Prototype Measuring Tool for CNC Cutter Connected to Microsoft AZURE

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ABSTRACT

Abstract-CNC machine has a vital role in the modern manufacturing process. Since the CNC machine can operate autonomously after inputting the g-code or program. Creating add ons tools for CNC machines which connected to the database will create efficiency during the CNC machine operation. Appertain to create measuring tools for CNC cutter contactless and connected to the database. Since several CNC cutters have been created from frail material and the conventional measuring process will affect the tip of the cutter. And also creating the measuring tools connected to the database means do not need to measure the cutter frequently. It caused by the measuring result will be stored in the database. This research was to solve those problems. Which has focused on creating contactless measuring tools which connected to the database with more efficiency and less damage to the cutter tip using a waterfall method to solve the puzzle of the research. The destiny of this research was can create contactless measuring tools and connect them to the database. And this research will be developed as well in the future. Which will be connected to the cutter storage. And create the CNC machine to run autonomously

Keywords— machining process, database, measuring tool, control system

I. INTRODUCTION

CNC machining plays a vital role in the growth of modern manufacturing. CNC machining can process raw materials such as metal sheets, steel beams, plastics, etc. [2], Into finished products like tools with specific shapes or specific equipment, using settings that are programmed by computers.

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Figure 1 CNC Machine During Operation

In order we need to use the CNC machine, we need to input several parameters into the g-code. The parameters have a function to prevent the raw material or the cutting tools from damage. it is caused by the parameters was include the dimension of the raw material, cutter dimension, and also the cutter type. Since each cutting tool has different dimensions, we need to measure all cutting tools before we can use them. Measuring the cutter using a conventional method several times will cause damage to the tip of the cutter. Since several cutters have been created from frail material, it means if we measure it frequently it can affect the condition of the tip. Especially if we use a vernier caliper while measuring the cutter. Cause the vernier caliper has been created from tough material. [1]. Measuring the cutter before using them also can waste a lot of time and be less efficient. If we can create a tool to measure that will be connected to a database, it will be more efficient for the production process. For example, we only need to measure once and the data will be stored in the database. If we need to use the cutting tool for the second time, we only need to call up the saved data from the database. Nowadays, many machining tools are connected to databases. That means we can download or upload a lot of information about the machine in real time. Referring to the CNC machining process, creating a database for measuring cutting tools can simplify the operation of CNC machines. 'Design and construction of a CNC cutting tool measurement tool connected to Microsoft Azure' is a tool that will make the operator more efficient in operating the CNC machine. Because this tool is equipped with a laser sensor and a camera for contactless measuring. This means that the accuracy of the measuring tool becomes more precise and accurate.

II. BACKGROUNDAND MOTIVATION

This research was conducted with the aim of improving previous research. Our research was based on references from several previous journals. In 2018, there was a study on manual measurement of cutting tools, and there were several reasons why this research continued using image processing for measurement. The first reference is a scientific paper in the form of a journal titled "Manual Measurement of Cutting Tools on a Coordinate Measuring Machine" written by I P Nikitina, C V Kamenev, and A N Polyakov in 2018. This study explained that manual measurement of cutting tools on CNC machines can cause damage to the cutting edge or tool, especially for certain materials like carbide. Therefore, the conclusion of their study is that carbide-cutting tools can only be measured using the CMM method. [1]

Regarding this research, the design that was created will also be developed into a presetter tool for CNC machines. This presetter tool will also affect the stability of the milling machine, and this journal is the second reference for the development of this design. This is because the design of the tool has a connection to the results of the study. In this tool design, it is hoped that it can become a presetter tool that works well so that the CNC machine can work optimally. The conclusion of the study is to explore the relationship between the length and diameter of the presetter extension, the frequency response function (FRF) point, and the stability of the milling machine. There are three case studies in this research: 1) the extension of the tool from the controlled surface during setting and measured by the presetter for validation; 2) the extension length of the tool from the surface is not controlled during setting and measured to update the program; and 3) the measured extension length is used to update the predicted stability limit and appropriate operating parameters in the program. The presetter measurement results with uncertainty are presented and determined using statistical analysis methods. For the tool diameter, the standard deviation of 90 separate tests is 0.0056 mm. For the tool extension, the standard deviation is 0.0080 mm. The receptance coupling substructure analysis (RCSA) method is used to predict the FRF point of the tool as a function of the spindle system, surface response, and tool response based on the measured extension length and diameter by the presetter. The uncertainty in the presetter measurement is increased to the FRF uncertainty point using Monte Carlo simulations. The distribution on the FRF tool point is then used to determine uncertainty in the milling process stability limit. Each of the three scenarios is then evaluated to understand its implications for milling stability. The study shows that the RCSA FRF prediction allows the correct milling parameters to be selected as free operations based on the measured tool extension length. [3].

