparat tersebut. Menggunakan pengukuran persamaan regresi, akan memperoleh nilai persamaan yang akan berkorelasi sebagai output dari sensor dengan jumlah bakteri Tuberkulosis. Kemudian proses digitalisasi akan menghasilkan real time (masa inkubasi) dan data yang akurat dari bakteri Tuberkulosis.* ***Hasil:*** *Prototype alat penghitung jumlah bakteri TBC dalam dahak penderita.*

Kata Kunci: *Tuberkulosis, Ziehl-Nellsen pewarnaan, TCS230 sensor warna, counter bakteri, sputum*

INTRODUCTION

Tuberculosis (TB) is an infectious disease caused by *Mycobacterium tuberculosis*. *World Health Organization* in 2005 estimated that the number of TB patients was 8,8 million and 1,6 million of them ended in death. TB itself is placed the third among diseases in Indonesia after cardiovascular and airway canal diseases and the first among diseases which cause death in the type of infectious diseases. Indonesia itself is the third country with most TB problems in the worlds, with the death number of one person every 5 minutes. In 2004, 211.753 new cases of TB in Indonesia had been noted and approximately 300 deaths due to TB every day were also noted. New cases of TB in Indonesia always rise to 250 million cases per year.[1]

Based on the TB combat program in Middle Java, it has been shown that the number of TB case findings in 2006 had not reached the target which was 53%.[2] Many kinds of TB therapy have been used including routine standard therapy based on the Ministry of Health's program. But somethimes the therapy do not work well due to a variety of reasons, one of the main reasons is people's poor knowledge of TB. It was considered that even though the therapy has been taken for a long time, the disease has not been cured yet.[11] Long therapy would pase a big physiological pressure to the patients. The patients would feel worried that their disease would never heal or become even worse. This excessive anxiety would also trigger other diseases to occur.

Based on the observation of the case handling which was focused on unspecified physical symptoms in patients, we offer *Tuberculosis Counter* (TC), a diagnostic tool which is capable of counting the number of TB bacteria in sputum in order to provide data of the TB degree of severity so that the clinicians could diagnose the disease in *real-time condition*. By using Ziehl-Nellsen staining in patient sputum, the red one produced by Acid Fast Bacillus (AFB) was filtered and processed digitally then and yielded *real-time* and *up-date*.

MATERIAL AND METHOD

Tuberculosis is on infectious disease which attacks lungs, and caused by *Mycobacterium Tuberculosis*. *Mycobacteria* are aerob bacteria, rod-shaped, and have no capability to produce spores. They are difficult to be colored. If these bacteria have been colored, They will stand to laxative color such as acid or alcohol. There fore they are called acid-resistant bacteria or acid-resistant basil.[3]

TCS230 color sensor is a chip color sensor which works by conversing the acceptance of light emission from certain colors in the form of frequency. TCS230 color sensor is composed of 2 main parts which are acceptance light parts in the form of array photodiode and light converter to frequency. In general, TCS230 color sensor is a light sensor which is complemented with a light filter for basic color RGB (Red-Green-Blue) and a light sensor without a filter in 8 bit scale in each sensor part. Photodiode in TCS230 color sensor extracted the current of which the magnitude of the flow is comparable to basic color of light overwriting. This current then was converted into a pulse shape with a frequency comparable to the magnitude of the current. The output frequency of the TCS230 color sensor could be made as a scale by arranging data configuration S0 and S1 in selector pin S0 and S1 of TCS230 color sensor.[4]

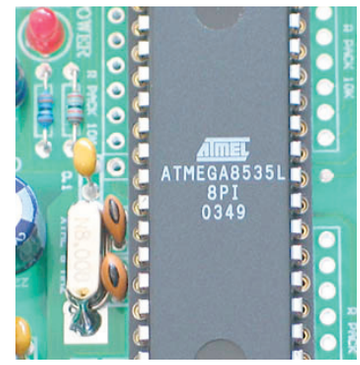

Figure 1. TCS230

Figure 2. IC Microcontroller

Microcontroller is a digital electronic equipment which has on input, on output and a controller with a program which could be written and deleted with special manners. Microcontroller is a computer inside a chip which could be used to control electronic equipment so that it could be efficient and effective in cost. Electronic system usually needs many supporting components such as IC, TTL and CMOS. It could be reduced or minimized. It also has been focused and controlled by this "tiny controller" so that this electronic system could be compendious, faster, easy to modify and the distraction finding could be easier because the system is compact.[5]

