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Oral 3D Scanner Camera for Dental Treatment

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Abstract
Background/Objectives: The concept of digital workflow in the production of prosthetics, including CAD-CAM (Computer-aided Design / Computer-aided Manufacture) technology, which designs and processes prostheses and images, using 3D scanners in the dental field. More than 20 years have passed since its introduction. But most of this has been done only in the laboratory. The conventional method of taking an impression in the oral cavity and then scanning a three-dimensionally plastered plaster model in a laboratory room has become widespread. However, it is not long ago that the concept of digital flow is actively applied to the doctor's office by directly taking images of patients through digital oral scan.
Methods/Statistical analysis: Lattice pattern projection device is applied to high speed camera with high frame rate using small optical lens and image sensor and using one-dimensional laser scanner.
Findings: The grid pattern projection apparatus was constructed by using the one-dimensional laser scanner and the line laser, and the three-dimensional measurement was performed by irradiating the grid pattern image on the inspection object. Accordingly, compared with the prior art, it is simpler to manufacture and smaller in size than the conventional two-dimensional laser scanner and the dot pattern laser lattice pattern projection apparatus, and it is possible to manufacture the light source such as LED, halogen, etc. which is a problem of the conventional lattice pattern projection apparatus. It is possible to solve the problems of improvement of the light efficiency, focusing of the projection object and focusing, and the like, which occur when the light is collected. In addition, in the conventional grid pattern projection apparatus, it is difficult to measure 3D using a real-time grid pattern in a high speed camera due to a decrease in the frame rate when the grid pattern is projected, but this problem can be easily solved when the grid pattern projection apparatus is applied.
Improvements/Applications: Three-dimensional oral scanners provide a means for manufacturing dentures as well as implants without using rubber molds. Therefore, it can be widely used in dental treatment.

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1. Introduction

Recently, 3D scanners have been used in various fields such as machinery, construction, and clothing design [1-8]. The Dental 3-Dimensional scanner helps make the process of creating dentures, such as dentures, easier and faster during dental care. In dentists, patients usually bite rubber clay into their mouths and shape the teeth to be treated. When you harden it into a tooth shape, you pour plaster to make a mold, and then create an implant that fits the tooth. In this complex process, patients usually wait longer than a week before receiving a dental implant. But the oral scanner shortens this time. A vibrating toothbrush-like scanner scans your mouth in a minute or two, and the dental implant is completed in almost an hour. There is no need to use plaster molds. There is also an advantage in hygiene. When dental implants were made in the old way, bacterial infections could not be ruled out by sending a patterned box to the laboratory by courier. Using a three-dimensional scanner, only patient data needs to be sent to the laboratory, greatly reducing risk in terms of hygiene and time. For this reason, some patients visit a dental clinic with an oral scanner. On the other hand, as implants are becoming more common, 3D scanners are being used to form prostheses without shaping [9-13]. Dental 3D scanner is a dental device for obtaining a three-dimensional image from a two-dimensional image obtained by photographing a subject having a three-dimensional shape, such as teeth in the oral cavity to obtain the same image information as the actual image of the subject, tooth restoration, It can be used to acquire various three-dimensional images of the shape of teeth and oral tissues during dental treatment such as prosthetics [14]. In particular, older people are known to prefer oral scanners. When tooth patterns were made with existing rubber clay, it was often felt that there was a feeling of foreign body or wasted. But with just a few minutes of scanning your teeth, you can get your dental implants.

2. Grid pattern projection device

The three-dimensional measuring method of non-contact inspection object in the industry is mainly based on optical triangulation. The main methods are laser, lattice pattern, spatial coding 3D shape measurement method using camera, and Moire method. Most of these conventional measuring methods are composed of equipment for three-dimensional measurement. According to the three-dimensional measuring device of the inspection object, most of them are composed of a grating pattern projector and a camera-only dedicated equipment. There are problems such as price problems, constraints on installation space, and adjustment of the focus of the grid pattern image on the projection position when irradiating the grid pattern on the inspection object. As a method for measuring the surface shape of a transparent thin film layer, a white-light scanning interferometry (WSI) has been proposed. Overcoming this problem, rough surfaces and measuring surfaces with high steps can be measured with high resolution. The basic measurement principle of the white light scanning interferometry uses the short coherence length characteristic of white light. This uses the principle that the interference signal is generated only when the reference light and the measurement light separated by the beam splitter, which is an optical splitter, experience almost the same optical path difference. Therefore, if the interference signal is observed at each measuring point in the measurement area while moving the measuring object in the optical axis direction by a micron interval of several nanometers by a transfer means such as a PZT actuator, an optical path difference is generated where each point is the same as the reference mirror. At this point, a short interference signal is generated. When the generation position of the interference signal is calculated at all measurement points in the measurement area, information on the three-dimensional shape of the measurement surface is obtained, and the surface shape of the thin film layer is measured from the obtained three-dimensional information [15].

