CMM MEASUREMENTS AND QUALITY CONTROL APPLICATIONS
CMM ÖLÇÜMLERİ VE KALİTE KONTROL UYGULAMALARI

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Özet

CMM'ler, imal edilen ürünlerin boyutsal doğruluğunu ölçen endüstriyel denetim araçlarıdır. Üretim kalitesinin izlenmesinde çok önemli bir endüstriyel ölçüm yöntemidir. Nesneleri X, Y ve Z ekseni boyunca ölçmek için tarayıcılar, dokunma tetikleyicileri ve görsel problar gibi farklı mekanizmalar kullanırlar. Daha sonra elde edilen ölçümler, bitmiş ürün ile aynı olduğundan emin olmak için ürünün ilk tasarım planları veya spesifikasyonlarıyla karşılaştırılabilirler. Müşterinin tercih ettiği tolerans seviyeleri dahilinde orijinal tasarım planlarıyla eşleştiğinden emin olmak için üretilen ürünlerin kalitesi izlenebilir. CMM'ler, proje bitmeden veya büyük hacimli çalışmaları tamamlanmadan önce sorunları hızla tespit etmek için üretimin farklı aşamalarındaki nesnelerin ölçümlerini yapabilirler. Akıllı fabrikalar, Nesnelerin İnterneti (IoT), Yapay Zeka (AI) gibi ileri teknolojileri kullanmalarıyla tanımlanır. Üretim sürecinde verimliliği, esnekliği ve kaliteyi artırmak için büyük veri analitiği kullanırlar. CMM bu süreçte önemli bir bileşendir. Parçaların ve ürünlerin fiziksel boyutları hakkında gerçek zamanlı verileri sağlayabilirler. CMM, akıllı fabrikaların ve akıllı üretimin geliştirilmesinde çok önemli bir rol oynamaktadır. CMM, akıllı bir fabrikanın verimli ve etkili çalışması için gerekli olan hassas ve doğru ölçümleri sağlar. CMM tarafından oluşturulan veriler, üretim sürecinin genel kalitesini ve doğruluğunu artırmak için kullanılabilir. Veriler, parçaların tasarımında veya üretim sürecinin kendisinde iyileştirmelerin yapılabileceği alanları belirlemek için kullanılabilir. Bu, verimliliğin artmasına ve atıkların azalmasına yol açarak üreticinin genel rekabet gücünün artmasına yardımcı olurlar. Ayrıca CMM tarafından oluşturulan veriler, parçaların bulunabilirliği hakkında gerçek zamanlı bilgi sağlayarak tedarik zincirini optimize etmek için de kullanılabilir. Bu, tedarik zincirindeki aksaklıkları en aza indirmeye yardımcı olur ve üretim sürecinin sorunsuz ve verimli bir şekilde ilerlemesini sağlar. CMM'ler, genel akıllı üretim sistemine entegre edilebilir ve böylece üretim sürecinin gerçek zamanlı izlenmesine olanak sağlarlar. Üreticilerin ortaya çıkan sorunları hızlı bir şekilde tespit edip çözmesini, arıza süresini azaltmasını ve kalite kontrol sürecinde üretkenliği artırmasını sağlarlar.

Anahtar kelimeler: CMM, Ölçüm Teknikleri, Kalite Kontrol, Makine Mühendisliği

Abstract

CMMs are industrial inspection tools that measure dimensional accuracy in fabricated fragile. It is a very important industrial measurement method for recording production. They use different mechanisms such as scanners, touch triggers, and visual probes to navigate objects through the X, Y, and Z program. Measurements obtained can then be aligned with the product's initial design plans or specifications to ensure it matches the finished product. Unwanted quality produced can be monitored to ensure that it matches the original design plans with tolerance levels preferred by the customer. CMMs can take measurements at different stages of

