Chapter 14

Automation in Sputum Microscopy:
A Hybrid Intelligent Technique in Diagnostic Device Automation

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ABSTRACT

This chapter describes an automatic intelligent diagnostic system for Tuberculosis. Sputum microscopy is the most common diagnostic technique to diagnose Tuberculosis. In Sputum microscopy, Sputum are examined using a microscope for Mycobacterium tuberculosis. This manual process is being automated by image processing, where classification is performed by using a hybrid approach (color based and shape based). This hybrid approach reduces the false positive and false negative rate. Final classification decision is taken by a fuzzy system. Image processing, soft-computing, mechanics, and control system plays a significant role in this system. Slides are given as input to the system. System finds for Mycobacterium tuberculosis bacteria and generates reports. From designing point of view ARM11 based, 32 bit RISC processor is used to control the mechanical units. The main mathematical calculation (including image processing and soft computing) is distributed between ARM11 based group and Personal Computer (Intel i3). This system has better sensitivity than manual sputum microscopy.

INTRODUCTION

Tuberculosis (TB) is an infectious disease that is caused by a bacterium called Mycobacterium tuberculosis (Centers for Disease Control and Prevention [CDC], 2014). TB primarily affects the lungs called Pulmonary TB, but it can also affect organs in the central nervous system, lymphatic system, and cir-

culatory system among others. TB is spread from person to person through the air. The TB bacteria are put into the air when a person with TB disease of the lungs or throat coughs, sneezes, speaks, or sings. People nearby may breathe in these bacteria and become infected. If TB is not treated properly, it can be fatal. However, TB is not spread by shaking someone's hand, sharing food or drink, sharing toilet seats, etc. People, who have TB disease, do feel sick, have symptoms, and may spread TB bacteria to others. The active TB disease symptoms are:

- Overall sensation of feeling unwell;
- Cough, possibly with bloody saliva;
- Fatigue;
- Shortness of breath;
- Slight fever;
- Weight loss;
- Pain in the chest;
- Night sweats.

The occurrence of additional symptoms depends on where the disease has spread beyond the chest and lungs. For example, if TB spreads to the lymph nodes, it can cause swollen glands on the sides of the neck or under the arms. When TB spreads to the bones and joints, it can cause pain and swelling in the knee or hip. About one-third of the world's population has latent TB, which means people have been infected by TB bacteria, but they are not yet sick with disease, do not have symptoms and cannot transmit the disease. Persons infected with TB bacteria have a lifetime risk of falling ill due to TB with a certainty of 10%. However individuals with compromised immune systems, such as persons living with HIV, malnutrition or diabetes, or people who use tobacco, have a much higher risk of falling ill. When a person develops active TB disease, the symptoms of cough, fever, night sweats, weight loss, etc. may be mild for many months. This can lead to delay in seeking care and results in transmission of the bacteria to others. People sick with TB can infect up to 10-15 other persons through close contact over the course of a year. Without proper treatment, up to two-third of people, who are ill with TB, will die (World Health Organization [WHO], 2015). The following factors may play a role in promoting active disease in someone who has an inactive TB infection:

- Diabetes;
- Cancer;
- Illnesses that suppress the immune system, such as HIV or AIDS;
- Kidney disease;
- Long-term steroid use;
- Malnutrition;
- Medications that suppress the immune system, such as anticancer medications (e.g., cyclosporine);
- Pregnancy;
- Radiotherapy.

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