Wireless Personal Information Terminal for Indoor Spatial Optical Communication System Using a Modified DataSlim2

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A compact Personal Data Assistant with a liquid crystal display called DataSlim2 is refitted and employed as a handheld mobile terminal for data uploading in an indoor laser radar communication system. In order to send and receive messages between the terminal DataSlim2 and its source laser radar, we first embed a corner-cube-array sheet behind the liquid crystal panel of the DataSlim2 to return the entering beam, regardless of orientation, exactly to its source laser radar, and then develop the application software programs to carry and modulate information with DataSlim2. Data transmission quality and reflectivity modulation capability of the DataSlim2 as a communication terminal are measured and evaluated.

Key words: spatial optical communication, information terminal, MDS2

1. Introduction

The present internet and telephone communications are based on addresses and phone numbers to identify individuals. In these systems, services are provided along the same line and paid via credit-card numbers, so who has which service cannot be concealed.

On the other hand, spatial optical communication is an advancing field, which has received much attention. Its attractive features are adequate privacy protection by directionality of light beams, human safety because it is electromagnetic wave free, and easily divided into segment because photons are uncharged and do not interfere with one another as readily as electrons, making it excellent for application in wireless personal communications and local-area communication systems. We are developing a new 1-to-n type indoor communication system based on the spatial optical communication technique and a location-based information service technique for human information support, as shown in Fig. 1.1.2) This communication system consists of an indoor laser radar system as information environment equipment to locate, track, and wirelessly communicate between users and an information environment and its terminal equipments with corner-reflection modulation property, thus maintaining the security and privacy of users and uploading data in a bi-directional communication operation.3,4)

In this paper, a compact Personal Data Assistant (PDA) with a liquid crystal panel called Data Slim2 is employed as the handheld mobile terminal because it not only is compact, has low power consumption, and low cost, but also can be refitted and developed both in hardware and software to realize corner-reflection and reflectivity modulation. The Data Slim2 after refitting will be called modified Data Slim2 (MDS2) hereafter. Key performance characteristics of the MDS2 are experimentally investigated. Several characteristics that are important for the communication terminal, including dependence of the reflection intensity on the angle, the reflectivity modulation, and data transmission quality are evaluated, which indicate the MDS2 can be used for a spatial

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Corner Cube Prism
(injecting in the corner cube array)

MDS2

Fig. 2. The DataSlim2 with a corner-cube-array sheet.

Fig. 3. Experimental setup used to measure the dependence of the reflection intensity on the rotation angle.

the MDS2, we constructed an experimental system as shown in Fig. 3 to measure dependencies of reflection intensities on rotation angles of the MDS2. The MDS2 on a rotating stage is illuminated by a laser beam from a 50-mw YAG laser that is pumped by light from a semiconductor laser diode at the 1.06-μm wavelength. An optical chopper is used to generate continuous rectangle wave signals. The MDS2 is rotated within the possible range of the light received when writing a totally bright and dark image onto the MDS2, respectively; its reflection intensities are detected by a photodetector through a beam splitter. The output voltage signals are displayed on an oscilloscope via a power-meter. Using this experimental system, the reflectivity of the MDS2 is also obtained by placing a corner cube prism with a known reflectivity in the position of the MDS2. Measurement results are plotted in Fig. 4. The abscissa is rotation angles of test objects and the ordinate is normalized reflection intensities. The implications of the results shown in Fig. 4 are as follows:

1. The maximum reflectivity for the totally bright MDS2 is about 40% and for dark is about 35%, respectively, because the maximum reflectivity of the corner cube prism is known to be 92%.

2. The MDS2 is useful as a corner-reflection device in the range of about ±20° when totally bright and about ±15° when totally dark because it has higher reflectivity of greater than 30%.

There are three typical output waveforms on rotation angles by the experimental system of Fig. 3: 0°, 24°, and 56°, when the MDS2 is bright as shown in Fig. 5. We can see that the reflection intensities decrease with increase in the value of rotation angles.

3. Realization of Reflectivity Modulation by Software Development

Using the MDS2 as the information terminal in the proposed communication system, not only is the capability of corner-reflection required, but also the capability to modulate the reflectivity for data transmission. To realize the capability of reflectivity modulation, we developed the application software using the Addin-Software-Development-Kit. A program to modulate the reflectivity of the MDS2 by messages/ID from users has been created.

Figure 6 is an example of the reflectivity modulation by a user’s messages using the proposed program. A start image will be displayed when running this program, and then, if the “Start” key is touched, another image for the selection of messages which are desired by the user will pop as shown in Fig. 6(a). Guided by this image, e.g., if the user wants to ask “Where are you?”, by touching the third button from the top at right, this message will be transmitted. Figure 6(b) is a transient image when the message is being sent. The reflectivity of the MDS2 is modulated by bright (code “0”) and dark (code “1”) images. The modulation frequency can be controlled within an allowable range of the MDS2 by this program. The output signal displayed on the oscilloscope is shown in Fig. 6(c). Since data transmissions are within a local area and the work distance is not too great in this system, the simple unipolar RZ (return to zero) signal is used for easy implementation of data communications. Once the data transmissions begin, all buttons and keys on the panel of