The research methodology uses the waterfall method which has a project management approach that emphasizes a linear progression from the beginning to the end of a project. The process of development starts with analyzing the design. The next step was to define the result by creating a list of system control requirements. Then, it can proceed with the development of the required control system design. After that, developing the control system that have created, aiming to integrate the tool with the database we will use. Once the development is deemed sufficient, the next step is to test the system. This is to identify any shortcomings in the system that has been created so that improvements can be made.

III. GRID-ORIENTED SYSTEMFOR COLLABORATIVEU-LEARNING

The proposed system in this research will be described as well below on fig 1.

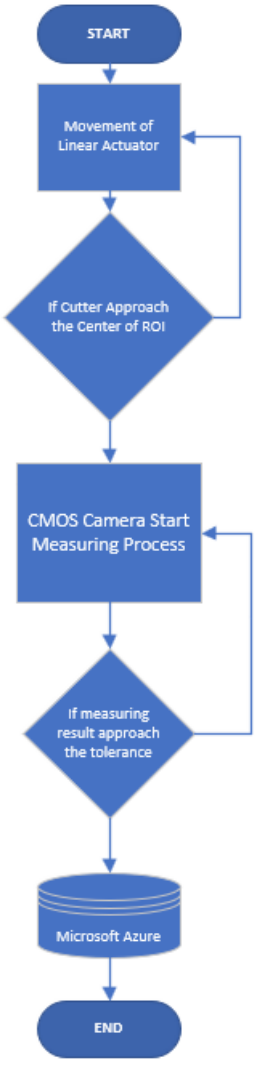

Figure 2 Flowchart System

The flowchart in Fig.1 explains how the measurement process work. Based on the flowchart, the measurement process will start by moving the linear movement actuator on the X and Y axes. After moving the actuator, we need to ensure

that the cutting tool is in the correct position using a camera. When it approaches the ROI at the labview interface, the camera will start measuring precisely. But before storing the data, it needed to input the cutter number, it has a function to separate the cutter based on it specification and dimension, also we need to input the actual dimension of width from the cutter. It needed because they need to compare between the measuring result and actual dimension. After it, if the measuring result approach the tolerance. It need to touch the enter button. It has a function to store the data After it is precisely at position 0 ensure the condition of the cutting tool. Once all processes are completed, if they are in good condition, the data will be collected by LabView and sent to the database.

A. Linear Actuator Block Diagram

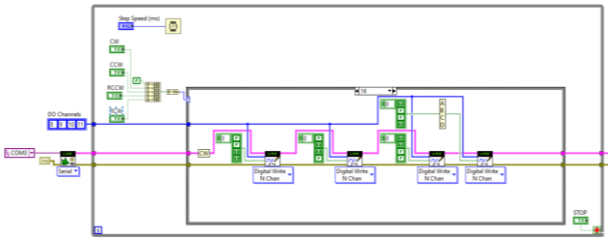

Figure 3 Linear Actuator Block Diagram For Y Movement

Linear actuator block diagram has a function to control the movement of linear actuator. As previously stated that we need to move the linear actuator. Which mean it need to be controlled by the labview. As it shown on Fig. 3 the linear actuator was controlled by the block diagram using Arduino which connected using the LINX Firmware Wizard on Labview.

