

iTB Scanner:

An intelligent microscope for TB detection



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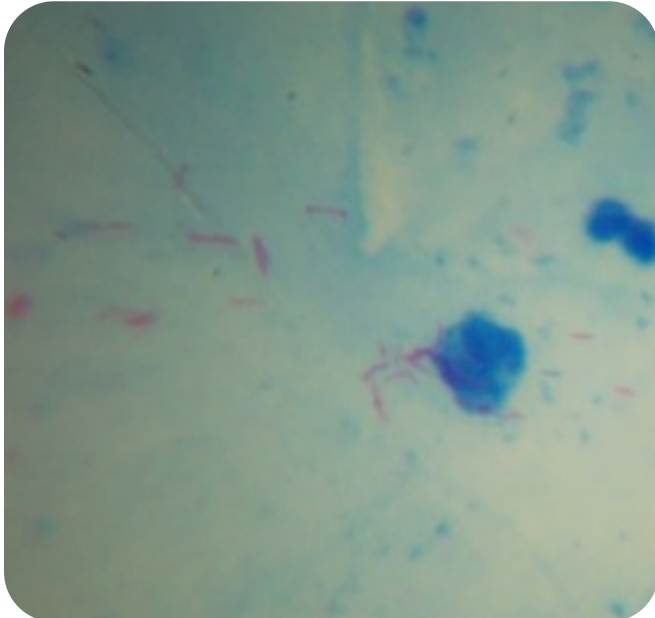


Introduction

According to the World Health Organization (2023), an estimated global total of 10.8 million people fell ill with TB (equivalent to 134 cases per 100,000 population). It is nearly 4.9 million people cases in South-East Asia region. Unfortunately, **estimated 700,000 of them died**.

Acid-Fast Bacillus

This method of diagnosing tuberculosis, with the dye specific to the bacteria that causes tuberculosis, *M. tuberculosis* (MTB), is used from the patient's sputum. **Then a physician will count the number of MTBs through a microscope. The final step takes about 15 to 30 minutes.** The authors foresee that artificial intelligence can be applied to help physicians in diagnosing tuberculosis.



Inspection ranking		
GeneXpert	Tuberculin skin	AFB sputum
Most accurate	Least accurate	Moderately accurate
Fastest time	Slowest time	Slow time
High cost	Low cost	Lowest cost

Objective

“We are making an AI to automatically detect MTB in given images from a microscope extension that captured images simultaneously in order to accelerate and provide convenience in the TB diagnosis process.”

