# Real-time Label-free Monitoring of Protozoa using Micro Opto-fluidic System and Image Classification

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**Abstract:** An automated real-time system for the rapid detection of protozoa, Giardia lamblia and Cryptosporidium, in drinking water is implemented based on the micro opto-fluidic system and image classification. Processing around 15 images of protozoa per second are realized in this system.

## 1. Introduction

Giardia and Cryptosporidium are harmful to people and very common in drinking water. Establishing an automated real-time system for the detection of Giardia and Cryptosporidium is necessary. Have drinking water flow in the optical channel using micro opto-fluidic system, in which particles in the water like Giardia and Cryptosporidium can only pass one by one, and get images of these particles through laser scattering. Then classify these images to Giardia, Cryptosporidium and others based on support vector machine.

## 2. Results and Discussions

Figure 1(a) shows the detection micro-fluidic chip and how to catch the images of particles in the detection chip. The detection micro-fluidic chip is fabricated by silicon-glass bonding. The sample of the drinking water flow through the channel in the detection chip and camera continues to take the photo of the spot lighted by the laser. When a particle coming to the spot, the laser will scattering and the camera catch the image of this scattering. Figure 1(b) and (c) shows the image of Cryptosporidium and Giardia. In order to get the images of Cryptosporidium and Giardia, save the images of which the intensity is between 10cd and 30cd, at this range there are more images of Cryptosporidium and Giardia and less images of other particles. Figure 1(d) shows the photo of the detection micro-fluidic chip.

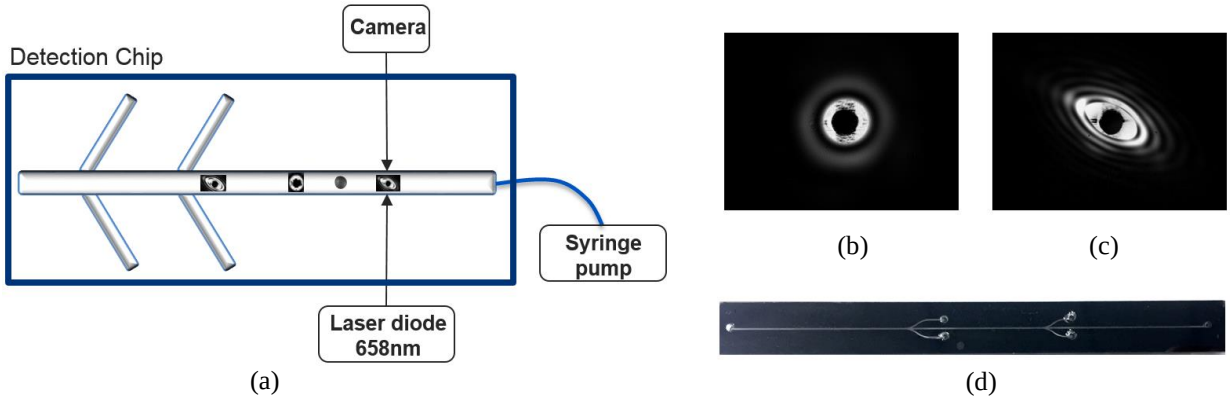


Fig.1. (a) Detection Micro-fluidic Chip. (b) Image of Cryptosporidium. (c) Image of Giardia. (d)Photo of the Chip.

Figure 2 shows the detailed image classification strategy of the image processing algorithm. After the optical detection we get a great many images, around 60 images per second, and in order to find if there are images of Giardia and Cryptosporidium image classification are in process to classify these images to Giardia, Cryptosporidium and defect images. In the image processing algorithm the final justification is made after plotting out the similarity scores of all the scattering patterns of particles in the tested water samples. The similarity score represents the risk level on how likely the detected particle is considered as the targeted protozoan pathogen, which is calculated by comparing the features extracted from the captured images and the reference database. Around 15 images can be classified per second using the current code.