2.1. 2D laser scanner

Generally, laser scanners are classified into one-dimensional laser scanners and two-dimensional laser scanners. The two-dimensional laser scanner consists of an x-axis support and a y-axis support centered around a micromirror. When the signal waveform is irradiated onto the surface of the micromirror, the pattern image can be projected onto the screen member, thereby implementing a two-dimensional image projector. As a two-dimensional laser scanner, MEMS (micro electro mechanical systems) technology is applied to reduce the size of the two-dimensional laser scanner.

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However, the lattice pattern projection apparatus using the two-dimensional laser scanner is more difficult to manufacture than the one-dimensional laser scanner. Figure 1 shows an example of irradiating pattern image to screen member using two-dimensional laser scanner and dot laser.

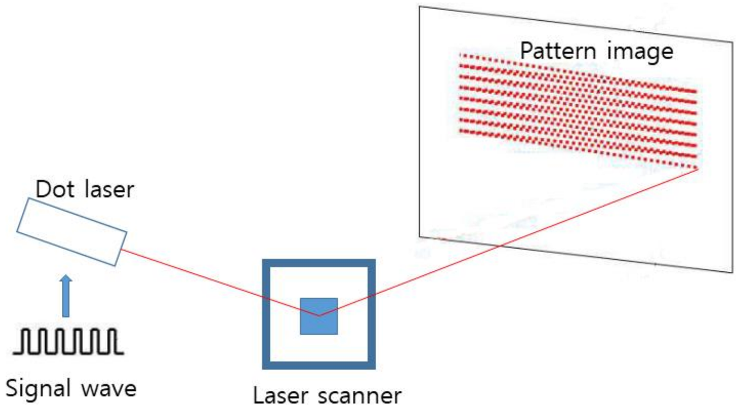

Figure 1. Example of irradiating pattern image to screen member using two-dimensional laser scanner and dot laser.

2.2. 1D Laser Scanner

It is possible to develop a grid pattern projection apparatus for a high speed camera having a high frame rate by using a one-dimensional laser scanner. One-dimensional laser scanner is composed of the x-axis support centered around the micromirror, and performs the x-axis rotational movement at regular intervals. Condensed and irradiated on the surface of the mirror, the light is irradiated to the screen member according to the rotation angle of the micromirror to project the image of the grid pattern is implemented as a two-dimensional grid pattern image projector. In addition, the signal waveform of the one-dimensional laser scanner can project the three-dimensional measurement grid pattern image by using the line pattern of the line laser during a half period of one rotation period of the micromirror. In the grid pattern signal generator, the signal waveform is transmitted from the one-dimensional laser scanner to the line laser of the grid pattern emitter during the 1/2 rotation period of the micromirror. The grid pattern is matched [16]. Figure 2 shows an example of irradiating pattern image to screen member using one-dimensional laser scanner and dot laser.

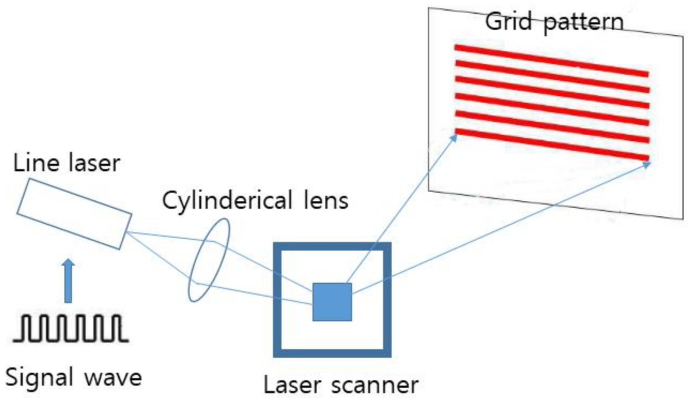

Figure 2. Example of irradiating pattern image to screen member using one-dimensional laser scanner and dot laser.