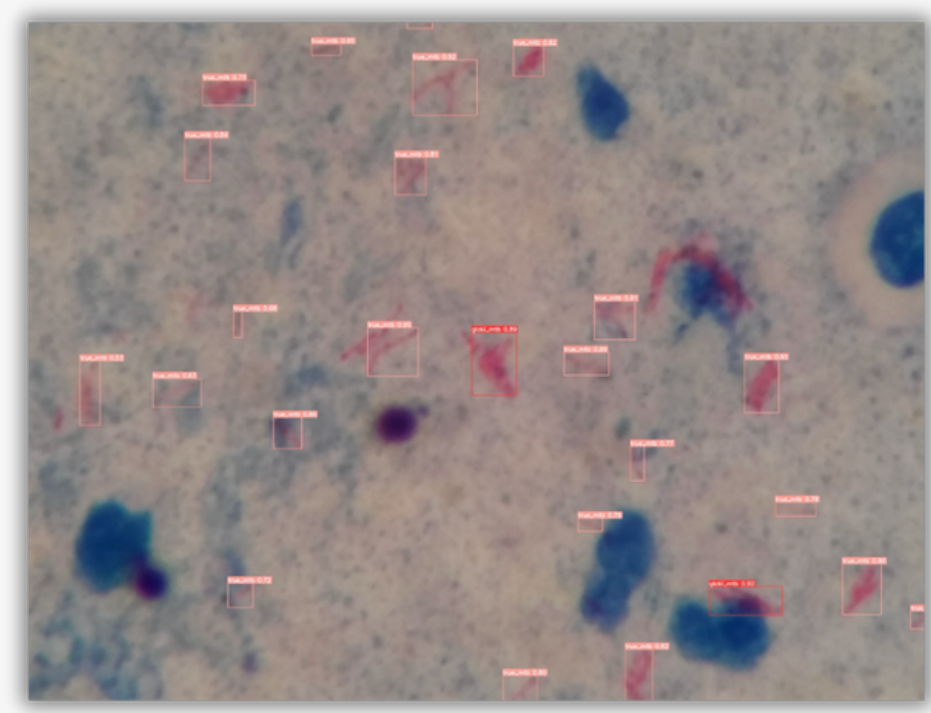
Detector Evaluation

Dataset Sources	
Kaggle	ZNSM-iDB
1257 images	695 images

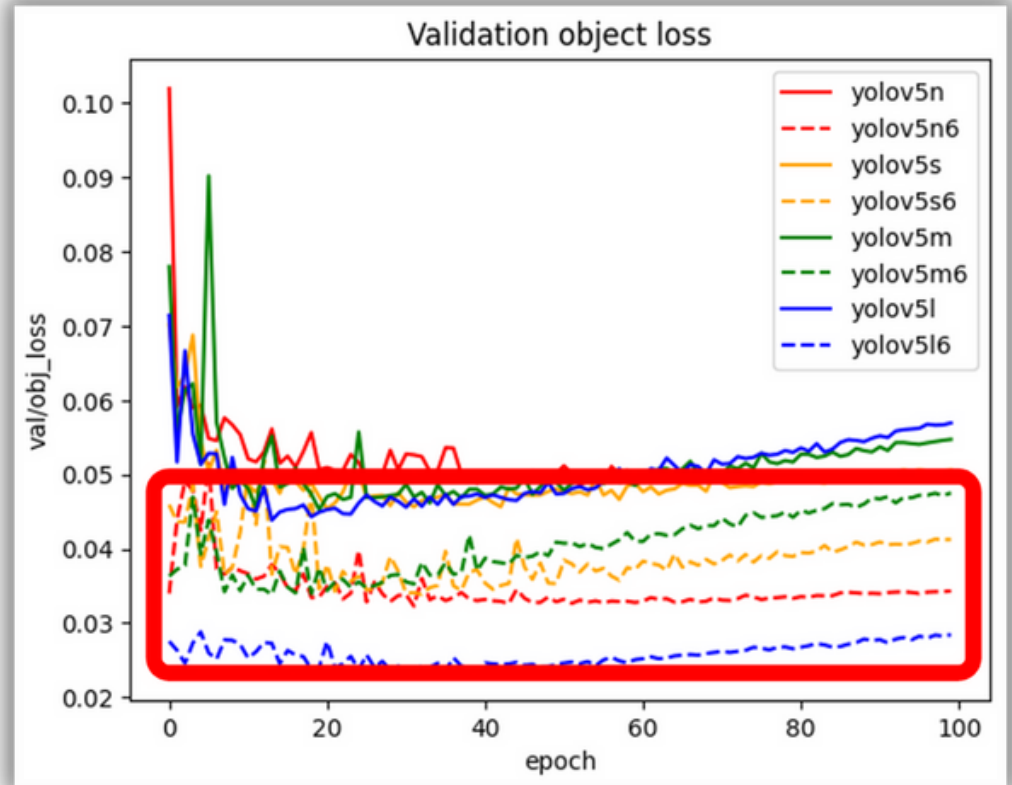
We collect image datasets of AFB microscopic sputum test.

Models			
Yolov5n	Yolov5s	Yolov5m	Yolov5l
Yolov5n6	Yolov5s6	Yolov5m6	Yolov5l6

We labeled MTB and trained with the eight **yolov5** models.

