

# An Automatic Moving Stage in Optical Microscope

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## Abstract

The main objective of this study is to develop a two-dimension automatic moving stage in optical microscope for the medical laboratory. The most significant feature is the moving stage translation designed by microcontroller PIC 16F874 and focus control knobs to drive the stepping motor as horizontal feed mechanism. In addition, the operators allow easy operation with only a single finger. There are 3 push-button: manual, automatic and re-examination. The automatic mode is to scan the specimen which is controllable X and Y axis positioning to allow to move the specimen slide into the stage translation to viewing field of the microscope. The re-examination equipped with an automatically returned to the microscope stage and refocusing the specimens. It can be concluded that the re-examination of the specimen slide is 86.1% accuracy

**Keywords:** automatic moving stage, microscope, microcontroller PIC16F874, stepping motor

## Introduction

Microscopes are used for the examination of clinical specimens such as to detect parasite infected red blood cell (1,2). Direct examination of specimens can be used for the preliminary identification of most parasites. The microscopic detection of organisms stained with antibodies labeled with dyes or other markers has proved to be very useful for the specific identification of many viruses and bacteria (2,3). Five general microscopic methods have been used. The microscope with attached to actuate the stage and control is affected through manual (4,5). The basic principal for diagnostic in red blood cell is using microscope manually (6,7). In such cases, electronic systems may be used to automatically examine and analyze the optical images of the microscope (8,9). Where electronics systems are used for rapid analysis of microscope specimen images it becomes desirable to automatically regularly and rapidly feed the specimens to the microscope optics. After analysis a specimen would be removed to make room for the next specimen and would be collected for either further examination, reference, record keeping or disposal (10,11,12).

The main objective of this study is to develop an automatically returned to the microscope stage for reexamination. These technologies dramatically increased the accuracy of measurement results and contributed greatly to the modernization of testing and medical care.

## Research Process

1. Sample preparation: To prepare the blood smear sample and set up the microscope working area at 1000x with 0.2 mm. dimension as shown in Figure 1. In order to the area of the specimen

slide is viewed during examination of the specimen without sliding it.

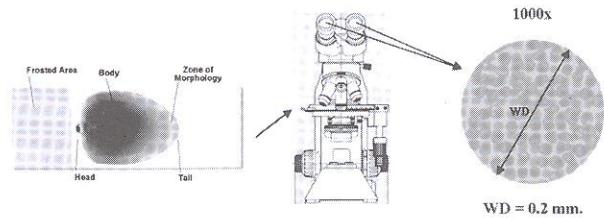


Figure 1: Microscope working area

3. To set up the scope of microscope moving stage scanning area with 40 x 26 mm. as shown in Figure 2. About the specimen stage this opening in the specimen stage is made as large as possible and exposes the full width of the specimen slide.

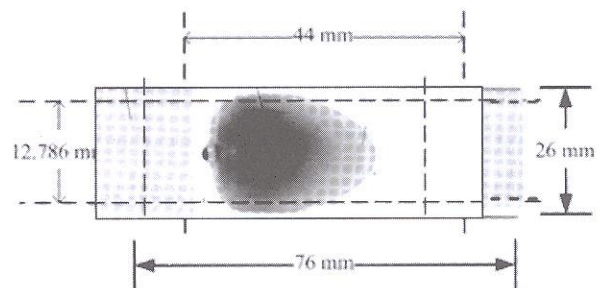


Figure 2: Scanning area

3. The automatic sequential examination of a group of microscope specimen slides comprising:

### 3.1 Moving stage design:

Apparatus comprised a sub-stage directing serves to move stage in a horizontal plane. There is provided further positioning means supporting said translation means and operable for moving said stage with a specimen slide supported therein vertically as shown in Figure 3.

### 2. Digital Electronics Design:

The digital electronics architecture has two main functional blocks, Master Board and Slave

