Introduction

- **Tuberculosis or TB (Tubercle Bacilli) is a bacterial infection caused by Mycobacterium tuberculosis**
  - Primarily affects lungs & central nervous system
  - Is impartial - can affect any part of the body.
  - Contagious and airborne - cough, sneeze or spit.

- The vast majority of TB deaths are in the developing world.
- 1.7 million people died from TB in 2009, equal to 4700 deaths a day.
Tuberculosis (TB)

- TB infects a third of the world’s population (1.9 billion people), takes two million lives each year, and is increasingly resistant to existing drugs.
- By 2010, 11.6 million will be sick with TB, increase of 45%.
- US$1 Billion is spent on TB tests and evaluations
- Approx US $300 Million is spent on drugs for treatment of TB
- In low and middle income countries around US$326 million annually is spent on TB Diagnostics
- Only 23% of TB patients are currently treated properly.
- Primary and Secondary Health-care networks have no access to microbiology laboratories
- Reduce Mortality Rate due to TB in Developing Countries
- Improve Turnaround Times for TB Detection
- Reduce the Cost of TB Detection
- Non-availability of Accurate Disease Surveillance Data
Objective

- To Provide an Automated TB Detection System / Algorithm that
  - Is Cost Effective - Routine Sputum Smear Test
  - Can be used at a Primary Care Center
  - Does not require sophisticated infrastructure
  - Provides Results Immediately
  - Helps in Screening more people quickly
Current Methods for TB Detection

- **Fluorescence Microscopy**
  - Standard Diagnostic Method
  - Sputum Smears are analyzed
  - Several Image Analysis Techniques have been proposed
  - The segmentation of the mycobacterium uses a threshold operation
  - Requires Lower Efforts
  - The high cost of the fluorescence microscope and its maintenance is not feasible for all the developing countries
Current Methods for TB Detection

- Conventional Light Microscopy
  - Sputum Smears are analyzed
  - Several Image Analysis Techniques have been proposed
  - Requires Lower Efforts
  - The best results achieved by this method so far
    - Sensitivity : 76.65 %
    - Specificity : 12 %
Images from the stained sputum smear are acquired through digital camera from an oil immersion 100x lens.

TB Bacilli Detection Algorithm

- Uses the hue, saturation and intensity (HSI) color model to identify the Bacilli.
- HSI color space renders itself much better for analysis compared to RGB color space.
- Detects the Bacilli inside the sputum smear by applying size threshold and checking neighboring pixel clusters to eliminate the possibility of detecting artifacts over Bacilli.
- Evaluated for acid-fast stained thin smears
- Uses images of resolution as small as 640 × 480
The background and the bacilli have distinct hue components that could be used for detection.

The hue components are studied to arrive at hue thresholds for each of these artifacts.
The hue of the bacilli lying between PH1 and PH2 as shown below is near to dark pink.

By applying these hue thresholds, the background is eliminated.

The image after hue-histogram windowing is as below.
TB Bacilli Detection Algorithm

- The other artifacts found along with bacilli in the sputum smear are removed using saturation components of HSI color space and size threshold.
- The size and saturation thresholds are determined by examining many standard smears by using the intensity and saturation histograms.
- The bacilli lie in the intensity range between 0 and PI4 as shown.
- Using these histograms as shown in figures, the TB bacilli is differentiated from the other artifacts.
The combined application of both hue and intensity histogram windowing gives the results as shown in the Figure and the resultant image contains tuberculosis bacilli.

- The bacilli are perfectly identified as marked in the white box.
- The above marked ROI's are the TB bacilli.
The algorithm is tested with 130 TB positive and 100 TB negative images.

118 out of 130 positive images were positively classified as TB with an Accuracy / Sensitivity of 90.8%.

90 out of 100 negative images are classified as negative and 10 as positive giving a Specificity of 90%.

Both Accuracy and Specificity are higher than the earlier attempts of automating this process.
Conclusions

- This automated system reduces fatigue by providing images on the screen and avoiding visual inspection of microscopic images.
- The system has a high degree of accuracy, specificity and better speed in detecting TB bacilli.
- The method is simple and inexpensive making it suitable for use in rural / remote areas in the emerging economies.
KTwo Products for Rural Healthcare / Remote Healthcare
Kshema Software
✓ Electronic Health Records (EHR)
✓ Collect & Transfer Patient Data
✓ Integrated Disease Surveillance Kit
  ✓ Pathology
    ▪ Differential Blood Count
    ▪ Malarial Parasite Detection
    ▪ Tuberculosis Detection
✓ Vital Signs Monitor
✓ Workflow Management
✓ Knowledge Management

K2-Kiosk Hardware
✓ Intel Embedded Processor (Dual Core)
✓ Keyboard / Mouse / Web-Cam
✓ GSM-GPRS enabled
✓ Powered by Solar Panel & UPS
✓ Microscope with Digital Camera
✓ Vital Signs Monitor
Mother & Childcare Management System

- Integrated Management of Pregnancy & Childbirth - Prenatal & Postnatal Care
- Includes the recommended series of inoculations, monthly weigh-ins, advice on feeding, developmental checkups, detection of hearing & vision problems and health education in general.
- Centralized, electronic patient record for mother and newborn
- Diet, Vaccination / Immunization Management
- Comprehensive Knowledge Management
Personal Health Monitoring System

- Provides personalized, intelligent, non-intrusive, real-time health monitoring.

- Vital signs – Temperature, Pulse, Heart Rate, Blood Pressure, SPO2 and ECG - measured automatically.

- Using Wireless Technologies, the health indicators are routed to a server

- System informs personal physician and medical experts on the health of patient.

- Health Trend Analysis to track personal health.
Thank You
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