

INTRODUCTION

Neglected Tropical Diseases (NTDs) continue to affect more than 1 billion of the poorest populations around the world, causing debilitating life-long complications [1]. NTD infections affect those in extreme poverty and can lead to adverse economic disruption and severe health consequences [2]. Soil Transmitted Helminthiasis (STH) are the most common NTDs and are the second highest infectious diseases after malaria [3].

Quick and efficient diagnosis is hence of paramount importance. The disease has a high re-infection rate, therefore consistent tracking and testing is crucial. Diagnostic methods rely on manual microscopy which is the gold standard as well as other rapid diagnostic tests. Parasite detection is done from stool samples usually by microscopic slide analysis such as the kato-katz and wet mount methods [4]. The kato-katz method is the cheapest and easiest amongst all and hence remains the most commonly used method. This research hence involves digitizing and automating the detection process by mimicking the manual kato-katz diagnostic method in the digital world.

The kato-katz images used in this study are *Schistosoma mansoni* at 10x magnification, as in Fig. 1. This work is the first of its kind in this field and will support the analysis and development of an effective and rapid automated diagnostic tool against these potentially fatal infectious diseases.

METHODS

The intensity images of kato-katz slides undergo a series of image processing operations to identify the parasites present and determine the infection rate, thereby aiding in diagnosis. The methodology and steps involved are as follows:

- The images undergo grayscale conversion followed by rescaling to $\frac{1}{4}$ of its size.
- This is followed by feature extraction using the Maximally Stable Extremal Regions (MSER) algorithm that involves region detection based on thresholding and scaling [5].
- This enables identification of a set of True Positive (TP) and False Positive (FP) regions. To filter out the false positives located by the MSER, the images undergo a cross correlation-based template matching process on all the coordinates obtained from MSER.
- Template matching involves choosing one of the parasite eggs in the image as a template and rotating it iteratively at specific angles between $0^\circ - 360^\circ$.
- The template is then passed over the query image, producing a matrix with cross-correlated values. A threshold is then applied to find the areas that match.

KATO-KATZ IMAGES

Figure 1. displays a Kato-katz image taken under the microscope at 10x magnification. The images are characterized by a number of features:

- Spurious intensity patterns
- Random cell orientation and distribution
- Heterogenous and non-uniform background
- Non-distinctive foreground objects

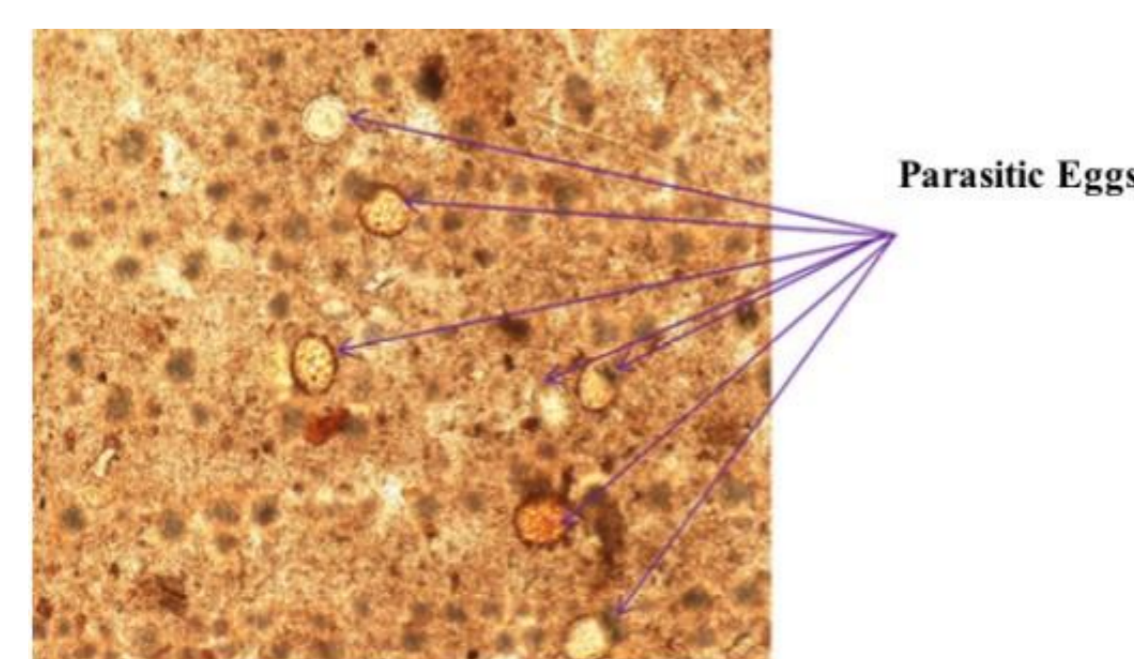


Figure 1. Kato-katz image under the microscope at 10x magnification.