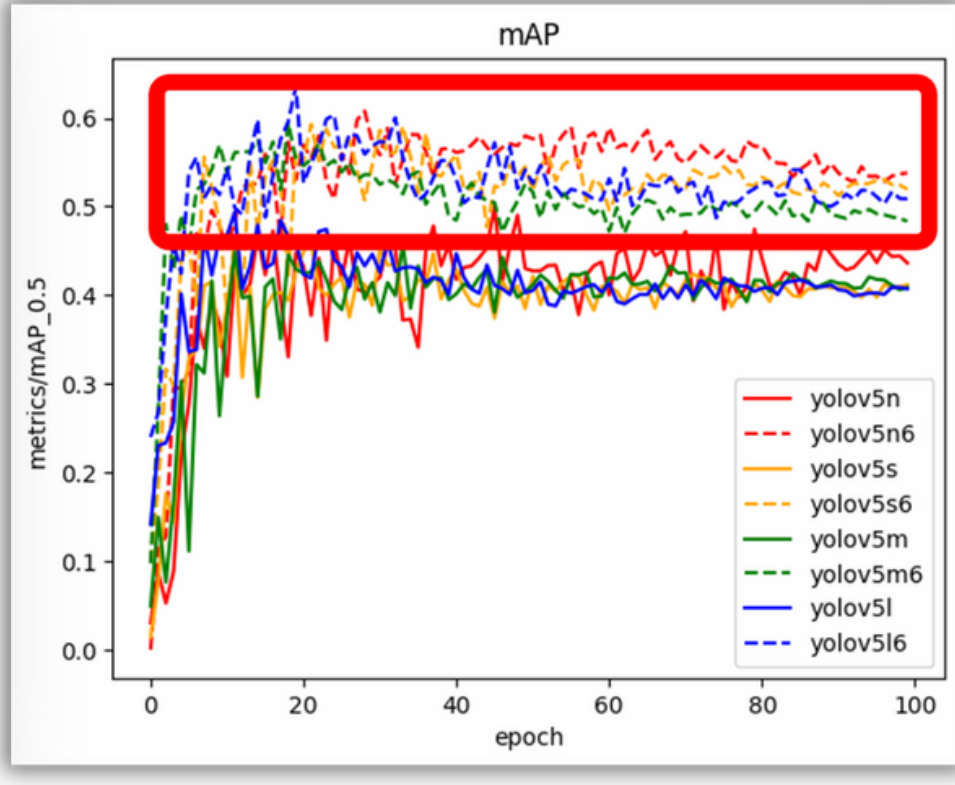


Example of an AI detected image



Validation object loss

The system can learn from a set of images.



mAP on each epoch

Large models were found to be more effective.

Model	Measures			
	Sensitivity	Specificity	F1-score	Avg.time (ms)
yolov5n	0.9743	0.969	0.9717	10.6
yolov5s	0.9802	0.9647	0.9727	11.1
yolov5m	0.9818	0.9572	0.9699	13.6
yolov5l	0.9845	0.9364	0.9614	17
yolov5n6	0.9898	0.9353	0.9636	13.7
yolov5s6	0.9947	0.9064	0.9526	13.9
yolov5m6	0.9952	0.9037	0.9517	18.7
yolov5l6	0.9952	0.8775	0.9399	23.8