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2.3. 3D measuring device using grid pattern projection device

A drawing showing an apparatus for three-dimensional measurement of an inspection object includes image input means, grid pattern projection means, information processing means, and output means. The image input means receives a grid pattern image sequentially irradiated onto the inspection object by a camera and transmits the image to the information processing means, and is synchronized with the grid pattern irradiation time of the grid pattern signal generator. The grid pattern projection means is a means for irradiating the grid pattern on the inspection object, and comprises a grid pattern signal generator, a grid pattern emitter including a line laser, a cylinder lens, and a one-dimensional laser scanner. The information processing means sends a sequential grid pattern irradiation signal to the grid pattern projection means when the three-dimensional measurement is started. The grid pattern image irradiated to the test object is received from the image input unit, and the grid pattern image is sequentially stored in the storage unit. The storage unit may be configured as a memory or a hard disk. The output means comprises a monitor. The output means outputs a grid pattern image or three-dimensional image information processed by the information processing means. When the one-dimensional laser scanner is driven at 1,000 Hz, the grid pattern image may be projected at 2,000 frames per second. Line lasers can be fabricated in real-time three-dimensional measuring devices using grid pattern projection devices for high-speed cameras with frame rates of 2,000 or less, with modulations of about 1 MHz (480 lines x 2000 frames = 960khz). The image input unit receives a grid pattern image sequentially irradiated to the inspection object by a camera and transmits the grid pattern image to the information processing unit, and is synchronized with the grid pattern irradiation time of the grid pattern signal generator. When the three-dimensional measurement is started, the information processing means sends a sequential grid pattern irradiation signal to the grid pattern projection means, receives the irradiated grid pattern image from the image input means, and sequentially stores the grid pattern image in the storage unit. The storage unit may be composed of a memory or a hard disk. In addition, the CPU (Central Processing Unit), which is a central processing unit, extracts data for three-dimensional coordinates through arithmetic logic operation or image data processing using a sequentially input grid pattern image to form a wire frame and map three-dimensional text. You can compose an image. The output means comprises a monitor. The output means outputs the grid pattern image or the extracted three-dimensional image information processed by the information processing means. Figure 3 shows Grid pattern projection device for three-dimensional measurement of inspection objects.

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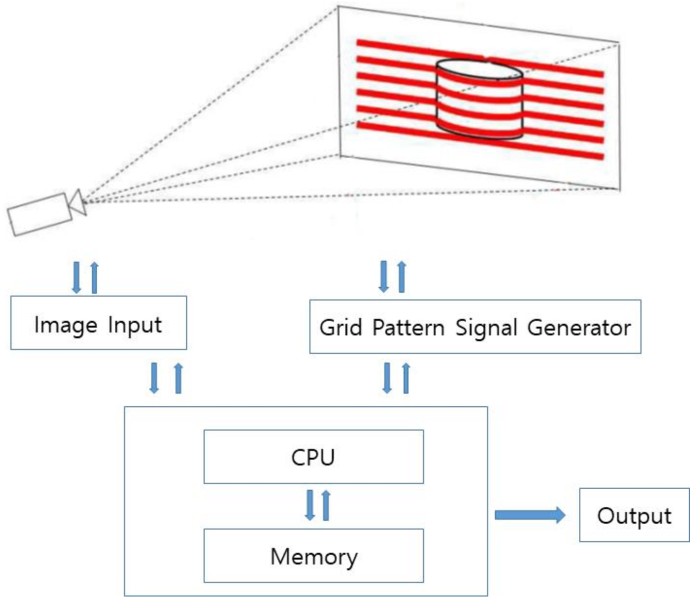

Figure 3. Grid pattern projection device for three-dimensional measurement of inspection objects.

3. Prototype development

3.1. Prototype design

3.1.1. Lens and image readout system design

The lens uses a combination lens with an aspherical lens to reduce aberration. Aspherical lenses reduce spherical and distortion aberrations, while combination lenses prevent chromatic aberrations [17]. As a lens, a wide-angle lens having a variable focusing function was applied mutatis mutandis. Image sensor has Full-HD resolution and can shoot more than 120fps. Image size is less than 1/3 inch, it is full color and Global shutter is applied. Figure 4 shows the flow chart for the imaging. Figure 5 shows the driving principle of the three-dimensional oral scanner in a block diagram.