Kato-katz is the most commonly used microscopy-based technique in the diagnosis of Neglected Tropical Diseases (NTDs).

Preliminary studies involving the automated detection of parasitic eggs in a given Kato-katz image is hence described. The studies involve the application of pattern recognition techniques based on template matching to detect the presence of parasites in the images of kato-katz slides.

The results from this study indicate that using a combination of image segmentation and pattern recognition algorithms generates better results as they deal with the complex nature of the images, such as their spurious intensity patterns and shapes.

This interdisciplinary work applies image processing algorithms to kato-katz images to solve clinical parasitology problems.

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RESULTS

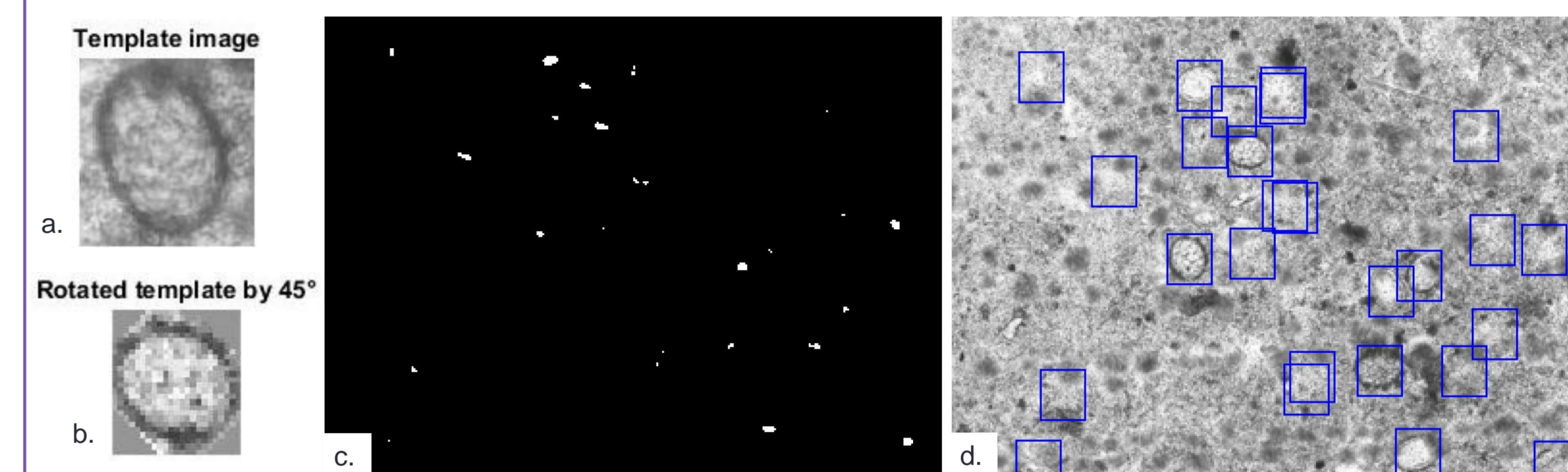


Figure 2. a. template image, b. rotated template image with angle rotation 45° , c. matched binary image and d. image with bounding box.

A pictorial demonstration of the method is provided in Figure 2. The template image, in Fig. 2a, is rotated by the desired angle, in this case 45° , Fig. 2b.

Normalized cross-correlation is performed and using a threshold, a binary image showing matches between the template and objects in the image is generated, Fig. 2c.

The areas that match are denoted by the white areas. The final image, Fig. 2d, shows bounding boxes around all the areas that were deemed a match.

SUMMARY / CONCLUSION

Along with template matching at varying angles, a threshold is also applied to the located areas for further filtering. For example, the threshold applied for the image in Fig 2 is 0.35.

For each image the angle and threshold which gives the maximum TPs are recorded. This hybrid model of MSER coupled with template matching effectively removes 90% of the FPs, if the correct angle and threshold is applied.

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