



## Proposed model of an earthquake detector by using UBG-04LX-F01 laser rangefinder

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**Abstract**— This paper presents the earthquake model by using a laser rangefinder while using laws of reflection and few trigonometric equations. It give very quick output and very accurate. As it is known that the earthquake is the most destructive force of the nature, in present number of detectors are used to detect the earthquake. Here a new detector is proposed to detect the earthquake by using a laser rangefinder. The laser rangefinder gives the output very fast and its sensing ability is also very good, that is why it is used with a mathematical approach [3] to detect the earthquake in this proposed model .The sensor response to the surface properties like reflected property and its intensity changed w.r.t material properties. This whole approaches used in this paper to detect the earthquake.

**Keywords**- laser rangefinder, UBG-04LX-F01 laser rangefinder, LIDAR

### I. INTRODUCTION

As there are many detector that are used now a days to detect the earthquake. An earthquake is occurred due to the movement of the tectonic plates of the earth. Due to the moments of the plates the upper layer began shake and it is called and earthquake. As few years ago Japan was destroyed by Tsunami, Tsunami is also occurred by the earthquake that happens inside sea. Now a days we required a very quick response earthquake detector that will detect the earthquake as soon as possible, so that many lives can be saved by giving warning to people before earthquake will give strike with full strength. This paper presents the proposed model of an earthquake detector by using a laser rangefinder. As a laser rangefinder give a very quick output because it use laser as a core element and the speed of laser light is very fast so it give very fast response.

LRF Hokuyo make UBG-04LX-F01 (UBG) is shown in Fig. 1 use the phase shift measurement principle to detect the distance to a target. The characteristics and the calibration model of URG were proposed by Okubo et al. [1] and Kneip at al. [2].Phase shift principle works on the change in phase of receiving wave of laser with the sending wave. We use few laws in this proposed model like laws of optics and few trigonometric equations. The basic thing that is used in this proposed model is the reflection of laser light that is usually happen when a highly reflected surface is placed in front of the laser rangefinder study by Ravinder Singh [3]. This is one of the disadvantages of a laser rangefinder but here we use this disadvantage as an

Advantage of making a proposed model for an earthquake detector.

UBG is the new and small LRF has improved specification compared to the earlier Hokuyo LRFs. This paper is organized as follows: in section 2,we present an overview of the sensor and its working principle i.e. phase shift principle .In section 3 the experimental setup for the proposed model of earthquake detector of our study and in section 4 provides the conclusion and result for the paper.



Fig 1. UBG-04LX-F01 laser rangefinder,

**II. OVERVIEW OF THE HOKUYO UBG-04LX-F01**

Main specifications of the UBG are given in Table 1. The measurement system with LRF is the fast. It consists of a laser diode, a photo diode, a mirror, a lenses and an actuator. The actuator rotates the mirror and the lens with the speed of 2140 rpm, due to the rotation period of 28 ms and the photo diode measure 682 steps on the 240 per one rotation and therefore the angular resolution is  $0.352^{\circ}$ . Note that the minimum measured distance is 20 mm and the data, less than 20, are error code resulting from certain circumstances.

**A. PHASE SHIFT PRINCIPLE**

Higher precision, in the domain of millimeters, and higher measurement rates, can be obtained applying the phase shift measurement principle. A c/w (continuous wave) laser is used as the carrier for a signal modulated onto it, typically using amplitude modulation. The phase of the emitted and the received signal are compared. The relation between phase differences,  $\Delta\psi$  given in radians and the one-way range is:

$$r = \Delta\psi / (2 \times \pi) \times \lambda / 2 + \lambda / 2 \times n \text{ ----- (4)}$$