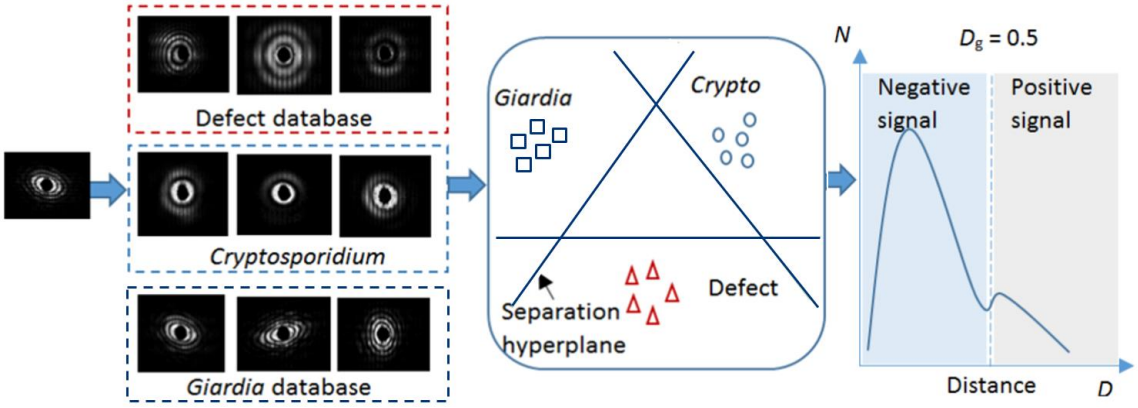


Fig. 2. Schematic illustration of the SVM based similarity score method for image processing

Figure 3 shows the flowchart of image classification. One captured image will be compared with three databases, i.e. Cryptosporidium, Giardia and defects. After the comparison, a SVM based scoring evaluation will be given. And another classification method Naïve Bayes classifier is used to improve the accuracy of the algorithm.

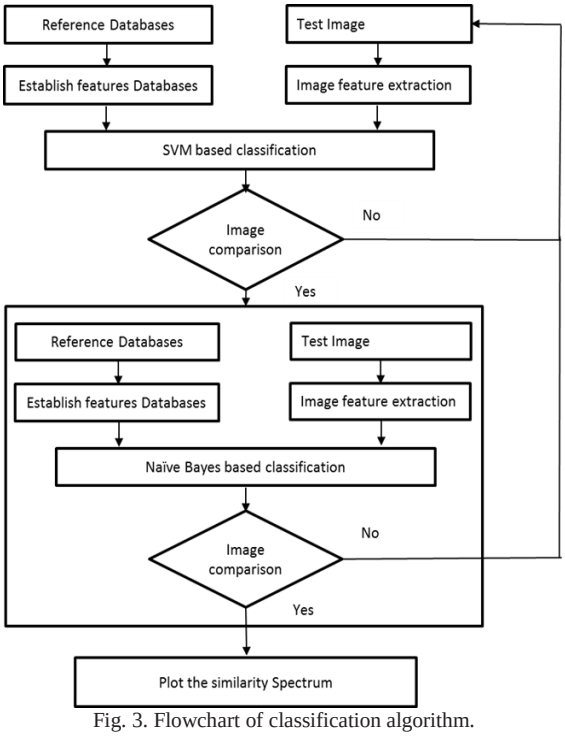


Fig. 3. Flowchart of classification algorithm.

## 3. Summary

An automated real-time system for the rapid detection of Giardia lamblia and Cryptosporidium in drinking water is implemented using the micro opto-fluidic system and image classification. Processing around 15 images of protozoa per second are realized in this system.

## 4. References

[1] He, Yiping, Sue Reed, et al, "Rapid identification and classification of Campylobacter spp. using laser optical scattering technology." *Food microbiology* **47** 28-35 (2015).
[2] Amit David, Boaz Lerner, "Support vector machine-based image classification for genetic syndrome diagnosis." *Pattern Recognition Letters* **26** 1029-1038 (2005).
[3] Huang, Qiangui, et al. "An evaluation of fake fingerprint databases utilizing SVM classification." *Pattern Recognition* Letters **60** 1-7 (2015).

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