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Design and Implementation of a CNC Based Scanner for Imaging

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Abstract: This paper describes the development of an image scanner. A hardware set up has been designed. Hardware development includes the framework, the stepper motor and drivers, laser circuitries for imaging. A laser module, which is placed in the scan head, is the key element used for text detection and imaging. Line by line scanning has been achieved using stepper motors. The laser module detects the color (black/white) of each point in the text. The resulting data obtained from the laser module is used for image creation. Laser scanning technology has been used widely to provide real, life-like images of the text. This technology has been used to capture the text with high resolution and precision.

***Keywords* — CNC machining, Image scanner, Laser sensor, High resolution, Text detection.**

I. INTRODUCTION

Laser technology has achieved an unavoidable role in today's industrial world. Various consumer products like Blu-Ray and DVD players use laser technology to read information from the disks. The highlighting characteristics of the laser technology are its power, pulse energy, wavelength pulse length, and coherence [3]. The integration of laser technology into various devices has opened the door for new applications. Laser technology is not limited in the world of image scanner, but it has been widely opened to the world of surgery, weaponry, welding etc. Researches have been going on in the field of laser technology for the processing of increasingly thick materials.

CNC machining is overruling today's market for machining products. CNC stands for C omputer Numerical Control. The main elements used in CNC machineries are: the control and electronics, electric drives, and mechanical elements. The key reason for the wide acceptance of CNC machines is because of its ability to provide services 24 hours a day without fail. The main feature of CNC machining is that the design patterns can be easily programmed. This feature enables the easy updating of design patterns in CNC machines [2]. CNC machines guarantee the users to get high quality identical products each time. CNC machines are more precise than manual machining, and it can be repeatedly used in the same manner many times. Complex shaped images are impossible to achieve with manual machining. So, for the formation of complex shaped images, CNC machining is always the best option. Hence, CNC machining is the best option in industries that requires a high level of precision or repetitive tasks. CNC have found their applications mainly in lathes, drills, milling machines etc.

The laser sensing technology described in this paper detects the colour (black/white) of each point of the text and the collected data is used for imaging application. An image scanner is developed for the above applications and the key element of this scanner is the scan head. A laser module has been attached to the scan head. Higher accuracy of measurement is achieved using laser scanning technology. The high-quality data has been produced by laser scanners and these data is used in many of surveying's specialty fields, including topographic, environmental, and industrial.

The Faro Focus 120 laser scanner methodology [4] uses point cloud data acquisition for scanning. But the complexities of the Faro process lead me to find out a new way for scanning. A basic idea for the development of the hardware setup [2] has flaws like inefficiency, complexity. It was a closed source platform too. These flaws inspired for the development of the new hardware setup.

The primary aim was to develop a cost effective image scanner having a laser sensor module attached on its scan head. This setup will provide a mechanism for detecting each point of the text and its imaging in Visual Studio. Hardware and software subsytems was integrated to meet all the criteria.

II. METHODOLOGY

Laser module is the key element used for detecting the text and its imaging. The scan head, which was developed, was used to move over the laser beam. The laser beam collects data from each point of the text. And the resulting data from the laser beam was used for image creation.

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2.1 Laser sensor

The laser sensor module makes use of modulation processing technology. Modulation is the process in which the information is added to a carrier signal and the carrier signal is transmitted over an electronic medium. The transmitted information is received for demodulation, in which the blended information is extracted. It makes use of a boost converter chip which accepts an input voltage between 2.5-5.0V and convert it into a regulated output voltage [5]. The high switching frequency allows for tiny surface mount inductors and capacitors. Laser modules can be used to monitor the slowly changing colours. The laser beam has been protected from external damages by embedding the light sensor in a rugged housing below a layer of transparent epoxy which protects the sensor from external damages.