B. Interface Block Diagram

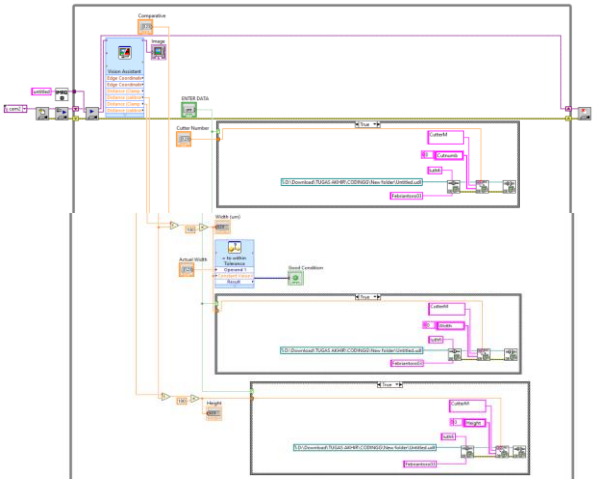

Figure 4 Labview Interface Block Diagram

As Fig.2. shown. It uses the vision assistant feature on LabVIEW. The feature can help process the image processing to get the measuring result. As previously stated that it will show the 2 measuring result in the interface. Now it can define how the result is converted. Since the output data from the vision assistant was on the pixel. But for the measuring result of the CNC cutter, require a milimeter [5]. So it will be converted by inserting the formulation described below

$$\mu m = \frac{\text{Result x (Pixel calibration)}}{\text{(Actual Measuring)}} \text{ x } 1000 \qquad (1)$$

As it is shown in Formula 1, the formulation to convert the nominal from the pixel unit to the micrometer. It cause that the database only can store the data only on numerical not in decimal, so it means we need to multiplied by 1000 nominee, so the database can store the data more precisely. The results from the measuring process will be multiplied by the pixel calibration which divided by the actual measuring. Then it will be multiplied by 1000 nominee which stated before on the first sentences in the paragraph. So after inserting that formulation into the block diagram code. It will be automatedly converted to the µm measuring result. This means it will make it easier for the CNC operator to use it. Also since it has accuracy down to micro it also helps the operator for inserting the CNC code parameter with more detail on the dimension parameter. Also it the measuring result can stored on the database with more precise and accurate. And it can prevent to damage the cutter if we use the conventional method.

C. Database Connectivity Block Diagram Code

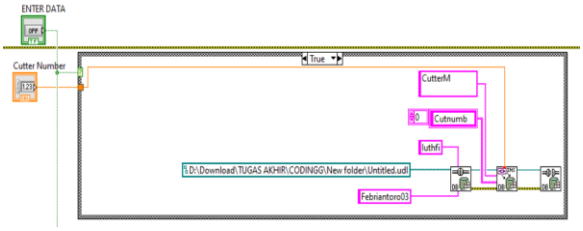

Figure 5 Database Connectivity Block Diagram for Block Diagram

Block diagram for connectivity has a function to create a connection from the measuring tools to Azure as a database. As previously stated, these tools will be connected to the database to help the CNC operator during the machining process. Which means they do not need to measure the cutter frequently. As shown on Fig 5. The block diagram has a function to store the cutter number data on the database. So it means it can separate several cutter which use numbering method for cutter identification.

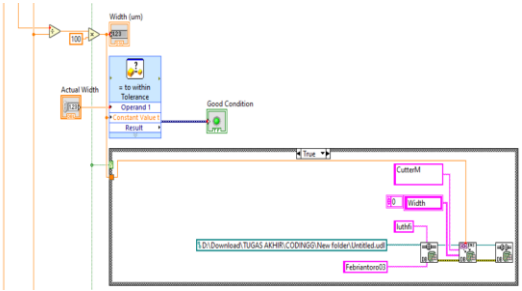

Figure 6 Database Connectivity Block Diagram for Width

As shown on Fig 6. The block diagram for width has a function to store the width dimension of the cutter to database. As stated before this tools has a function to measure the cutter which can connected to the database. So it means that the width dimension can be stored on database

Figure 7 Database Connectivity Block Diagram for Height

Database connectivity block diagram for height has a function to store the measuring result from the height of the cutter from the top of the chuck until the cutter tip. It means the height of the cutter which appear from the chuck surface can be measured precise and accurately and it can be stored on the database. This section was an important section from the measuring process before using the CNC Machine. It caused by the cutter height parameter on G-Code has a function to prevent the damage which caused by the cutting process on CNC Machine, raw material, and also the CNC Cutter.

D. Calibration

Calibration Process is the important thing in measuring process. Since measuring process need accuration and highly precise, it need to calibrated frequently. To calibrate this tool, it need to compare the pixel result which compared by the actual dimension. For that process it need to take a picture from the measuring tool, or indicator which has measuring unit in mm such as vernier calipper or etc.

Figure 8 Calibration Process(a)

After taking the picture, the picture need to open in paint in order to start comparing between the pixel and the mm unit. To get the result of the comparison, it need to use the line on paint, and start to draw the line between the length unit in vernier calipper or length unit indicator.