production to quickly identify problems before the project is finished or large volumes of work are completed. Smart factories provide connectivity by using advanced technologies such as Internet of Things (IoT), Artificial Intelligence (AI). They use big data analytics to improve production process efficiency, procedure and quality. CMM is an important product in this process. They can provide real-time data of parts and broken physical dimensions. CMM plays a crucial role in the development of smart factories and smart manufacturing. The CMM provides the precise and accurate measurements necessary for a smart factory to operate efficiently and effectively. The data provided by the CMM is available to increase the overall accuracy and accuracy of the manufacturing process. The data can be used to identify areas where it can be performed in part design or within the manufacturing process itself. This helps increase the overall competitiveness of the producer leading to increased efficiency and the regeneration of waste. The data provided by the CMM is also available to optimize the supply chain by providing real-time information on parts availability. This helps minimize disruptions in the supply chain and keeps the production process running smoothly and efficiently. CMMs can be integrated into the overall smart manufacturing system, allowing real-time monitoring of the manufacturing process. They enable manufacturers to quickly identify and resolve emerging issues, reduce downtime and increase productivity in the quality control process.

Keywords: CMM, Measurement Techniques, Quality Control, Mechanical Engineering

1. INTRODUCTION

CMMs are often used to evaluate a part or assembly to see if it adheres to the original design intent. CMMs are used in quality assurance or quality control workflows to examine the dimensions of produced components in order to avoid or address quality concerns. The advantages of employing CMMs over manual inspections or checks done with traditional metrology equipment like as micrometers and height gauges include precision, speed, and reduced human error.

In the world of manufacturing, being able to measure accurately and reliably is critical to quality production process control in the industrial industry. Coordinate measurement machines (CMMs) are one of the most efficient methods of establishing and enforcing stringent quality control. CMM inspection services are used as part of a complete production quality control procedure to ensure that all dimensions measurements are as planned. CMM inspections employ cutting-edge software to ensure that your machined components are the precise shape that they should be.

2. METHOD

Measurement of Coordinates Machines are industrial machines used to determine the dimensions of items. They measure things along the X, Y, and Z axes using various technologies like as scanners, touch triggers, and vision probes. The measurements can then be compared to the object's initial design plans or specifications to confirm that the completed result is sufficiently identical to the original design. CMMs are often made of granite and aluminum to provide functioning and accuracy even in extreme temperatures and conditions (Artkin F., 2022) (C. Veera A. et al., 2019).

Traditional CMMs use a probe that moves on three Cartesian axes to measure an object's physical characteristics, whereas portable CMMs use articulated arms or, in the case of optical CMMs, arm-free scanning systems that use optical triangulation methods and allow complete freedom of movement around the object.Portable CMMs with articulated arms feature six or seven axes with rotary encoders rather than linear axes. Portable guns are small and light enough to be carried and utilized almost anyplace. However, optical CMMs are becoming more used in the business. Certain non-repetitive applications, including as reverse engineering, quick prototyping, and large-scale inspection of parts of various sizes, are well suited for portable CMMs. Portable CMMs have several advantages. Users have the ability to take 3D measurements of all sorts of parts in the most remote/difficult areas. They are simple to use and do not require a controlled environment to collect precise readings. Furthermore, portable CMMs are often less expensive than regular CMMs.The fundamental drawbacks of portable CMMs include manual operation (they must constantly be used by a person) (Athanasios G., et al., 2015) (CWS, 2023) (Hansen H.N., et al., 2006).



Figure 1. The different types of CMMs.

3. FINDINGS

CMMs are widely utilized in both industry and laboratories. CMMS can do 2D dimensional measurements in addition to 3D measurements.Tactile-CMMs (contact CMMs) are frequently used as a reference to verify or check the findings of dimensions and geometrical measurements produced from optical CMMs (non-contact CMMs) due to their well-established traceability. Significant advances in CMM technology have been made recently, including the development of a 5-axis probing system for tactile-CMM, a high-speed tactile probing system, and a variety of optical CMM technologies, such as laser scanning and optical CMMs based on objective lenses (microscopy). Nowadays, there are various CMMs that are especially built to do certain measurements, such as fitting a specific production machine or being able to follow a specific component shape (technoxmachine.com, 2023) (M.B. Bauza et al., 2005) (teletecsi.com/blogs, 2023).