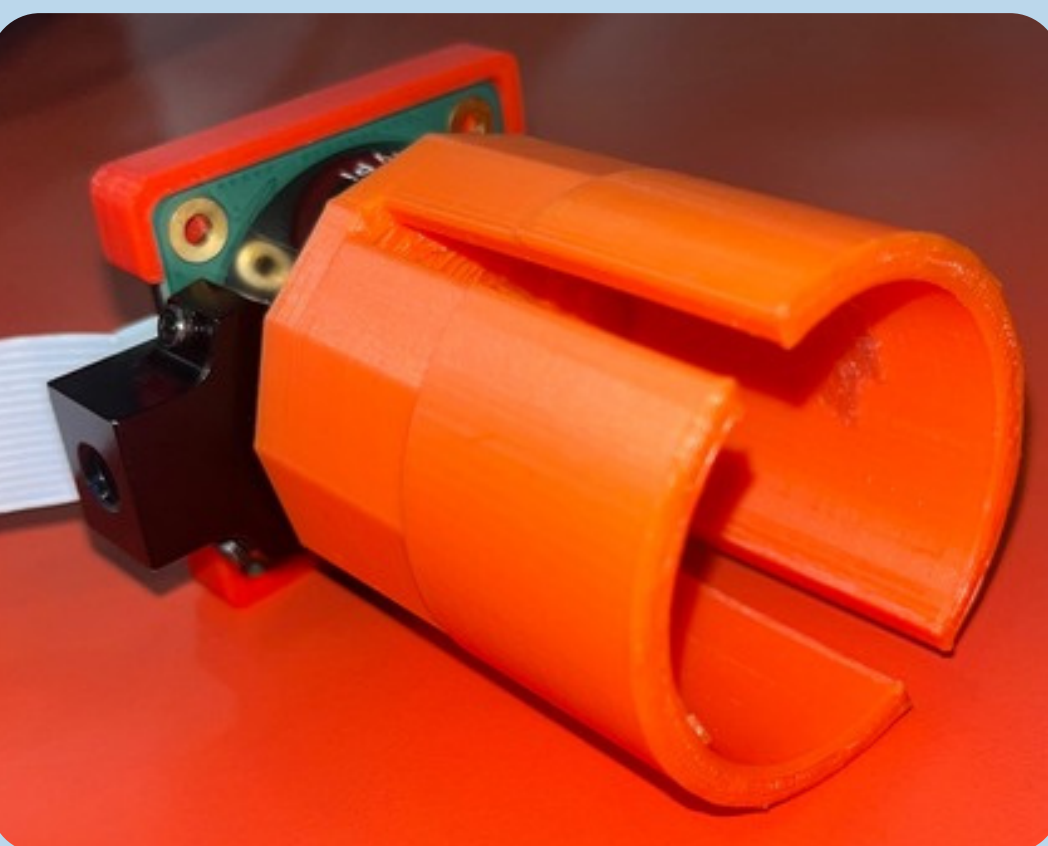
Results of the image classification

Measured by the accuracy of the AI model in determining whether a given image is infected or not.

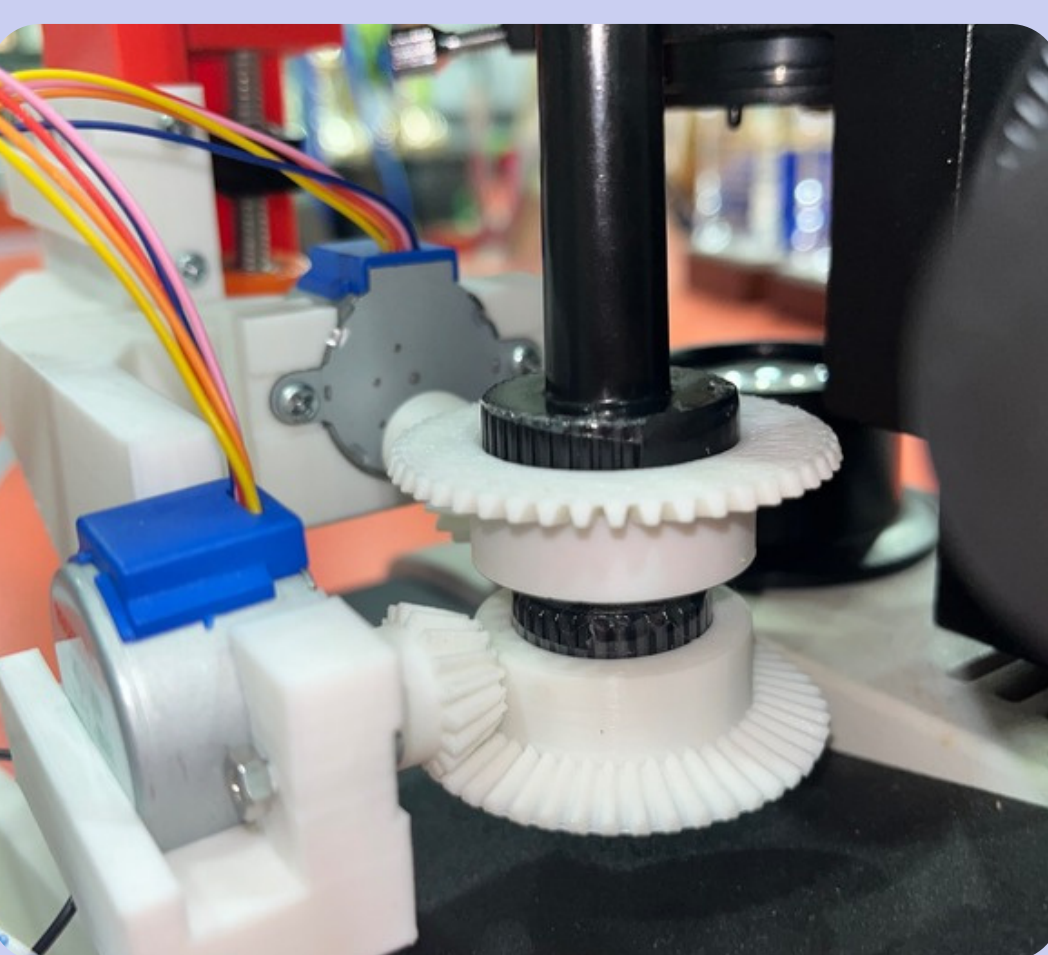
Model	Measures for object detection		
	Precision	Recall	mAP
yolov5n	0.605	0.582	0.584
yolov5s	0.624	0.595	0.569
yolov5m	0.666	0.652	0.645
yolov5l	0.615	0.551	0.537
yolov5n6	0.673	0.761	0.727
yolov5s6	0.738	0.732	0.71
yolov5m6	0.708	0.735	0.699
yolov5l6	0.714	0.748	0.718