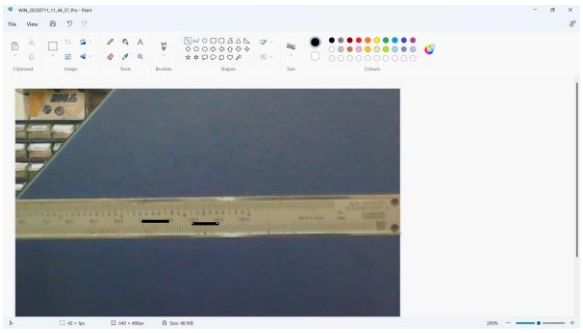

Figure 9 Calibration Process(b)

As shown on Fig 9., it need to start the calculation to compare between the pixel and mm. the method to compare it will be shown on the formulation below.

$$\text{Comparative Nominee} = \frac{\text{Pixel}}{(\text{mm Unit})}$$

Knowing that comparative nominee will help the tool user to makesure that the measuring process will show the result properly. The comparative nominee also will be inputed on the interface of the tool in LabView. Comparative nominee means that the 1 pixel shown in the screen is equal to mm or no. pixel means that the nominee shown on paint which will be compared by the mm unit which has the fixed nominee.

E. Simulation Limitation

In this research, the limitations of the simulation measuring method are. This tool only specified for the chuck BT-40. Also this tool only support the measuring range between the 80 mm, until 100 mm. as shown on Fig 10.

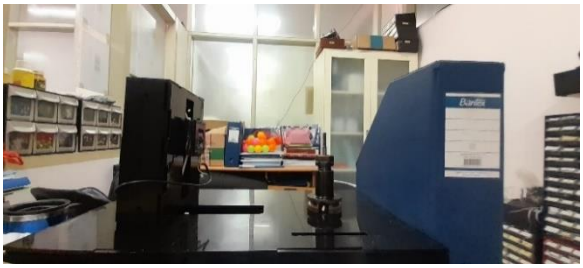

Figure 10 Distance Measuring Object

Also, this research will be focused on measuring the width and the height of the cutter. This research will Confidence interval for a single parameter to state the margin of error. It is used to count or state the measuring result [9].

IV. EXPERIMENTAND ANALYSIS

The simulation Result of this research is shown in Figure 5, which shows a lot of information sections, such as dimension section which contain the width and the height which show in micrometer. Since the database can store the decimal value, so it need to be stored in micro. Image section which show the measuring object, and also has a function to makesure that the measuring object was fit in the ROI. Enter button has a

function to store the data. Good Light has a function to prove that the measuring result was in the tolerance. Run CW and CCW button has a function to control the movement of the Linear Actuator. Cutter Number Section has a function to identify the cutter which will separate the measuring result in database. and stop button has a function to stop the measuring process.

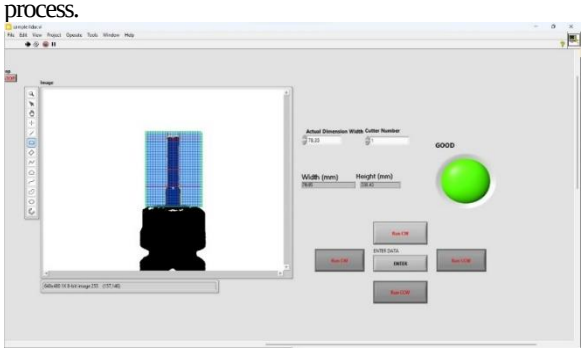

Figure 11 Simulation Layout

This measuring tool can measure the cutter with an accuracy down to micro. Since this tools will use the CMOS Camera [1], cause of that, so the user can input the data of the cutter dimension with more accuracy and precision. Since it was connected to the Microsoft Azure, and the data will stored on SQL Database. Also to more practice using CNC Machine, the data will be separate using the cutter number. It has a function to separate between each cutter. so that the user only needs to know which cutter number before use to check the data on a database. About the stored data on Microsoft Azure as a database will be shown in Table 1. For this experiment the experimental will take 42 measured data which has 2 study case and will be stored on database.