Where  $\lambda$  is the wavelength in meter and n is the unknown number of full wavelengths between the sensor system and the reflecting object surface. Choosing, e.g.,  $\lambda=100m$ , means that there is a unique measurement range of 50m. All measurements to objects further away will be folded into the first 50m interval. The precision of the measurement is in the order of one percent of the phase and can even be better. With the values from above this would result in a measurement precision of  $\pm 50cm$ . This problem can be solved by using more than one modulation wavelength, i.e. two or three wavelengths (Figure 2). Then, the longest wavelength defines the uniqueness range and the shortest wavelength defines the precision that can be obtained. Higher ranges for “pulse round trip” and higher

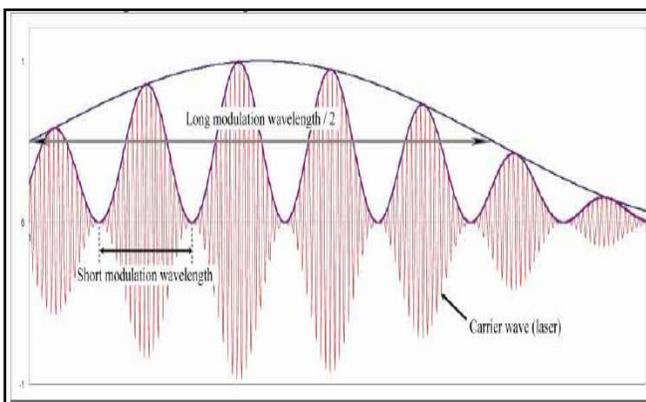


Fig. 2 Schematic drawing of two modulation wavelengths and carrier wave for phase-based laser ranging.

Table .1 specifications of UBG-04LX-F01 laser rangefinder

S.No	Specification	UBG-04Lx-F01
1	Measured distance	20-5600mm
2	Measurement resolution	1mm
3	Measurement error	Up to 1m: +/- 10mm
4	Scanning angle	240 <sup>0</sup>
5	Angle resolution	0.36 <sup>0</sup>
6	Scan frequency	36hz
7	External dimension	60x75x60mm
8	Power source	DC 12V

**A. EXPERIMENTAL SETUP**

Experimental setup consist of a transparent glass box , in which a wooden block hanged up by using two springs or threads, so that little vibration of the earth will make the wooden block moving. Note that the wooden block should be hollow from inside, to make it light in weight because lighter in weight, more easy it will move when vibration occur. We fixed 10 pieces of different color of equal size on the wooden block as shown in figure.3.The laser rangefinder

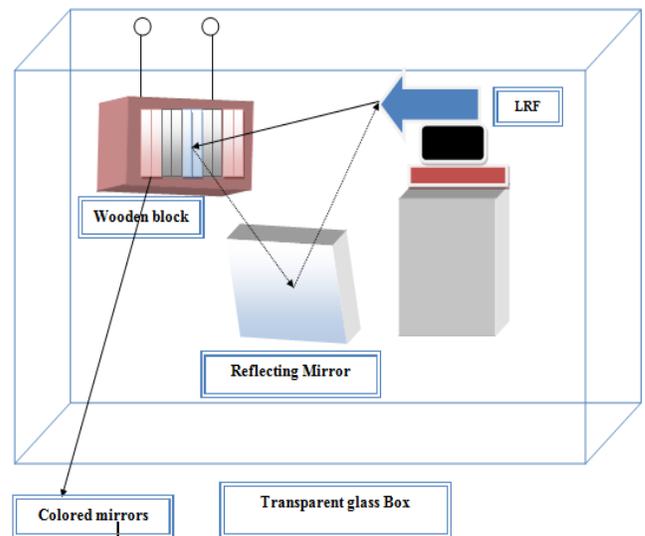


Fig.3 Experimental setup

is placed at approximately 15cm away from the colored mirrors at the same height as of the colored mirror. The reflecting mirror is placed in such a ways that the laser strike on it, always reflected toward the laser range finder. As we know that the laser rangefinder scan 240<sup>0</sup>, now select that ray that will strike on the colored mirror at an angle 45<sup>0</sup>. After strike it again reflect toward the reflecting mirror and

finally reached the laser rangefinder. Note that the wooden block is hanged up in such a way that it will be stable when there is no earthquake, because if it move without earthquake, it will give false reading during output taken by it. It should be fix in such a way that it remain stable so that when laser beam fall on it should reflect at  $45^0$