Object detection experiment

Measured by the accuracy of the AI model in locating every MTB in the image.



HQ Camera captures high resolution images

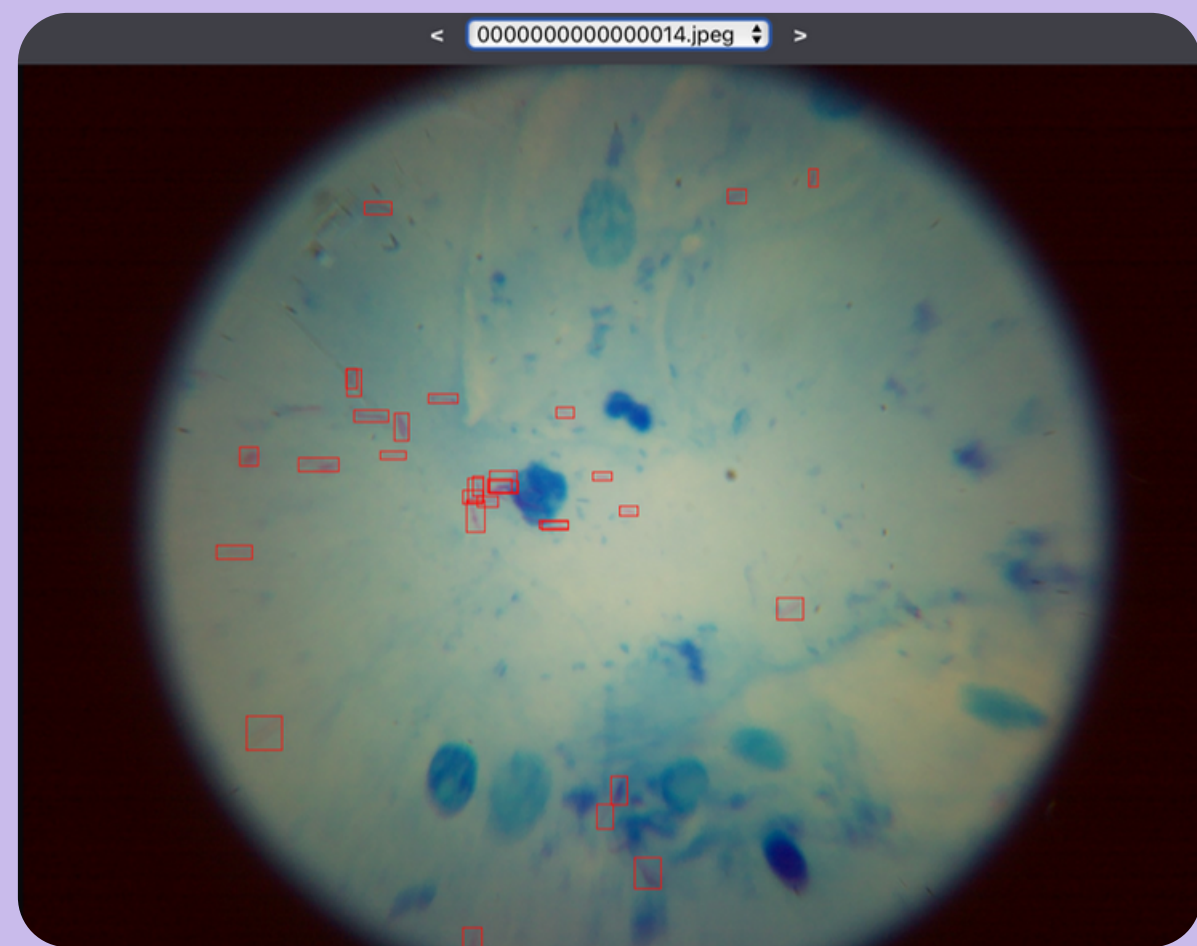


2 Stepper motors and bevel gears control movement of stage in x-y plane

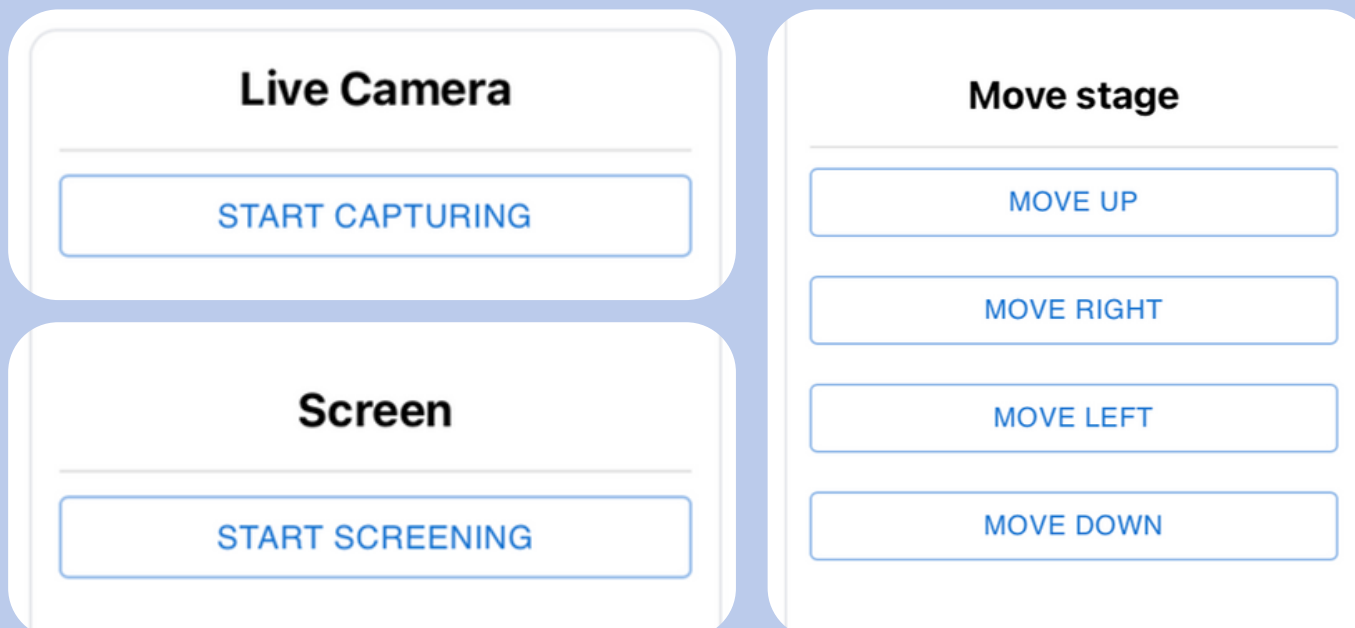


IP & Current Status

- Petty patent. Application Request No. 2403002061
- Copyright No. 11291

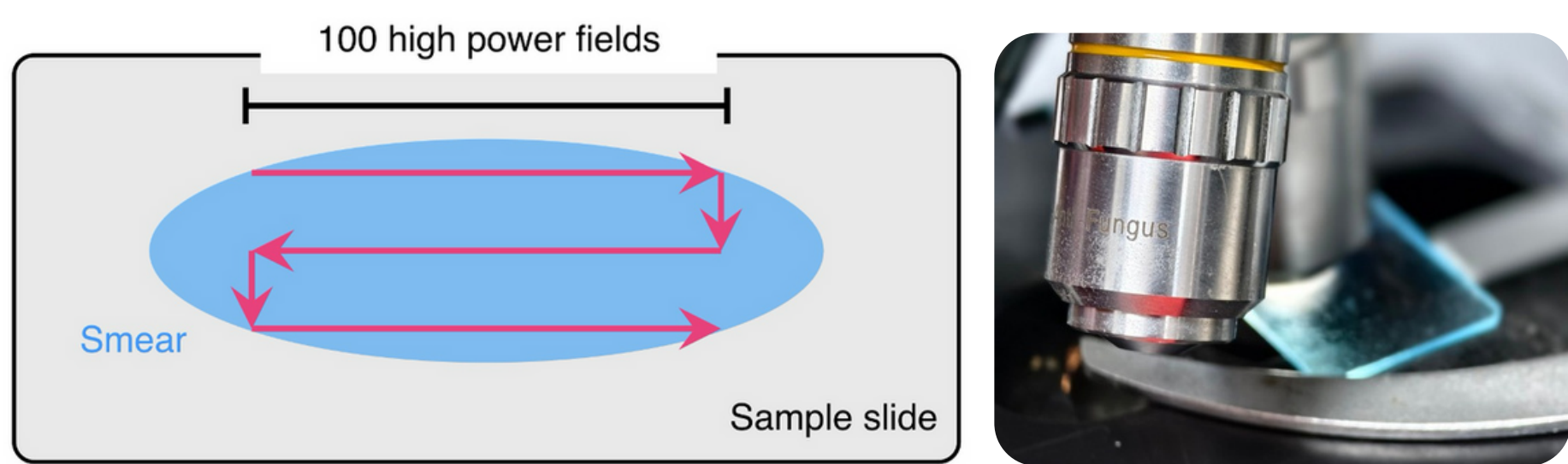


Watch real-time image from camera on the web



Control EVERYTHING with the web, providing convenience!

Entire system evaluation



This picture shows the path way of the images capturing by iTB Scanner up to 300 high power field (x1500).

	Time taken
100 high power field	1m 40s
300 high power field	5m

Duration of the iTB Scanner scanning per round, including slide scanning and AI detection.

Highlights and Novelties

- ★ **Yolov5 powered detection:** high accuracy and speed
- ★ **Easy integration:** does not require disassembly of microscope
- ★ **Cost effective yet high performance:** 100-500times cheaper
- ★ **User friendly interface:** control EVERYTHING with the web
- ★ **Various potential applications**

Benefits

- ✓ Faster TB diagnosis and treatment
- ✓ Better access to TB screening in rural area
- ✓ Reduce cost of TB screening
- ✓ Reduce cost of importing tools and for TB diagnosis
- ✓ Reduce infection and death rates from TB

References

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Applications

- Accelerate and automate the TB diagnosis process. Or simple screen the sputum AFB slide
- Adap with other microscopic organisms spection such as white blood cells
- Facilitate learning and education of micro organisms and biology

Cost of production

- Raspberry pi 4 model B (35 USD)
- HQ Camera (65 USD)
- 2 motors and drivers (10 USD)
- **TOTAL 110 USD**