Table 1 Stored Data on Database

No.	CutNumb	Width (µm)	Height (µm)	Message
1	1	7751	37652	N/A
2	1	7750	37510	N/A
3	1	7810	37625	N/A
4	1	7775	37420	N/A
5	1	7800	37751	N/A
6	1	7785	37651	N/A
7	1	7790	37810	N/A
8	1	7810	37786	N/A
9	1	7795	37795	N/A
10	1	7743	37800	N/A
…	…	…	…	…
43	2	7985	37951	N/A

A. Margin of Error

The measurement process should include an estimate of the level of confidence associated with the value. Especially reporting an experimental result along with uncertainty allows other people to make judgments about the quality of experiments [7]. So, in this experiment counting the margin of error will compared the average measuring result with the actual value of the cutter which informed by the cutter specification.

$$\text{Relative Error} = \frac{(\text{Average Measured Value} - \text{Actual Value})}{(\text{Actual Value})} \text{ x } 100\% \quad (2)$$

The average measured value has meaning the average value from the measuring result. For the explanation, 2 study cases will be used for this experiment with different values of the object. The study case has a different value.

B. Study Case 1.

For study case 1 this experiment will use the CNC Cutter with a diameter of 7.8 mm. as the measuring object. the measuring result will shown such as below.

Measuring Result Study Case 1

No	Cut-Numb	Width (µm)	Height (µm)	Actual Dimension (mm)	Relative Error	Error Percentage
1	1	7751	37652			
2	1	7750	37510			
3	1	7810	37625			
4	1	7775	37420			
5	1	7800	37751			
6	1	7785	37651			
7	1	7790	37810			
8	1	7810	37786			
9	1	7795	37795			
10	1	7743	37800			
11	1	7750	37652	7800	0,001947	0,19%
12	1	7775	37795			
13	1	7810	37800			
14	1	7800	37786			
15	1	7795	37810			
16	1	7758	37420			
17	1	7789	37625			
18	1	7810	37800			
19	1	7780	37751			
20	1	7795	37651			
21	1	7810	37786			

As shown in Table II, the data from the simulation has a different measuring result, even though there they are same measuring object. It was caused by the measuring process using image processing relying on the lights. intensity, measuring background, etc. after getting the measuring result from the database which shown on Table I, the measuring result will be processed using the Formula 2.

For the processing data was shown on Table II. As shown on table II, the relative error was near 0,00194. Which mean this experiment on Study Case 1 has the error percentage on 0,1%. After processing the data, in this section will show the chart who compare the measuring result and actual dimension. The comparison between the measuring result and the actual dimension will be shown in Fig.6. As the chart show, the

measuring result has different value between each other. It was caused by many factors. Such as light intensity and many more. For the sample measuring result in the first time and the second time has a different value but they have measure same object. Measuring process using image processing will be have the disadvantages such as below. Since the measurement process will affected by light intensity and also the shadow which formed by the lighting position, etc.

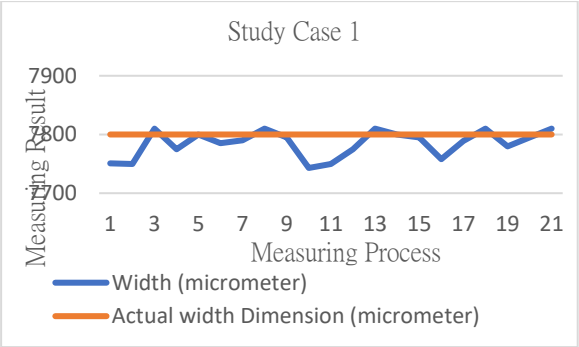

Figure 12 Study Case 1 Chart

On Fig 12. It show the comparative between the measuring result and the actual dimension from the datasheet. As it shown on fig 12. The measuring process using image processing have different value. That was prove the statement which declare that the measuring process using image processing was affected by many factor such as light intensity, measuring background, etc.

C. Study Case 2..

For study case 2 with a measuring object a CNC cutter with diameter of tip 7.9 mm as a measuring object. The study case 2 have acquisite 21 data, and it will be stored on database as shown on Table I and the measuring result will be shown below on Table III.

