Development of compact and lightweight laser range sensor for the application in service robot


Toshihiro Mori *1　　Shin'ichi Yuta *2

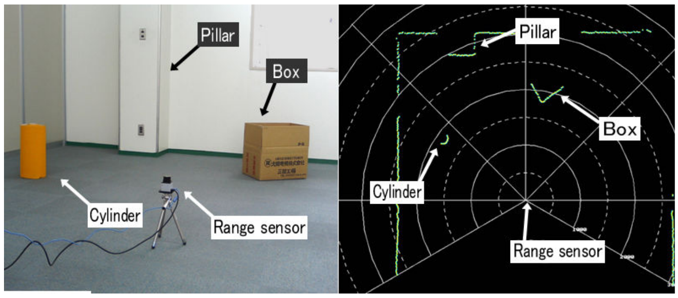
1. Introduction

A real-time laser range sensor with high-practicability was developed for autonomous robot. Since most of the service robot coexist in human living environment, it is essential for the service robot being capable in recognizing the surrounding environment while at the same time avoiding collision with human being during navigation. On the other hand, industrial conveyance robot is required to work precisely and efficiently in narrow working environment. As shown in figure 1, since the laser range sensor is capable of recognizing the surrounding based on the precisely scanned data, this sensor could be one of the solutions for the industrial conveyance robot where precision and speed is needed. Currently, the conventional range sensor with reasonable scanning resolution is bulky and expensive while the cheaper sensor is far from practicability due to low scanning resolution. In overcoming the shortcomings of the conventional range sensor, a practical, inexpensive, compact, lightweight and high-resolution range sensor was developed.

2. Technologies

The range sensor was developed with an aim to be used by service robot as an environmental surrounding range sensor. The main focus of the development was to reduce sensor's size. As a result, the developed sensor's mass and volume is 1/28 smaller and the power consumption is 1/8 lesser compared with the conventional sensor. Figure 2 shows the main components of the developed sensor. High resolution, compactness and lightweight features of the sensor has enabled it to be applied on small size robot and hence creating new paradigm amount researchers, developers, hobbyists whose work with robot. Commercialization of the high resolution URG series sensor has enable various robot to perform accurate surrounding scanning and localization which was difficult using the conventional sensor. Besides, the transportation ability of industrial conveyance robots that are equipped with this sensor has increased greatly which was hardly achieved by the conventional range sensor.

For easier application, a special command system, Sensor Communication Interface Protocol (SCIP) was developed for this sensor. With the SCIP, the ranging data is extended, additional data such as time-stamp, communication speed settings and etc. enable the sensor for wider application. The measurement was computed based on the time of flight principle by sending a laser pulse in a narrow beam towards the object and measuring the time taken by the pulse to be reflected off the target and returned to the sensor. In the URG series, accurate measurement was done by 2 methods, phase difference of reflected wave and time of flight of a light pulse to travel to the target and back. Compact size of the range sensor was achieved by developing uniquely mechanical structured optical scanner, ASIC, simplification of compensation circuit and range data correction technology.



a) Real environment　　b) Range data

Figure 1. Laser range sensor

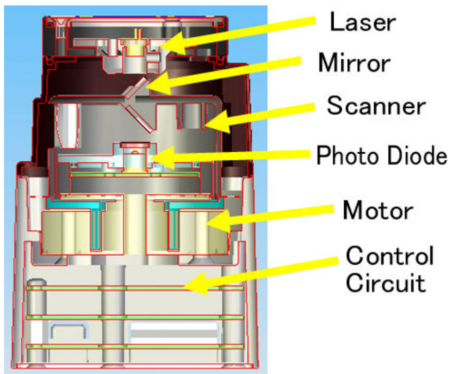


Figure 2. Main components

3. Conclusion

The developed URG sensor can be used in real-time both indoor and outdoor. With these various attractive advantages offered by the URG sensor, there are about 12,000 unit of URG sensor are being used in industrial robots and also service robot. With the application of URG sensor on robot, the day where robot and human being coexist in the same living environment would not be far. Besides, this compact and lightweight sensor has also being widely used in the development of 3D environment modeling and intelligent spatial.

*1 Hokuyo Automatic Co.,Ltd. (1-10-9 Nitaka,Yodogawa-ku,Osaka 532-0033,Japan)
*2 University of Tsukuba (1-1-1 Tennoudai,Tsukuba,Ibaraki 305-8577,Japan)