RESULT AND DISCUSSION

The making process of the *Tuberculosis Counter* equipment prototype took two months. In the preliminary study, the literature exploration and the experts' statements, indicated that it had been well known that Tuberculosis

bacteria could be detected chemically using Ziehl-Niellsen staining. Acid-resistant bacteria of TB was red in color and the others were be blue in color. From the optical symptoms, then the screening process using TCS230 color sensor had to be done to count and excute a certain calibration.[6,7] Based on the *image*, it would be difficult to differentiate TB bacteria from other artifact that it needs some special ability regarding sputum staining.

From the instrumentation scheme, the sputum of TB patient which had been coloured by Ziehl-Nellsen method was previewed by the camera in the microscope and then previewed on an LCD. TCS230 color sensor was placed above the LCD to gain color bit value on the LCD.[8] The result of output bit value was produced by the bit plot of the number of bacteria in each viewing area. The plot result was analyzed by regression to gain the regression equation which was converter bit formula of the number of bacteria in each viewing area. The formula was inserted into the chip as on analog data processor from the sensor.[9,10,11]

A conversion was performed to compare output bit sensor with the number of bacteria in the preparat. This conversion was performed by making a plot between two variables so that regression equation which would be used in the chip should be obtained. Calibration test result of this equipment was compared the conventional test. The conventional test was performed by paramedical staff by observing the object inb the microscope and counting them per viewing area whereas this equipment technique had the same procedures as those with a conventional manner. The difference between the two methods was only the bacteria counting manner, which sused sensor and the length of detection time which was shorter than that of the conventional way. In conclusions, the Tuberculosis Counter (TC) equipment utilized the optical symptoms of Tuberculosis bacteria by using Ziehl-Nielssen staining, and the processing utilized TCS230 color sensor. The benefit of the utilization of TB Counter was to provide the real time and accurate data of the number of Tuberculosis bacteria.[12]

REFERENCE

1. Center Data and Information, 2008. Ministry of Health Republic Indonesia.
2. Ronen Basri, David Jacobs, and Ira Kemelmacher , "Photometric stereo with general, unknown lighting," *International Journal of Computer Vision*, 72(3): 239–57, 2007. Preliminary version: *IEEE Conf. on Computer Vision and Pattern Recognition (CVPR-01)*, Kauai, Vol. II: 374–81, 2007.
3. Tirtana BT, Musrichan, 2011. Faktor-faktor yang mempengaruhi keberhasilan pengobatan pada pasien Tuberkulosis Paru dengan resistensi obat Tuberculosis di wilayah Jawa Tengah. Artikel Ilmiah.
4. Graham. J., Kryzeminski, M., and Popovic, Z, 2000.Capacitance based thickness mapping of thin dielectric films. Rev. Sci. Intrum., 71(5).
5. Yoder, J.2000.Coriolis Effect Mass Flowmeters.In: *Mechanical Variables Measurement*, J. Webster, ed.CRC Press, Boca Raton, FL.
6. Skubal, L.R., Meshkov, N.K., and Vogt, M.C.2001.Detection and identification of gaseous organic using a TiO_2 sensor, J.Photochem. Photobiol. A: Chem., 148, 103–8.
7. Smith, J.A., Polk B.J., Kikas, T., and Levermore, D.M. ChemFETs.2000. Chemical sensor for the real world. www.bizoki. chemistry.gatech.edu/janata-chemical-sensor.
8. Dybko, A. and Wroblewski, W.2000. Fiber optic chemical sensor. www.ch.pw.edu.pl/~dybko/csrg/fiber/operating.
9. Del Prete, Z., Monteleone, L., and Steindler, R.2001.A novel pressure array sensor based on contact resistence variation: metrological roperties.*Rev.Sci.Instru.* 72(3): 1548–58.
10 Kawamura A, 2007. Differential Recursion, ACM Transactions on Computational Logic, Vol. V, No. N, 20YY, Pages 1–20.
11. Philiph-Chandy R., Morgan R., and Scully PJ, 2000.Drag force flowmeters. In: Mechanical Variables Measurement, J. Webster, ed. CRC Press.Boca Raton.FL.
12. Pallas-Areny, R. and Webster, J. G.2001.Sensor and Signal Conditioning.2nd edition.John Wiley & Sons.New York.