Table 2 Measuring result study Case 2

No	Cut-Numb	Width (µm)	Height (µm)	Actual Dimension (mm)	Relative Error	Error Percentage
1	2	7850	38701	7900	0,001952984	0,20%
2	2	7875	37794			
3	2	7889	38655			
4	2	7900	38490			
5	2	7855	38805			
6	2	7863	38540			
7	2	7859	38500			
8	2	7910	38598			
9	2	7905	38620			
10	2	7889	38695			
11	2	7864	38732			
12	2	7854	38790			
13	2	7890	38804			
14	2	7915	38754			
15	2	7924	38690			
16	2	7901	38810			
17	2	7893	38769			
18	2	7899	38810			
19	2	7900	38820			
20	2	7876	38815			
21	2	7865	38818			

And from Table III, this experiment will calculate the percentage of error using Formula 2. The relative error was near 0,001952 and for error percentage was shown near 0,195%. After getting the result from measuring, this experiment will show the chart which compare the actual dimension and the measuring result. For comparing result will be shown below in Figure 7. Same as study case 1, in the study case 2 also the measurement process will be affected by many factor. It was caused by the same factor that affect the measuring process using image processing.

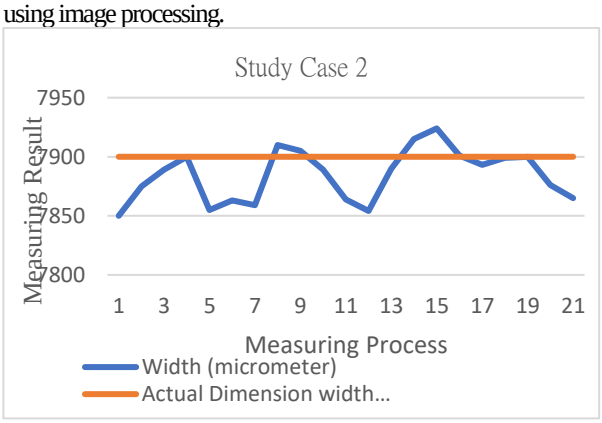

Figure 13 Study Case 2 Chart

For the comparing chart as shown on Fig 13. It compare the actual dimension which informed from the datasheet with the measuring result. As it shown the measuring result has a different value eventhough it has the same value from the object. It means that measuring process using the CMOS Camera was affected by many factor as stated before.

D. Comparative Result

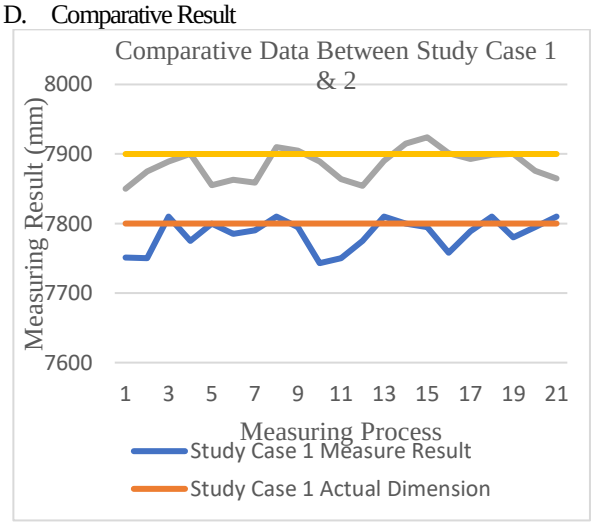

Figure 14 Cmparative Chart

As shown on Fig 14. It inform that the comparison between measuring result from study case 1 and study case 2 has a different value in graphic chart. Also from the Fig 14. It was inform that the measuring process using image processing method has more accuracy if the measuring object was lumping object. It was caused by the image processing method for measuring was based on the visual measuring.

E. Measuring Process Using Conventional Method

For comparison utilities, we need to compare the measuring method using image processing with conventional method. And the result will be show on Table IV below.

Table 3 Conventional Measuring Method on Study Case 1

No.	Study Case 1			
	Width (mm)	Actual Dimension	Relative Error	Error Percentage
1	7800	7800		
2	7760	7800		
3	7780	7800		
4	7800	7800		
5	7760	7800		
6	7760	7800		
7	7800	7800		
8	7760	7800		
9	7780	7800		
10	7800	7800		
11	7760	7800	0,003053	0,30%
12	7760	7800		
13	7780	7800		
14	7800	7800		
15	7800	7800		
16	7760	7800		
17	7780	7800		
18	7780	7800		
19	7760	7800		
20	7780	7800		
21	7740	7800		

Measuring process using the conventional method with vernier calipper has a result as shown on Table IV. In that table present that relative error which shown as 0,0030 with the 0,3 percent as error percentage. If it compared by the measuring result from the study case 1 which use the CMOS camera for measuring. It will has a quite different data. Since the vernier calipper only can measure the object with accuracy maximum 2 digits after the dots. Also the vernier calipper accuracy only approach 0,02 mm. so it affect the error percentage which show 0,3 percent of error. Which has a different with measuring method using image processing which has error percentage only 0,1% also the measuring result accuracy which can measure the data until micro with more detail. For the comparison chart between the actual dimension with the measuring result will be show below on Fig 15.