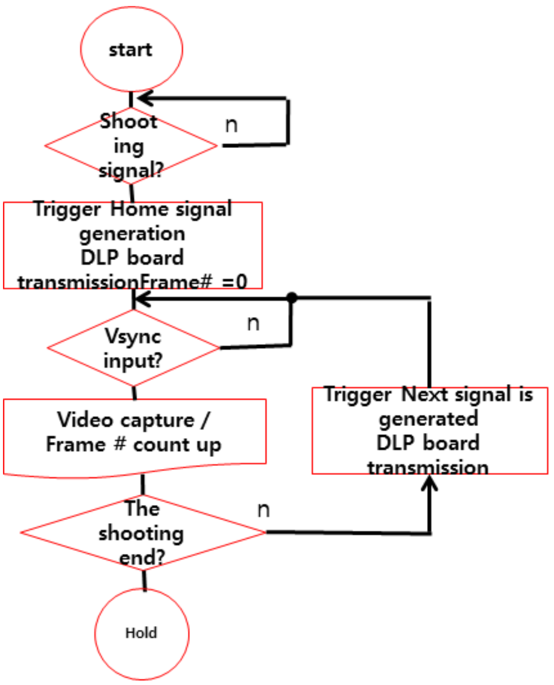

Figure 4. Design of Improved Decision tree algorithm for Educational Data minin

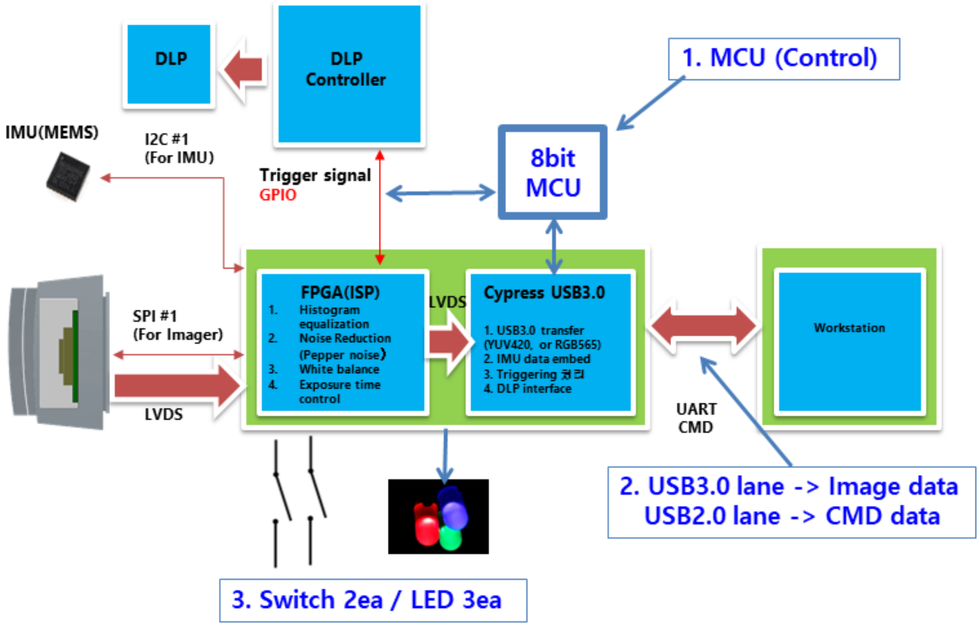

Figure 5. Driving Principle of 3D Oral Scanner

3.1.2. 3D Oral Scanner Design

Three-dimensional oral scanner was designed to meet the proposed specifications. Figure 6 is a perspective view of a designed three-dimensional oral scanner.

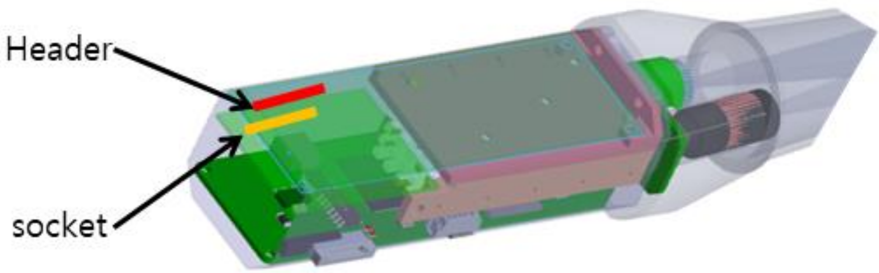

Figure 6. Design of 3D Oral Scanner.

3.2. Prototype production

Prototype was produced by combining camera module and readout system. Camera resolution was 1280x1024 and shooting speed was 165 fps. Figure 7 shows the combined state of the assembled internal components.