Fig 1: Laser sensor module

The laser module consists of a transmitter and a receiver. The transmitter contains an oscillating tube which is used to generate a shockwave in a frequency of 180 kHz. The shockwave is amplified by a transistor, and the amplified shockwave is applied to the laser tube for exciting. In the receiver, there is a receiving tube which is matched to the oscillator tube. The receiving tube efficiently prevents from receiving visible light because of the modulation sensing technology that has been used in the laser module. It only receives the reflected light in the same frequency [5]. Even though initial investment is large, laser scanning has many advantages over traditional scanning techniques. Time spent for data capture is 10 times faster. Higher accuracy of measurement is achieved with laser scan. This module has various applications in the field of obstacle detection, counter device in the pipeline intellectual robot, obstacle avoidance car etc. Researches have been going on in the field of laser technology for the processing of increasingly thick materials. This approach is used in a number of industries like architecture, transportation, logistics, aviation, building construction etc.

2.2 Experimental Setup

Figure 2 shows the experimental setup used for the text detection and imaging applications presented here. 2 axis movements are required for the laser beam to move over the text [2]. Two stepper motors has been used to achieve this movement. Nema 23 stepper motors have been used to achieve the movement of the X and Y axis. Nema 23 has high torque. This motor is the preferred motor for various robotics applications [6]. TB6600 motor driver has been used to drive the stepper motors. The advantage of using TB6600 is because of its reliable features: easy adjusting of the micro stepping factor (includes 5 micro step factors), over current protection, under voltage protection, over heat protection. The scan head is attached to this stepper motors. Control signals for the proper movement of the motor were given by the controller (LPC1769) and this controller also helps to acquire the data from the scan head. Laser module has been attached to this scan head for imaging. Line by line movement of the scan head is used for imaging. The data received from the laser module is transmitted to PC through UART. The transmitted data is used for imaging in user interface application.

Motion control system is a major subsystem responsible for the automation of CNC scanner. Success of a motion control is dependent on its control algorithm [7]. Existing systems have many drawbacks like complexity, leading to poor control performance. ARM has been used to control the hardware circuitry and is easy to customize which is not available with any existing microcontroller or a digital signal processor.

A scanning area of 10cm*5cm has been selected (50*25 pixels). The laser module has a resolution of 2mm*2mm. In Visual Studio, 50*25 pixels have been created. The laser module detects the colour (black/white) of each point of the text [5]. The detected value is transmitted using an UART module to visual Studio. Based on the transmitted value, a colour has been assigned to corresponding pixel in Visual Studio. When the scanning area is completed, a high quality image of the text will be displayed in Visual Studio.

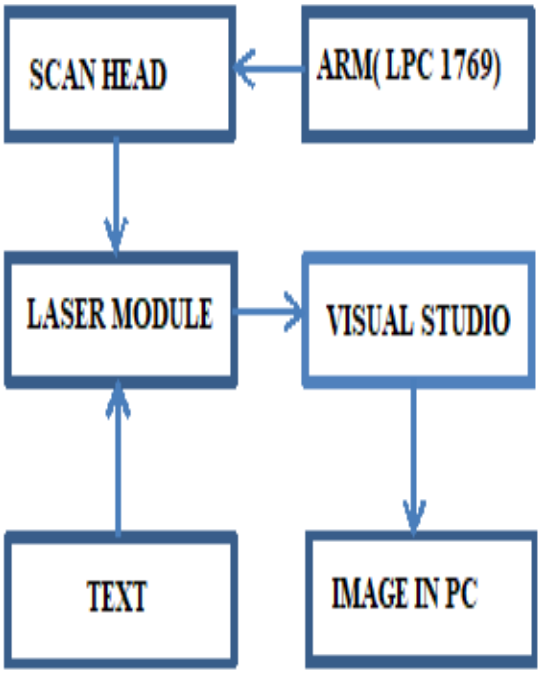

Fig 2: Block diagram of proposed system

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III. RESULTS AND DISCUSSION

Figure 3 shows the experimental arrangement used for this imaging application. Hardware setup has been created.