**A. Communication Interface**

The sensor is compatible to interface the host computer by using USB and the RS-232. The maximum transfer of USB interface is 9 mbps and the maximum transfer rate of RS-232 varies from 115.2Kbps to 750 Kbps. The interface is supported by two transfer protocols SCIP 1.1 and SCIP 2.0. SCIP 2.0 and the USB are selected in this paper for range measurement. Here we are using USB cable for connecting the laser rangefinder with the computer because it is easy to use and easily available in the market with low cost as compare with the RS232

**B. Drift effect of the Sensor**

Drift effect is known characteristic of the LRF and it has also been defined as “warm up time” by some researchers [1]. In order to observe the drift effect, the distance between the target and sensor was fixed at 2000 mm. the sensory information is logged for two hour as the result is given in the Fig. 4. It shows that as the time goes on, the measured distance is decreasing during the first 40 minutes.

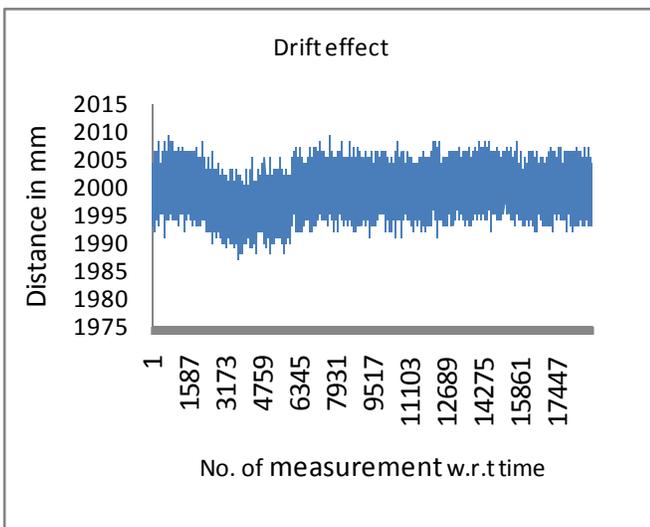


Fig.4 Drift effect on LRF

**C. Effect of intensity on the laser rangefinder**

Variations of intensity always affect the measuring result of the laser rangefinder. This variation in intensity occur due to these phenomenon refraction, reflection and absorption of laser light as shown in fig.5. We place different color mirror

in front of laser rangefinder, as we know due to different color mirror, there will be a variation in the intensity of the laser beam that are reflection from the mirrors. Variation of intensity always effect the laser rangefinder as study by Xiaomei Xu [4]

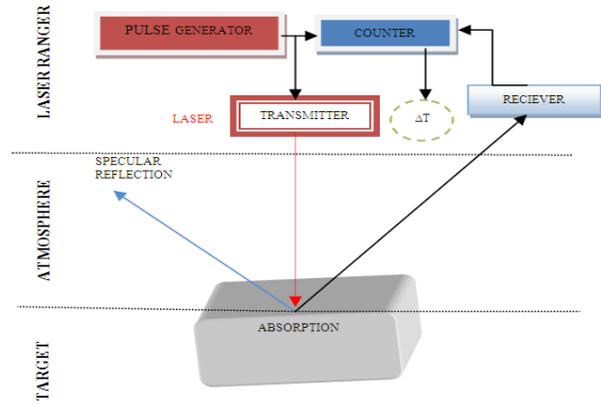


Figure.5 Cause of variation of intensity

**D. Use of Different color mirrors**

We use different color mirrors because the different color has a different tendency of absorbing and reflecting of light; this phenomenon is used in the model to get the result. Here three different color mirrors is used and due to these different color mirrors there will be a change in the intensity of laser beam that is reflecting from it after striking. When this reflected laser beam reached the laser rangefinder, we get reading on the computer. As it known that black color has the highest tendency of absorbing light with respect to other color same as we can use other color that have the absorbing characteristics. Every time when he beam strike on the black mirror it shows more variation n the reading as compare to other color that we are using. We use three different color mirror. And these three different colors has different tendency to absorbing color, so we always get different reading on computer with respect to more vibration of the wooden block. More vibration of wooden bleak is due to more strengthen earthquake