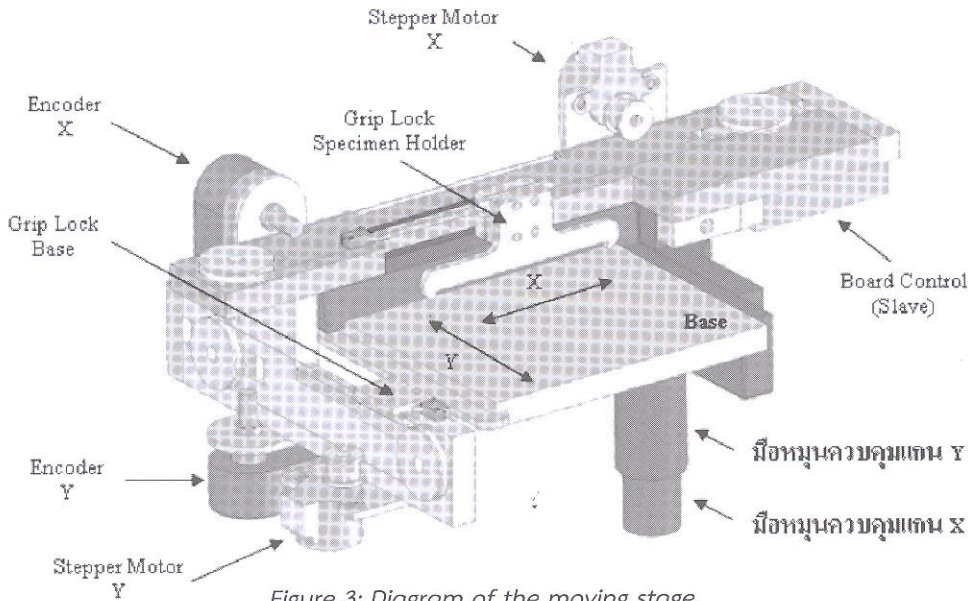


Figure 3: Diagram of the moving stage

Board. ICP (Instrument Control Processor): used a PIC 16F873 processor to perform all instrument control and event processing functions as shown in Figure 4. The ICP will be responsible for the following tasks: processing commands; monitoring source and adjusting the LCD readout mode as required; calculating centroids and transmitting centroid positions.

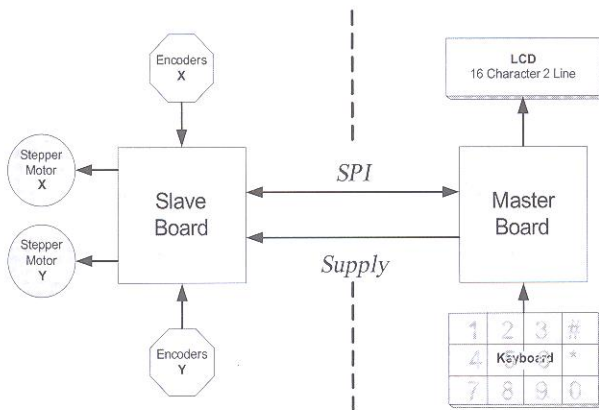


Figure 4: Digital electronics architecture

From Figure 4, it is to illustrate the overall digital electronics using 2 microcontrollers with serial communication and synchronous Serial Peripheral Interface (SPI).

### 3. Microcontroller in Slave Board:

3.3.1 Encoder: using sequential logic to control moving stage. The characteristic of encoder 2 signal using microcontroller PIC 16F873 via RA0-RA3 port as shown in Figure 5. The signals moving stage is to set up into 3 statuses 1. No movement 2. Increase the distance and 3. Reduce distance as shown in Figure 6.

CH A	1	0	0	1	Logic
CH B	1	1	0	0	
1	0	1	2		+
2		1	2	3	
2		1	2	3	
3	0	1	2		

Figure 5: The characteristic of encoder 2 signal

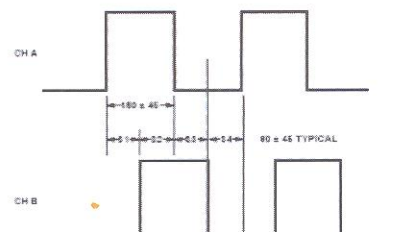


Figure 6: Logical control

2. Stepping motor: control moving stage using microcontroller PIC 16F873 via RB0-RB7 port and working together with IC ULN2803 to control stepping motor as shown in Figure 7.

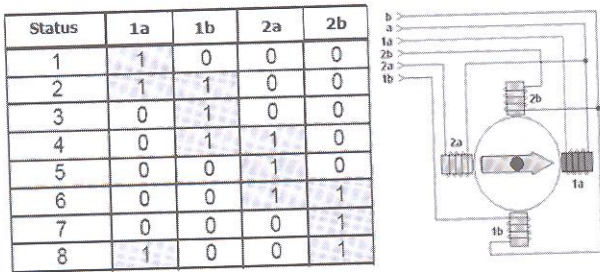


Figure 7: Characteristics of stepping motor control

3. Serial Peripheral Interface: using Master Synchronous Serial Port in microcontroller PIC 16F873 using Microcontroller in Slave Board as shown in Figure 8.

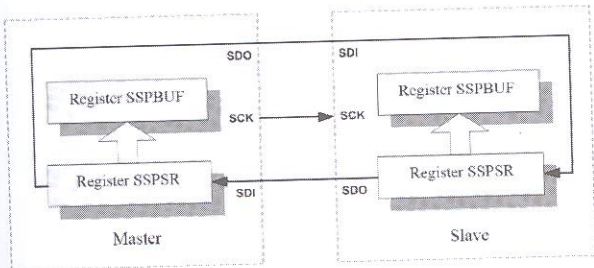
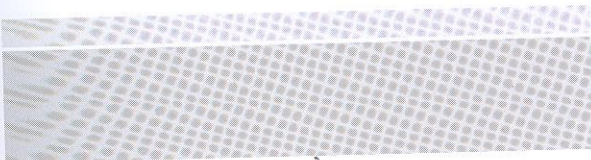


