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High-Precision Optical Profile Projector

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ABSTRACT

The profile projector is a very useful optical instrument that is used in industries for the purpose of analysis of the shapes of the components used in different product. The profile projector males it easy to measure the dimensions of the specimen with high accuracy. The instrument can be used for the measurement of the components that have irregular shapes that cannot be measured with conventional methods. This projection screen displays the profile of the specimen and is magnified for better ease of calculating linear measurements. An edge of the specimen to examine may be lined up with the grid on the screen. Obtaining a complete 360° view of a general 3-D object has been of increasing importance in topographical measurements. This is particularly useful in 3-D solid modeling, robotic 3-D vision, quality control, biostereometrics, numerically controlled machining, and other industrial applications [4].

When used in conjunction with a precision stage (or precision scale) and image processing, a profile projector precisely magnifies and projects a workpiece onto a screen, allowing for the measurement and observation of the workpiece's shape. The accuracy of the measurement is dependent on how well the workpiece edge the line separating the workpiece shadow from the screen's light is detected. Without complex image processing, the measurement accuracy is currently several microns[4].

Keyword - Lenses, Moving Table, Mirror, Prism, Optical Communication.

1. INTRODUCTION

An optical device that can be used for measurement is an optical profile projector, sometimes referred to as an optical comparator or even a shadowgraph. It is a helpful tool for the quality control inspection team in a production line or small parts machine shop. The specimen's profile is enlarged by the projector and shown on the integrated projection screen. In order to align the screen's X-Y axis with a straight edge of the machined part for inspection or measurement, this screen usually has a grid that can be rotated 360 degrees. In addition to saving time, optical comparators also reduce operator fatigue, inspection time, retraining expenses, and ease of use with ergonomic designs.[5]

2. LITERATURE REVIEW

2005 Founded Resson Technologies Co., Ltd. was founded RESSON brand, began to design, manufacture aluminum shell counter and EVM series of 2D Video Measuring Machines (Because a long time overlap with China Easson brand, resulting in customers to misunderstand its brand and origin, a company founded in 2005 and a new brand).

2006 Began to design, manufacture RP Series Optical Profile Projector.

2008 Chiayi establish warehouses, primarily in preparation for storing materials and semi-finished products, and for future plant expansion needs.

2.1 Objectives

- To design an optical system that provides high-magnification visualization of small or complex-shaped mechanical components.
- To fabricate a profile projector capable of accurate linear and angular measurement of component profiles.
- To improve the quality control and inspection process by enabling non-contact measurement.
- To enhance the accuracy and repeatability of component measurements using optical methods.
- To develop a rotating projection screen with a 360° grid alignment for better inspection flexibility.
- To integrate a precision stage or scale for improved dimensional measurement capability.
- To utilize high-intensity lighting and lens systems for clear and glare-free image projection.

3. ACTUAL WORK

The specimen's profile is enlarged by the projector and shown on the integrated projection screen. In order to align the screen's X-Y axis with a straight edge of the machined part for inspection or measurement, this screen usually has a grid that can be rotated 360 degrees. This projection screen shows the specimen's profile and is enlarged to make linear measurement calculations easier. The grid on the screen can be aligned with an edge of the specimen to be examined. Simple measurements of the distances to other locations can then be made. A light source is attached to an optical profile projector. light past the component and into the optical system using a condenser or collimating lens system. An appropriate work table that can be stationary or mobile, with high-definition optics that include both mirrors and lenses. screen that displays the workpiece's images and serves as a measuring device for comparisons or measurements.[1] It should be mentioned that not all parts are well suited for optical gauging, even though an optical projector shows a two-dimensional projection of a part. The optical design, production, and assembly of an optical projector also affect its performance. Each of these elements has a direct impact on the image quality (definition and clarity). Either a vertical or horizontal screen can be used to create the object's shadow image.

Fig -1 : Optical Profile Projector

A reflected image of the object's face is created by surface illumination. For surface characteristics to be projected, high intensity light is necessary. It is possible to roject materials like carbon and ceramic that are dull and non-reflective in the surface illumination system by using a high intensity source that converges available light in a concentrated beam on a part.[6] On the work table are the objects that are being tested. The contour in the focal plane is the sectional contour or the largest size of an object that can typically be projected onto the screen.