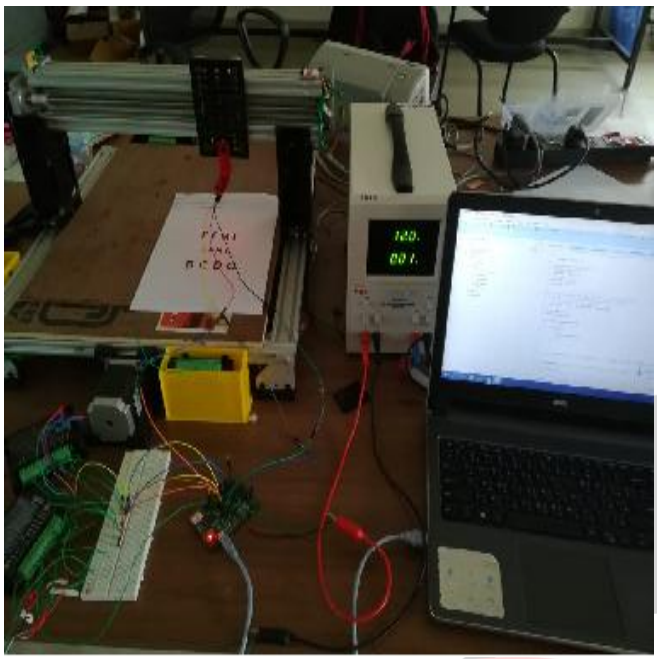

Fig 3: Experimental setup

3.1 Text Detection

Different styles of text have been used for verifying this experimental set up. The text is placed at a fixed distance from the scan head and the laser module is moved over through this text in a line by line motion using stepper motors and its driver module. The laser module has the advantage of detecting black and white images [4]. The detected colour has been assigned a specific value by the laser module. 0 has been assigned for the detection of black colour and 255 have been assigned for the detection of white colour. The detected colour value from the laser module is transmitted to Visual Studio for image creation.

3.2 Imaging

The XY scanner acquires the data and it is send to the PC where the image creating application (Visual Studio) is running.

Fifty readings are taken in X axis. The lead screw of the X axis has 2 mm pitch. The readings are sent over PC to user interface for image creation. After covering 10cm in X direction, Y axis is incremented by 2mm [8]. Then a reverse movement of equal distance of 10cm is done in X axis direction. Readings are taken in the reverse direction also. This process is repeated until the laser module covers the entire bed size. The laser module is fixed at a distance of 6cm from the bed. The screen shot of the application created for imaging is shown in figure 4. Microsoft visual studio is used for creating this application.

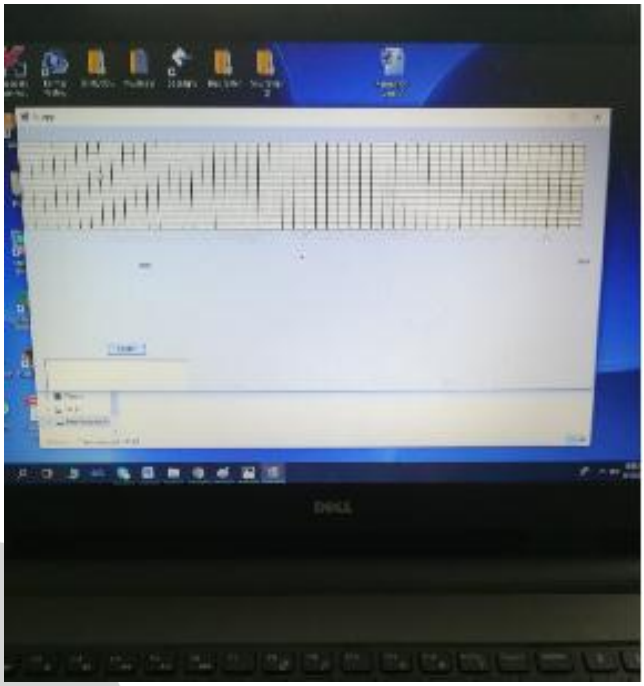

Fig 4: Screen shot of the App

Various readings are taken and the corresponding image of the text is created in the application (Visual Studio) for image creation [8]. First of all, the text to be scanned is placed on a surface which does not have any flaw. The imaging of the letter Z and N are shown in Figure 5.