Figure 8. Serial Peripheral Interface (SPI)

2. Microcontroller in Master Board

1. Input from keyboard using RB1-RB7 in term of matrix 4 x 3
2. Display result using RA0-RA5 for Liquid Crystal Display
3. Serial Peripheral Interface SCK port
4. Data communication using SPI as shown in table 1



Address for Slave	Data										Command					
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	Write X0										Not Use					
1	Write X1															
2	Write X2															
3	Write X3															
4	Write Y0										A H. +X -X +Y -Y					
5	Write Y1															
6	Write Y2															
7	Write Y3															
8	Read X0										Not Use					
9	Read X1															
A	Read X2															
B	Read X3															
C	Read Y0															
D	Read Y1															
E	Read Y2															
F	Read Y3															

Table 1 : Data communication using SPI

4. To design the software control program as shown in Figure 9.

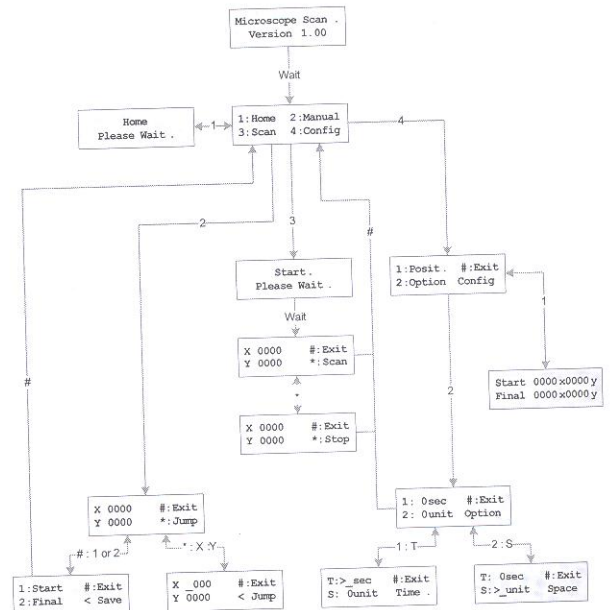


Figure 9: Framework of the software control program

Data Analysis

All equipment are connected and the microscopic examination of the specimen slide can take place either visually or automatically as shown in Figure 10. Motorized microscope components and accessories enable the investigator to automate live-cell image acquisition and are particularly useful for time-lapse experiments about 20 milliseconds. For this purpose the X and Y positioning systems can be controlled manually



or automatically. Thus, the specimen slide carried by the stage may be moved to any desired location relative to the optical axis by actuation of the Y-axis drive 43 and the X-axis drive 44. For automatic examination the drives 43, 44 would be energized under scan or other program control. To test the points and the results are shown in table 2.

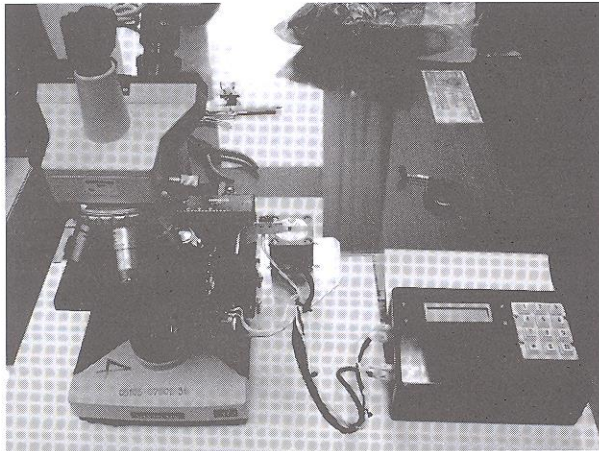


Figure 10: Automatic moving stage equips with the optical microscope

Image	X	Y
UT140001	0.03493151	-0.054089
UT140002	0.07802397	0.01477397
UT140003	0.03211301	-0.0347603
UT140004	0.06352397	0.01437329
UT140005	0.03775342	-0.0431164
UT140006	0.00633904	-0.0428151
UT140007	0.00553425	-0.0142192
UT140008	-0.0049349	-0.0085822
UT140009	0.03271918	0.01578082
UT140010	0.02103767	-0.0277123
UT140011	-0.0345342	0.00853425
UT140012	0.01137329	-0.0840925

Table 2: Sample testing results

## Conclusion

After the examination of a particular series of specimen slides has been completed any individual specimen slide that requires re-examination can be either operator signals or by predetermined control signals be fed automatically back into the microscope viewing optics for further examination.

Upon completion of the examination of a slide the horizontal positioning Y-axis drive returns the specimen slide on the stage to the position. It can be concluded that the accuracy of this equipment for reexamination the specimen slide is 86.1 % accuracy.

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