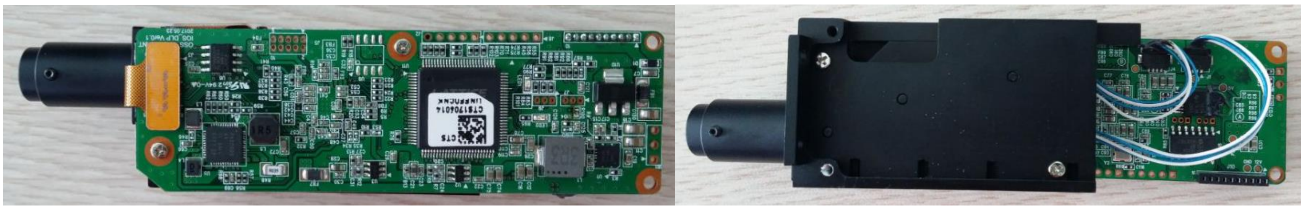

Figure 7. Internal assembled 3D oral scanner.

4. Results and Discussion

4.1. Demonstration

We have developed a compact handheld imaging device capable of performing three-dimensional imaging within the oral cavity and conducted basic experiments. Imaging and tooth design were performed to obtain meaningful results. Oral 3D scanning was performed using the manufactured equipment to secure spirituality. The impression acquisition process is very important for accurate prosthetics. This is especially true for precise prostheses, such as implants. The shape of the tooth can be optimized for faster capture and, if performed by a skilled technician, the shape of all oral teeth can be scanned within two minutes. It does not apply powder in the oral cavity, so it is precise and convenient. Figure 8 shows a three-dimensional scanned image.

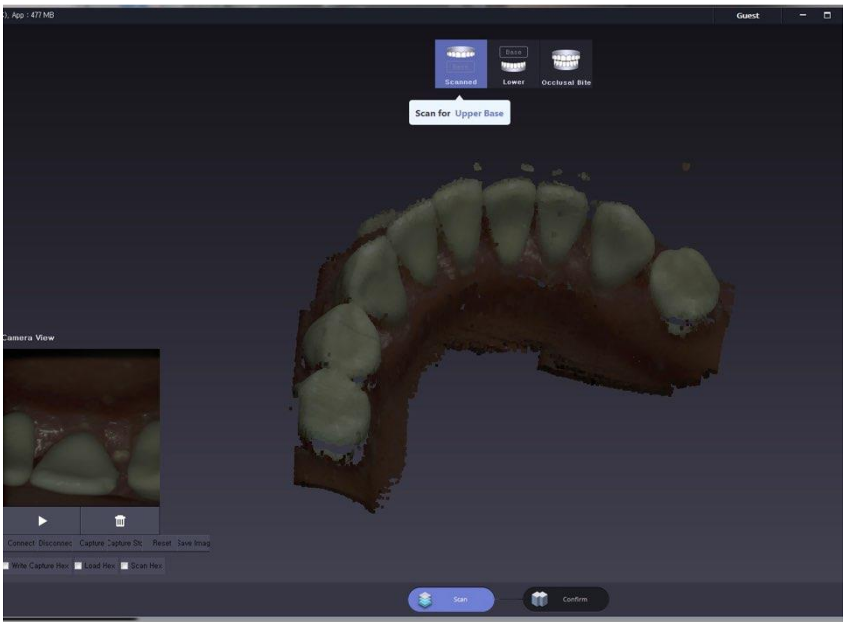

Figure 8. Design of Improved Decision tree algorithm for Educational Data mining

4.2. Effect of prototype

The advantage of digital oral impressions is that patients with severe gag reflexes do not use impression materials to reduce patient discomfort, reduce the risk of infection between the patient and the laboratory, and also keep data permanently when needed later. It has the advantage of being brought back from the library. In the conventional method, it is difficult to accurately capture the whole part at a wide range, such as acquiring a full-scale impression, but digitally has the advantage that only the wrong part can be compensated by the additional scanning method.

5. Conclusion

The older you get, the better your dental health should be. When I went to the dentist, I had to make a pattern to make a denture or an implant. Oral 3D scanners help make the process of creating dentures, such as dentures, easier and faster during dental care. Patients also have their own digital information, so they don't have to worry about problems with the treated teeth or implants. Not only can they produce the same implants as soon as possible, but customers can also take their data and see them in other hospitals. There is also an advantage in hygiene. When dental implants were made in the old way, bacterial infections could not be ruled out by sending a patterned box to the laboratory by courier. The use of 3D scanners reduces the risks of hygiene and time since only patient data needs to be sent to the laboratory. If the procedure is performed by taking a three-dimensional image of the shape of the teeth can reduce the labor of the doctor and the pain of the patient. The ridiculously expensive 3D imaging system is being introduced, but the development of cheaper localized equipment is important.

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