**E. Working of proposed model**

According to the experimental setup shown in figure.3, for an easy understanding a simple model is also given in figure.7. We select a laser beam of the laser rangefinder that exactly strike the colored mirror at an angle  $45^0$ , as according to the laws of reflection, when a beam of light strike a plane mirror it will reflect at the same angle as that of incident. After striking the colored mirror it will strike the reflecting mirror at an angle of  $45^0$ . At reflecting mirror same law is applied and the beam will again reflect at angle  $45^0$  and finally reached the laser range finder. This is the working of the whole model when the wooden block is at

rest i.e. there is no earthquake. At this stage the laser rangefinder shows a constant reading, now let us consider an

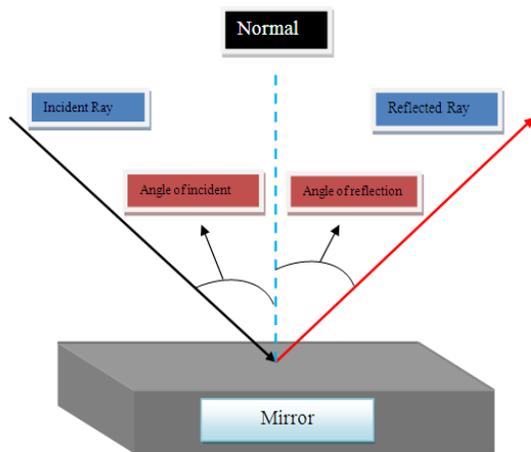


Fig. 6 Laws of reflection for a plane mirror

earthquake occur, due to earthquake the wooden block tends to move. Due to movement of wooden block the laser beam strike on the black or red mirror depend upon the strength of earthquake. Due to change in color of the mirror there become a change in intensity of the laser that are coming from the laser rangefinder, due to variation in the intensity the laser rangefinder shows variation on reading. As we know the laser rangefinder shows the distance between the target and the sensor, here same principle is

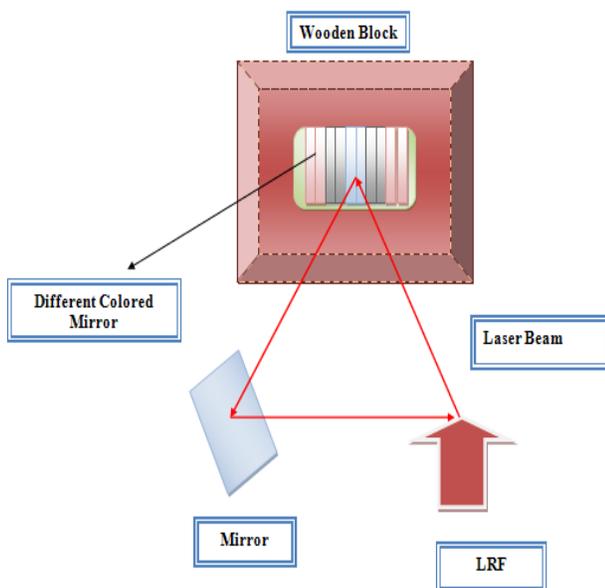


Figure.7 Working principle of model

used but here the distance is kept constant only a variation of intensity occur and this variation of intensity is calibrated in form of a detection of earthquake

### B. RESULT AND CONCLUSION

According to proposed model when there is no earthquake, the laser rangefinder shows constant reading but when earthquakes occur, there will be a movement in the wooden block and the laser beam will strike on different colored mirror. Due to striking on different color mirror its intensity will change and we get the result on the computer. The reading can be saved during the testing and during implementation these reading can be used for getting the strength of the earthquake

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