With the aid of the above hardware and software setup, colour detection (black and white) and its imaging can be done easily. The drawback of the existing subsystem is its complexity. This drawback will be overcome by this new technique of imaging.

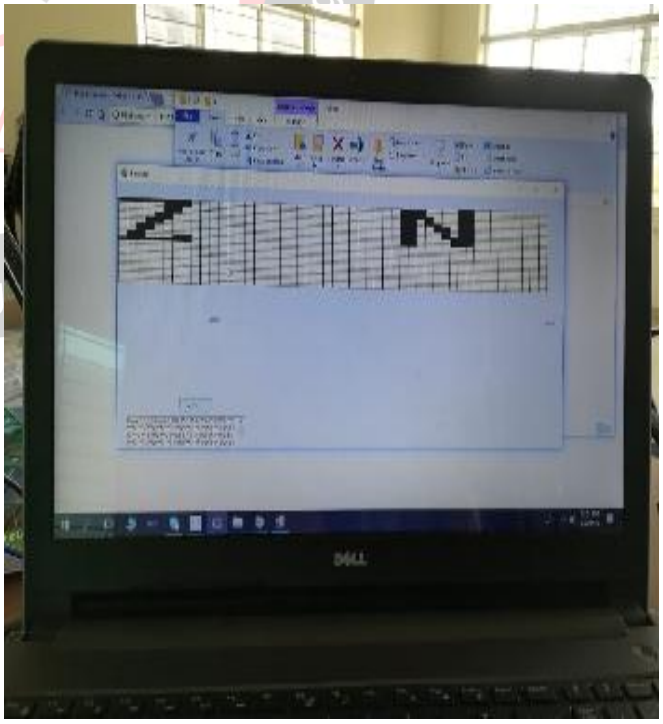

Fig 5: Imaging of the letter Z and N

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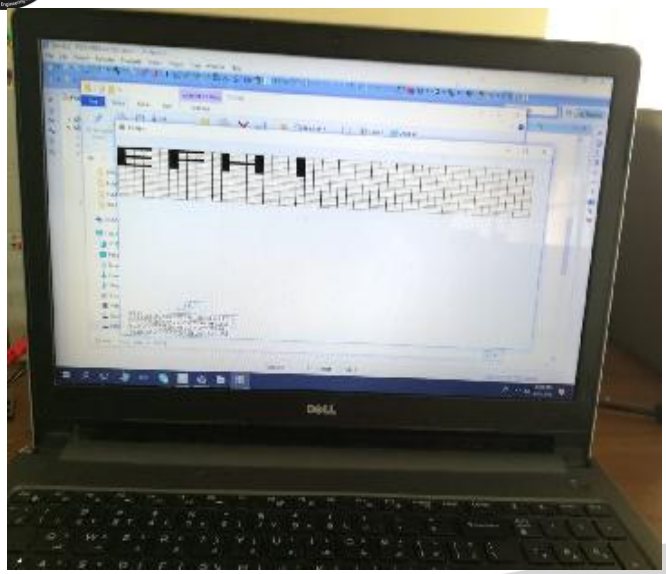