ISO1060 and ISO15530 are the two primary ISO standards that govern CMM. ISO10360 is for CMM performance verification. Meanwhile, ISO15530 is used to calculate measurement uncertainty from CMM measurements (wasyresearch.com, 2023) (Laser Scanners, 2023).

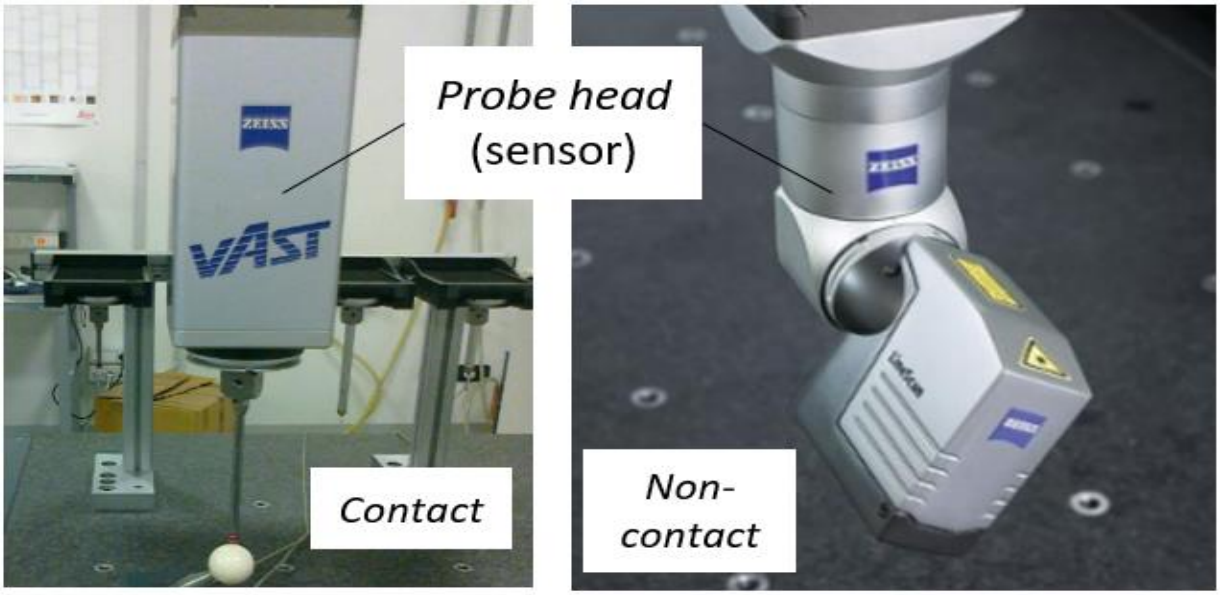


Figure 2. Tactile (contact) probing on the left and optical (non-contact) probing on the right.

Optical probing can be used to assess soft surfaces without causing harm to the surfaces. A laser-scanning head is commonly used on an optical probe placed on a Cartesian CMM. This laser-laser scanning head has a rather large laser spot of roughly 0.2 mm, limiting its capacity to measure minute details. Furthermore, optical probing cannot measure a vertical surface or a surface with a very high slope angle (greater than 80 degrees). Because reflected light from a vertical surface cannot be returned to the sensor (image sensor or photo-detector) of an optical probing device.

Furthermore, automated CMMs produce more consistent results since the impact of an operator may be avoided. A programmed CMM may automatically contact the same target repeatedly in a range of (0.005-0.05) mm, depending on the measurement, acceleration, and deceleration speed. In comparison, a manual CMM typically has a repeatability to contact the same target in a range of 5 mm, depending on operator expertise (Masour G., et al. 2015) (Weckenmann A., 2006).



Figure 3. CMM using in Manufacturing quality control.

The accuracy of CMMs is reflected by the maximum permitted error (MPE) criterion, according to ISO10360.MPE is described by ISO10360 as +- *(X + L/K)*, where is the accuracy level (for length measurement) of a CMM in, K is a constant, and L is the measured length in mm. It is critical to note that the variable L in the MPE indicates the impact of thermal expansion of a material and will impair the CMM's measurement accuracy. To calculate the MPE of a CMM, ISO10360 performance verification processes must be followed (WIZprobe Kit, 2023) (Robert J. Hocken et al., 2017).