There are two types of projector tables: stationary and mobile. Moving types can be either non-measuring or have facilities for measuring movement. Projector inspection is done on stationary tables. an optical system that uses the idea that by positioning a lens stop on the image side's focal point, the principle ray is aligned parallel to the optical axis. Its useful characteristic is that, even if the focal point is moved along the optical axis, the center of an image will remain constant in size due to image blurs. Because the ground surface's location dictates the position at which precise magnification is achieved, it is crucial to the projection system. Imperfections like burrs and scratches can be seen with optical profile projectors.[8]

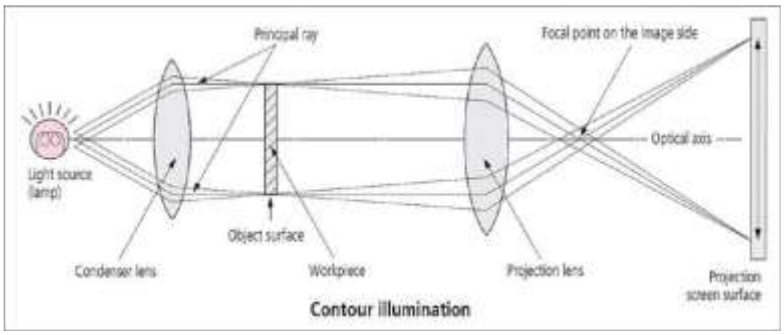
3.1. Related Works

James Hartness and Russell W. Porter came up with the concept of using a profile projector by combining measurement and optics in a single device. Before Hartness's work, the term "comparator" had been used in other contexts to refer to metrological equipment, but it had stayed in the domains of highly specialized applied science (like comparing master measuring standards) and pure science (like telescopy and microscopy). To standardize screw thread size, Hartness created the optical comparator. The invention has to do with profile projectors and

optical comparators, which are typically used in machine shops to examine an object's magnified image. In topographical measurements, obtaining a full 360° view of a general 2-D object has become increasingly important. This is especially helpful for quality control, biostereometrics, numerically controlled machining, 2-D solid modeling, robotic 2-D vision, and other industrial applications. Reconstructing 3-D shapes from multiple object views as viewed from various points of observation is one method that has been the focus of a lot of activity, particularly in computer vision research. Such a method of digital image processing is computationally demanding and typically provides only a limited level of accuracy. Using a peripheral camera in combination with the shadow moir6 method is a less common strategy. It requires laborious processing of fringe patterns captured on film and is mechanically clumsy.[2]

One of the most significant topics with many solutions is the measurement of linear displacement. Optical systems are among the most widely used because of their durability and frequently contactless features, especially when measuring rapid displacement changes. Furthermore, some of those systems (like optical interferometry) enable the measurement of linear displacements with resolutions and accuracies below the nanometer because of the physical principles that underpin their operation. When measuring tiny or extremely tiny linear displacements, optical interferometry is typically employed in a wide range of scenarios that call for high resolution and accuracy. This method is employed, among other things, in material science, scale calibration, and linear displacement measurements in machine tools. There has been minimal change in optical comparators. Over the years, improvements have increased accuracy and user-friendliness, but overall, optical comparators still look and work largely the same. Even so, an optical comparator is typically made to operate at its widest aperture in order to achieve the most work.[7]

4. PROPOSED SYSTEM DIAGRAM



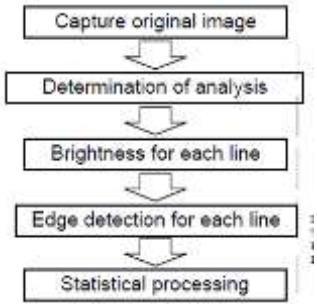


Fig -2 : Proposed System Diagram

4.1. Components

Reading Scale :- Specially designed for checking the magnified image of a standard scale on the projection screen.