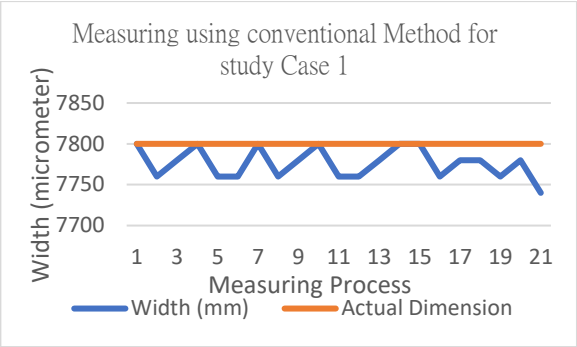

Figure 15 Study Case 1 Chart on Conventional Method

As show on chart the conventional measuring method has a advantage such as the measuring process wont be affected by light intensity, but as it shown on chart and table also the result was be specified on 3 digit.

Table 4 Conventional Measuring Method on Study Case 2

No.	Study Case 2			
	Width (mm)	Actual Dimension	Relative Error	Error Percentage
1	7860	7900		
2	7840	7900		
3	7820	7900		
4	7880	7900		
5	7860	7900		
6	7860	7900		
7	7840	7900		
8	7900	7900		
9	7900	7900		
10	7900	7900		
11	7880	7900	0,003857746	0,30%
12	7880	7900		
13	7860	7900		
14	7860	7900		
15	7900	7900		
16	7900	7900		
17	7860	7900		
18	7880	7900		
19	7860	7900		
20	7840	7900		
21	7880	7900		

Measuring result which use the vernier calipper as conventional method on Table V. has relative error near 0,038, and for the error percentage approach 0,4 percent. And if it compared with data which measured using image processing method it will show the contrast. As stated before that measuring process using conventional method have a maximum accuracy tolerance on 0,02 mm. furthermore measuring process using conventional method has a disadvantage such as accuracy and also it will affect the cutter. it can caused a damage on the cutter tip. Since the vernier calipper was create from a rough material, and several cutter was creat from the frail material. That's why the vernier calipper can damage the cutter. for the comparison chart will be show below on Fig 16.

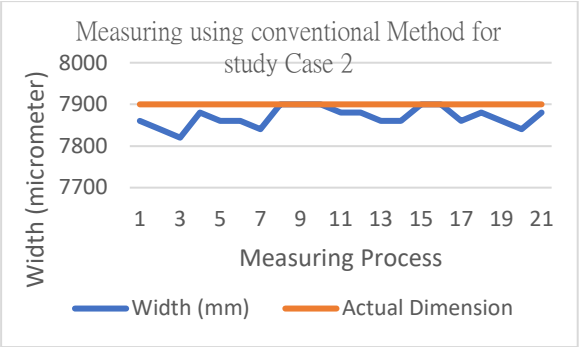

Figure 16 Study Case 2 Chart on Conventional Method

As stated before on study case 1 about the conventional measuring method have advantage. However the measuring process using conventional method has a disadvantage such as the percentage error approach 0,3 percent. Which means the measuring method using image processing has more advantage.

F. Comparison Between Image Processing Method and Conventional Method Result

In this experiment will compare the image processing method with conventional method which using the vernier calipper as a measurement tools. For the study case 1 the measuring result will show on Fig 17. As show on below.

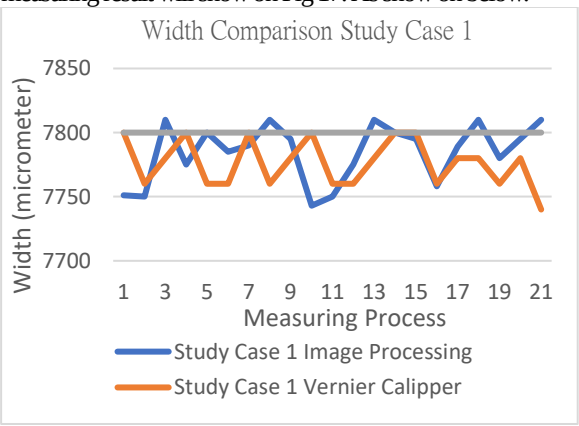

Figure 17 Width Comparison Study Case 1 Chart

For the comparison necessity we need to compare that 2 method for measuring with the actual dimension. For the study case 1, the comparison chart was show above on Fig 17. As it show on Fig 17. Measuring process using conventional method wont exceed the actual dimension. But the contactless measuring method which use the CMOS camera for image processing. Several time exceed the actual dimension.