4. RESULT, CONCLUSION AND SUGGESTIONS

3D laser scanning technology detects an object's form and gathers data defining the position of the object's outer surface. This novel technology has found applications across a wide range of industries, including discrete and process manufacturing, utilities, construction, archaeology, law enforcement, government, and entertainment. Over the last two decades, laser scanning technology has grown and developed to become a prominent surveying method for the capture of spatial information. A wide range of instruments with varying capacities is now commercially accessible. Laser scanners' high-quality data are currently employed in numerous surveying specialized domains, including topographic, environmental, and industrial.

These data contain dense point clouds that have been raw, processed, and altered; digital terrain and surface models; 3D city models; railroad and power line models; and 3D documentation of cultural and historical locations.

3D laser scanners use three primary sorts of techniques: Time-of-Flight, Phase Shifting, and The process of triangulating. 3D scanners are classified into three types: Airborne scanners, Teristerial scanners, Handheld scanners. Advances in technology in the areas of data quality, software processing, and ease-of-use are fast extending the possibilities for 3D laser scanning. The more effective product offerings improve the commercial benefits of 3D laser scanning while producing proportionately higher income.

5. REFERENCES

Artkin, F., CMM Machines and Industrial Applications, 1. International Conference on Engineering, Natural and Social Sciences, Pages 1029-1033, December, 2022, Konya, Turkiye.

Athanasios G., Dissertation: Reverse Engineering of an Impeller by using Laser Scanning Technology, International Hellenic University, June 2015.

C. Veera ajay, B. A. Pradeep, C. Boopathi, R. K. Sanjeev, V. Meganathan, Comparison of geometrical accuracy and surface finish of cam profile generated by wire-EDM and CNC milling machine, IOP Conference Series: Materials Science and Engineering, Volume 764, International Conference on Advances in Materials Processing and Characterization 10-11 September 2019.

Chromatic White Light (CWS). Hexagon Metrology US. Retrieved 2023-09-02.

Coordinate Measuring Machine History – Fifty Years of CMM History leading up to a Measuring Revolution, COORD3 Metrology Archived 2013-09-08 at the Wayback Machine. Accessed 23 August 2013.

Hansen H.N.; Carneiro K.; Haitjema H.; De Chiffre L. (2006). Dimensional Micro and Nano Metrology. CIRP Annals, 55-2, 721–743. doi:10.1016/j.cirp.2006.10.005.

https://www.technoxmachine.com/cmm-services/ received on 2023.09.01.

https://www.teletecsi.com/blogs/coordinate-measurement-machine-as-quality-control-tool received on 2023.09.02.

https://www.wasyresearch.com/coordinate-measuring-machine-cmm-an-introduction-types-considerations-and-applications/ received on 2023.09.01.

Laser Scanners. Hexagon Metrology.US. Retrieved 2023-09-01.

M.B. Bauza; R.J. Hocken; S.T. Smith; S.C. Woody (2005). The development of a virtual probe tip with application to high aspect ratio microscale features. Review of Scientific Instruments. Rev. Sci Instrum, 76 (9) 095112. 76 (9): 095112. doi:10.1063/1.2052027.

Masour G., Tsagaris A., Mansour M.T., Intelligent Interaction with CMM, IJMME-IJENS, Vol: 15, No:03, 154403-2828, 2015.

Robert J. Hocken (Editor), Paulo H. Pereira, Coordinate Measuring Machines and Systems (Manufacturing Engineering and Materials Processing), 21 April 2017.

Weckenmann A.; Peggs G.; Hoffmann J. (2006). Probing systems for dimensional micro- and nano-metrology. Measurement Science and Technology. Meas. Sci. Technol. 17, 504–509. 17 (3): 504. Bibcode:2006MeScT..17..504W. doi:10.1088/0957-0233/17/3/S08. S2CID 110372649.

WIZprobe Kit. nextec-wiz.com. Archived from the original on 2010-11-01. Retrieved 2023-09-01.

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