PERPENDICULAR DETECTION LEVEL FOR LAND SURVEYING

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Abstract—The objective of this research is to develop a device to detect perpendicular. This device is applicable to land surveying operations. In the land survey, theodolites or poles are set to be perpendicular. Usually people check the perpendicular visually. We are developing a digital level which is simple but have enough accuracy. The digital level measures the variation of the angle as the change of voltage. It uses a cheap and relatively simple circuit composed of LED and photo transistor. An LED is set just above the circular level. The LED sends an infrared right to a circular level to detect perpendicular. The bubble in the center of the circular level works as a concave lens. A photo detector is set directly below of the circular level. The appearance of the bubble is an indication that the piece is level. There is a shadow under the bubble. The quantity of light is measured by the phototransistor

Keywords- three-dimensional survey, digital level, phototransistor, AD conversion

I. INTRODUCTION

In land surveying, two people are needed usually. One person operates the total station or theodolites. The other holds the pole or stuff perpendicularly. It is not an easy task changing positions of the pole and set it vertical.

Usually perpendicular is checked visually. However if the perpendicular is checked automatically, the work of land survey will be improved. In this research, a new method to detect perpendicular is developed. It uses a circular level and simple circuit including a light-emitting diode (LED) and a phototransistor.

II. PRINCIPLE

There are two types of bubble tubes to detect the perpendicular or the level. One is a pillar tube and the other is a round shape type tube. Both of them have a liquid and a bubble. The pillar tube detects one-dimensional level and the round shape type tube detects two-dimensional level.

Light is projected on a pillar type bubble tube or a round shape bubble tube using a LED. The appearance of the bubble in the center of the circular vial is an indication that the piece is level. The bubble in the liquid works as a concave lens, the light passing through the bubble is spread. The bubble tube inclines and the shadow of air bubble moves. Light quantity of the shadow was measured by the phototransistor. The displacement of the shadow is expanded by projection of light.

To avoid the interference of visible light, we used infrared (IR) LED. Also to detect only infrared rays, we used a phototransistor with IR filter PT480F.

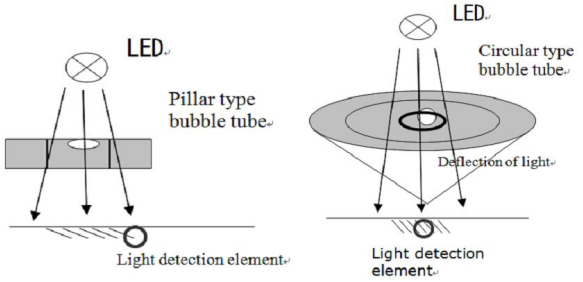


Figure. 1. Concept of measuring the perpendicular by pillar type tube and circular type tube

An experimental arrangement for the verification experiments Developed Perpendicular detection device was fixed to an inclinometer and verification experiment was conducted. The normal inclinometer has only the accuracy of about 0.1 degree.
Therefore micrometer was used to move the right end up and down and the left end was fixed and can be rotated. The experimental method is shown in figure 2. A pillar type bubble tube was used for this experiment.

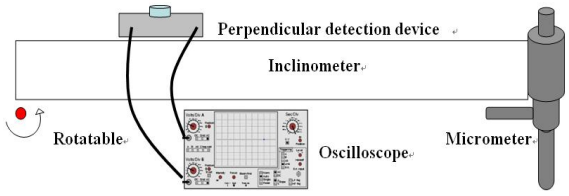
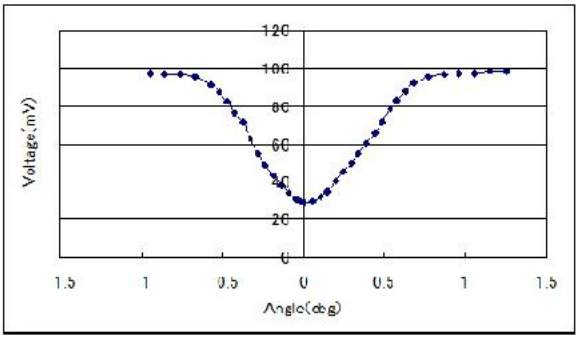


Figure 2 Experiment Arrangements.

When micrometer rotates clockwise the inclination angle of the Inclinometer was increased .Therefore bubble of the perpendicular detection device moved. Because of this, light quantity which passes through the bubble was changed and the voltage which generates inside the phototransistor was also changed. This voltage was measured and viewed by an oscilloscope.
Graph 1 shows the relationship between voltage and angle. The voltage of phototransistor is sensitive to the

small change of angle of the system.



Graph 1 relationship between voltage and angle

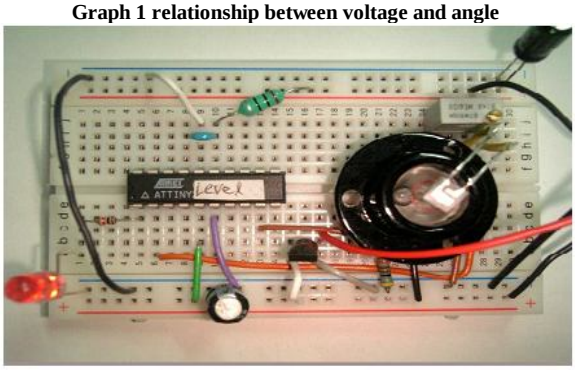


Figure3 Picture of the circuit

We developed an experimental perpendicular detection device. This equipment checks the perpendicular and notifies it by a visible LED. The picture is shown in Fig. 3 and the circuit is shown in Fig. 4.

In this circuit, when IR LED emits light that passes through the bubble, the light quantity is measured by the phototransistor and the AD conversion is done by a microcomputer. AT-Tiny26 Microcomputer was used for the AD conversion circuit.

As shown in the graph 1, when the equipment is set to level, the voltage of the phototransistor becomes minimum value. We can set a threshold voltage to determine the equipment is level or not. The microcomputer detects the voltage and lights the red LED when the equipment is not level.

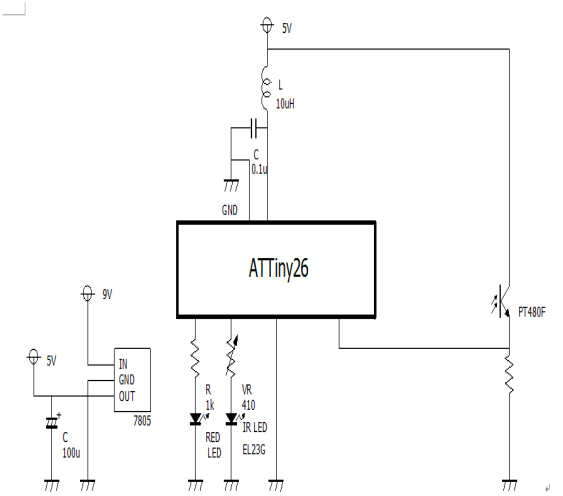


Figure 4 Circuit diagram

CONCLUSION

We proposed a method to detect perpendicular with a bubble tube, an IR LED, and a phototransistor. The sensitivity of the system was experimentally evaluated. And an experimental perpendicular detection device was developed and it works well. This device checks the perpendicular and notifies it by a visible LED.

Using this method to detect perpendicular, the efficiency and the accuracy of the work of land survey will be improved.

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