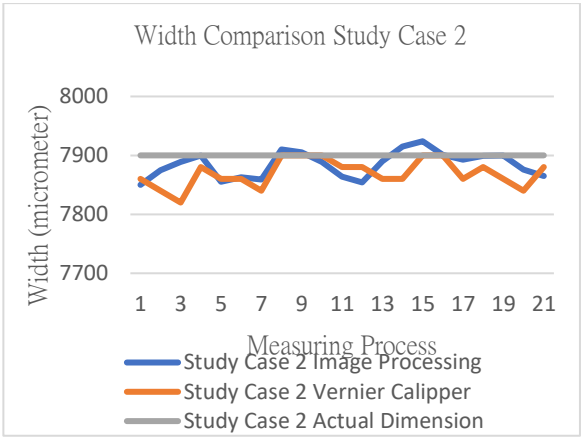

Figure 18 Width Comparison Study Case 2 Chart

For the study case 2, same as previous study case. The measuring process which use the image processing still exceed the actual dimension. But using conventional method which use the vernier calipper has a substantial margin which deficient from the actual dimension. So that was the result from the comparison between conventional method and contactless measuring method.

V. CONCLUSIONS

Based on the result and discussion, measuring object with a method using image processing have a lot of benefits. Such as less damage to the measuring object, measuring with high accuracy, and also can be connected to the database in real-time which means can store the data in the database easier, real-time, and more efficiently. However the measuring method using contactless measuring which use CMOS Camera or image processing method still have the disadvantage. In this experiment the contactless method was compared with the conventional method which use the vernier calipper as a measuring tool. Hopefully this research also can be developed in the future for creating storage for the cutter which is connected to the database. So the CNC operator just needs to input the type of the cutter into the g-code as a cutter parameter. But every benefit must have a disadvantage. The disadvantage of image processing such as the measuring result depending on the light intensity, camera quality, the distance between the camera and the measuring object, etc. from the result and discussion of the margin of error from the measuring process using image processing does not generate big gaps between actual dimension and measuring result. But every research still has to develop to build a new study.

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REFERENCES

[1] M. L. Oyoun, *Computer Numerical Control (CNC),* p. 1, 2020.

[2] V. R. M. S. M. P. N, "Study ON Computer Numerical Control," 2016.

[3] A. A. Aderemi Dada, *Production of Multiple Steps Shaft on CNC Lathe Using G-Code Programming,* p. 1, 2019.

[4] H. F. Reinhard Danzl, " Geometry and Wear Measurement of Cutting Tools," 2008.

[5] C. V. K. A. N. P. I. P. Nikita, "Manual measurements of cutting tools on a coordinate measuring machine," *IOP Conference Series: Materials Science and Engineering,* 2020.

[6] B. S. J., "Tech Target," October 2022. [Online]. Available: https://www.techtarget.com/searchcloudcomputing/definition/Windows-Azure. [Accessed 29 April 2023].

[7] E. A. B. L. A. S. S. T. Milton Vieira Juniora, "The role of tool presetting in milling stability uncertainty," 2018.

[8] Maple Tech. International LLC., "UnitConverters.net," [Online]. Available: unitconverters.net/typography/pixel-x-to-millimeter.htm. [Accessed 15 03 2023].

[9] College of Physic Labs Mechanic University of North Carolina at Chapel Hill, "College of Physic Labs Mechanic University of North Carolina at Chapel Hill," [Online]. Available: https://www.webassign.net/question_assets/unccolphys. [Accessed 15 3 2022].

[10] S. C. Lotus, "Chapter 14 - Confidence intervals for a single parameter," *Basic Statistics with R,* pp. 151-162, 2022.

[11] Y. L. Patrick W. Thompson, "Understanding of Margin of Error," 2005.

[12] M. M. Z. a. Hosny, *Basic Description of CMOS Camera Sensor and Color Precnible,* p. 2, 2017.

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