Fig 6: Imaging of the letter E,F,H and I

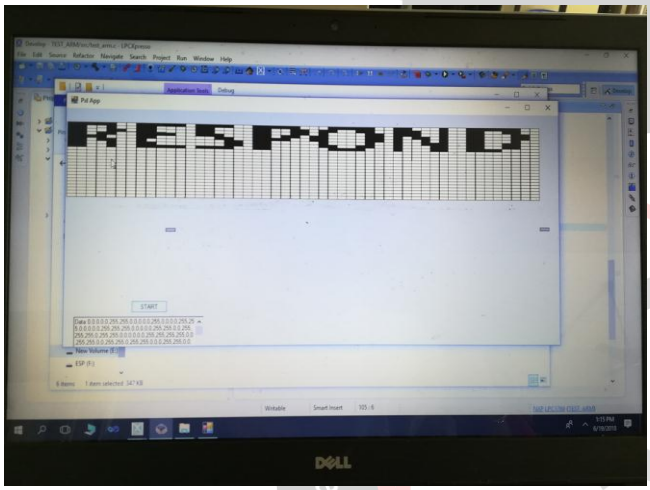

Fig 7: Imaging of the word RESPOND

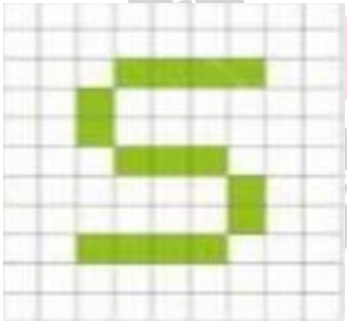

Fig 8: Imaging of the coloured letter S

The above subsystem has the ability to detect black and white images of the text only. But, if we use a more enhanced sensor module, then using this same experimental setup, we can easily detect colour images also. The example of imaging of the coloured letter S is shown in figure 8. Thus imaging of the text can be easily done with the above hardware setup and with the help of a laser module. Images with high resolution and high accuracy have been created using this setup.

IV. Conclusion

Hardware setup has been formed for scanning. This hardware setup is used to detect the colours (black and white) of the text to be scanned. Using this hardware setup, various texts have been scanned. Images of the scanned text are attached in the above sections. Real, life-like imaging is done with this scanner. Since imaging occurs in the reverse direction of X axis, imaging time is reduced compared to the available scanners in market. This setup can be used in barcode scanners. Its maintenance is cheaper compared to the scanners available in the market. Applications for scanning are expanding since technology advances in the areas of data quality, software processing and ease of use.

References

[1] Tekumatla Shivakumar, Manne Sai Sravan and K. Selvajyothi, "Python Based 3 –Axis CNC Plotter", in the Proceeding of 6th IEEE International Conference on Power and Energy(PECON 2016), Melaka, Malaysia, 28-29 Nov 2016.

[2] Venkata Krishna Pabolu, Prof. Sri K.N.H. Srinivas, "Design and Implementation of a Three Dimensional CNC machine", International Journal on Computer Science and Engineering, Vol. 02, No. 08, 2010, 2567-2570.

[3] Mostafa Abdel, Bary Ebrahim, "3D Laser Scanners Techniques Overview", International Journal of Science and Research (IJSR), 2013.

[4] Diamond, G. G., Hutchins, David A, "Research on 3D Laser Scanning Technology based on Point Cloud Data Acquisition", International Conference on Audio, Language and Image Processing,2014.

[5] Waveshare Laser Sensor User Manual.

[6] Yi- TiShiih, Chin – ShengChen, An-ChenLee, "A Novel Cross- coupling Control design for Bi – axis motion", International Journal of Machine Tools and Manufacture, Volume 42, Issue 14, November 2002.

[7] Byung-Sub Kim, Seung-Kook Ro, Jong-Kweon Park, "Development of a 3-axis desktop milling machine and a CNC system using advanced modern control algorithms", International Journal of Precision Engineering and Manufacturing, February 2010, Volume 11, Issue 1, pp 39–47.

[8] Wang Feng, Lin Hu, Zheng Liaomo, Yang Lei, Feng Jinjin, Zang Han, "Design and implementation of five-axis transformation function in CNC system", Chinese Journal of Aeronautics Volume 27, Issue 2, April 2014, Pages 425-437.

 DOI : 10.18231/2454-9150.2018.0366