MOBILE PHONE-BASED EVALUATION OF LATENT TUBERCULOSIS INFECTION USING DEEP LEARNING

Maclean S., Malila B., Mutsvangwa T., Douglas T.

ABSTRACT

The most common method used to screen for latent tuberculosis infection (LTBI) is the tuberculin skin test (TST). The test requires a follow-up clinical visit 48h - 72h after administration of the tuberculin for measurement of the resultant cutaneous induration. A mobile phone-based imaging application is in development for use as an alternative measurement procedure. Deep learning is being considered to improve the usability and accuracy of the current image processing application.

BACKGROUND

- Tuberculosis (TB) is one of the top 10 causes of death worldwide [1].
- A disadvantage of the TST is the follow-up clinical visit required to measure the induration [2].
- The diameter is most commonly measured using a ball point pen and ruler [3].

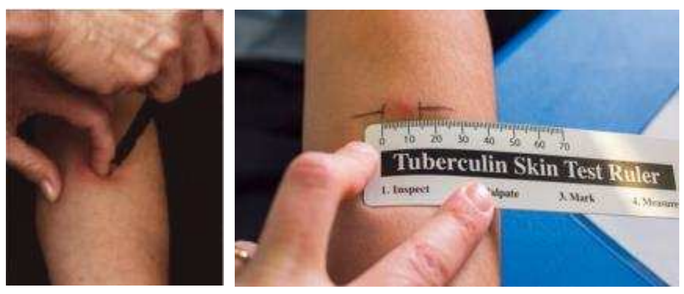

Figure 1: Ball point pen and ruler method of measurement for TST.

- Patients often do not return for the follow up reading leading to lack of diagnosis and risk of further disease progression.

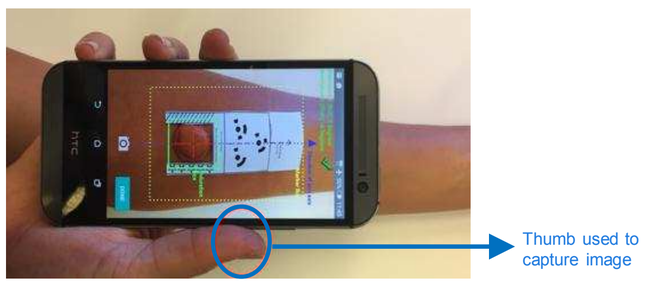

Figure 2: A mobile phone-based solution has been developed and tested in our research group and the results are promising [4].

- The current system requires the patient to send multiple images to a remote processing center leading to increased data costs.
- This has motivated the need for further research into a more cost-effective solution.

CURRENT MOBILE APPLICATION

Developed on the Android platform. It follows this procedure:

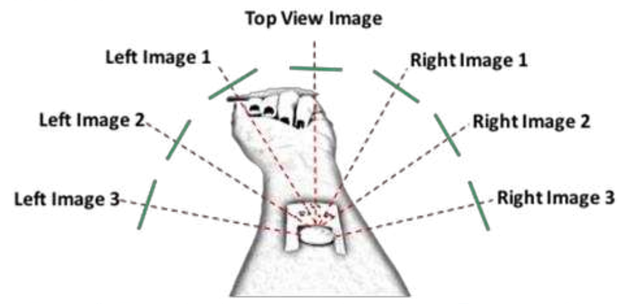

Figure 3: The patient is guided into capturing 7 images of the induration.

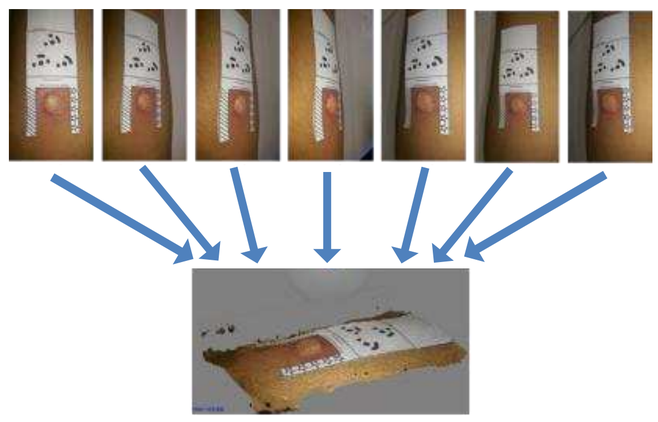

Figure 4: Photogrammetric 2D to 3D reconstruction using Agisoft PhotoScan allows reconstruction of the 7 images into a 3D model.

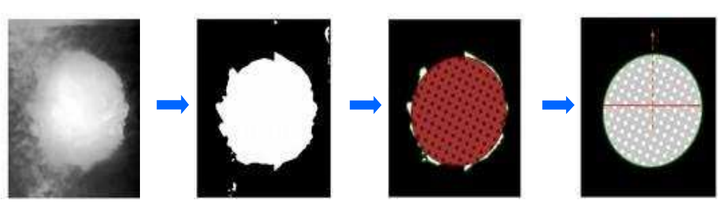

Figure 5: 3D measurement of the width of the induration is done with the aid of functions developed in the Python programming language.

GOAL

Although the current application is a notable advancement in the field, improvements will need to be made before it can be adopted as a viable alternative to the current method used for TSTs.

The aim of this research is therefore to improve the usability of the current application and improve the methods and formulae used to record the final measurement of the induration.

- Deep learning could reduce the number of images needed to do an evaluation from 7 images to a single image, rather than having to undergo the 3D reconstruction process.
- By allowing the neural network to find patterns in the data set, alternative indicators for LTBI could be used alongside the traditional linear measurement approach to enhance LTBI evaluations.

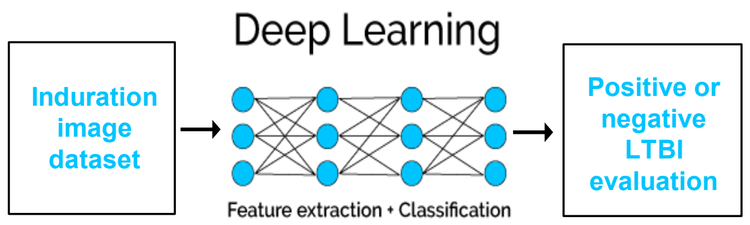

Figure 6: Neural network for the evaluation of induration images during TST.

CONCLUSIONS

- Optimization of the application and improved usability could potentially lead to adoption of the application as an alternative method for assessing the TST response.
- Adoption of the application would eliminate the inconvenience a follow-up clinical visit, increase the number of TSTs done per day and improve the efficiency of TST testing.
- The application may help reduce the overall TB prevalence worldwide by increasing the LTBI testing throughput and ultimately reducing the rapid rate at which TB is spreading through communities.

BIBLIOGRAPHY

[1] WHO, "Global tuberculosis report 2017," WHO, 2017.
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[4] Naraghi, S., Mutsvangwa, T., Goliath, R., Rangaka, M., Douglas, T., "Mobile phone-based evaluation of latent tuberculosis infection: proof of concept for an integrated image capture and analysis system." Computers in Biology and Medicine (in press).