Projection Lenses :- Magnifications of 5X, 10X, 20X, 50X, 100X, and 200X are available for projection lenses. For everyday applications, the 10X is typically the most adaptable. The size of the parts being inspected, the inspection area's diameter, the required magnification, and the lens's working distance all influence the decision.[9]

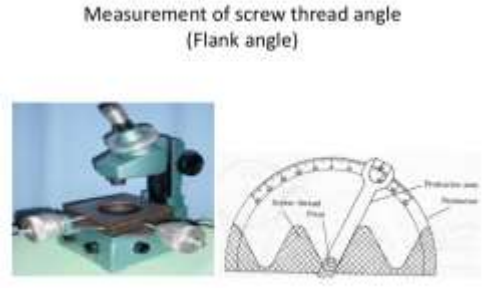


Fig-3. Reading Scale

Fig-4. Projection Lense

Fig-5. Screen

Screen :- The object's projected image shows up and is shown for examination on the screen. It is composed of finely grained ground glass, which produces a bright, glare-free image. The screen must display an image that is simple to measure accurately without wearing the operator out.[1]
Source of Light :- To prevent damaging heat transfer to the projector's operating components and optical system, the light source must be designed with a number of factors in mind. Consequently, a strong blower fan is typically used to mount the lamp house externally.[3]
Shadow Projection Light Source System :- In this system, light rays originating from the light source hit the object, whose physical body creates a shadow bounded by the actual contour of the object when viewed in the direction of light rays. This shadow is then magnified by the lens system and projected on the viewing screen.[6]

4.2 Types Of Optics System

- Simple optics: It incorporates a light source, a magnification lens, a main reflecting mirror and a screen. Machines with this design display images that are both upside-down and reversed.
- Corrected optics: This system uses two internal mirrors to flip the image so that it's displayed right-side-up, but it's reversed on the horizontal axis.
- Fully corrected system: which displays images that are both erect and unreversed.[9]

5. ADVANTAGES

- Largest possible picture :- Top projectors generate the biggest possible image size. You can use them to create the very large screen experience of a commercial movie theater in your own home. But in reality the size of any given projector's image is limited by its light output. Nevertheless, most projectors produce beautiful images at sizes of 90" to 120" diagonal, which is far larger than anything.[4]
- Low cost. :- Believe it or not, a Top projector can be the least expensive alternative for big screen video in your home. But even some of the best ones are now mass market consumer products and much more affordable than they used to be. And measured on a cost per diagonal inch basis, they are clearly the least expensive video products on the market.[9]
- Easy to install. :- The ease of installation can vary actually. But if you are setting up a simple system on a coffee table or a rear bookshelf and shining it onto a white wall, it really is as easy to set up as a simple television. They are lightweight, and one person can pull it out of the box, hook it up and get a picture on the base board with little trouble. Sometimes some adjustments are required to fine tune the picture so that it looks its best, but that is true of all video products including conventional televisions.[2]

6. LIMITATIONS

- Often, a dark room is needed. Like a movie theater, top projectors perform best in a dimly lit space. The picture has the most contrast and sparkle when viewed in a dark room. The brightness of your projector and how particular you are about preserving the highest possible image quality will determine whether or not you require a dark room.[5]
- Maintenance is necessary. :- Unlike flatscreen and conventional televisions, most projectors need maintenance. Every projector runs on lamps, which require periodic replacement and can cost anywhere in certain situations. Many projector users replace their lamps every two to three years, though this depends on the model and how often you use it. The majority of projectors have air filters that require cleaning or replacement every few months in addition to lamp replacement. While some projectors have sealed optics that solve this problem, most don't because doing so raises the unit's cost.[6]

7. APPLICATIONS

Profile Projector: Strong measuring instruments, profile projectors are frequently found in machine shops, quality control divisions, and occasionally on the floors of assembly shops. They work well for quality control and measurement of a broad variety of object sizes and weights. Finding a point or edge on the shadow and calculating its length from there is the most basic application for a profile projector. The operator is less likely to err when determining the beginning of the edge or point if the image is magnified. By, for instance, comparing an image to a standard to ascertain whether a part has been manufactured correctly, profile images can also be used to make straightforward stop/go decisions.[3]

8. CONCLUSIONS

Every day, manufactured parts are measured using optical comparators in a variety of global industries. Comparators can be utilized in a factory's incoming inspection areas, R&D labs, machine shops, assembly and production floors, and final inspection areas. They come with a wide range of features and options to suit various applications. Comparators are essential to any high-quality plan because of their adaptability, breadth of capabilities, and return on investment. Therefore, expanding the reach and transmission capacity of optical links is the goal of the ongoing development of optical communications. The application of coherent optical systems is currently highly significant and fascinating.

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