인텔리전트 열차운전을 위한 정보 전송

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An Information Transmission for Intelligent Train Operation

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Abstract -This study is presenting the method for an effective data transmission in MAGLEV which is now tested and intends to provide for an intelligent operation of signal system in future. To exchange a lot of information, it is ideal to adopt a digital system and a micro-based system is essential for these purposes. FSK modulation and HDLC protocol are adopted on this study and information line assembly which is used as the information exchange, as the speech communication, and as the detection of speed and position is constructed in one unit.

Actually this study is produced academic achievements of the data transmission system of MAGLEV train and an advanced method of intelligent operation in future railway system.

1. Introduction

The MAGLEV system, such as wheel-on-rail system, has an identity which it keeps regular intervals between body and rail, but in using the contact of wheel and rail, two systems are different extremely. In the contactless MAGLEV system, the safety of system is more important than the conventional wheel-on-rail system. And also considering mass-transportation and the rapidity, the swift exchange of the information transmission between on-board and ground-site is compulsory.

There are several methods of information transmission between them, but it can be adopted the information line assembly in the view of the low-cost realization. This information line assembly is necessary for the information exchange and the speech communication between the vehicle and ground-site. Also it is necessary for the detection of train position and speed. Korean prototype of MAGLEV which is a premise of practical system and located at KIMM(Korea Institute of Machinery and Metals) in Taejeon has been constructed through 1.1 km total length.

In this paper, an information transmission of Korean prototype of MAGLEV is presented. As the modulation method between the vehicle and ground-site, FSK(Frequency Shift Keying) modulation which has feature of strong anti-noise, fading, and an easy of realizing is adopted. Also as a communication protocol, HDLC(High-level Data Link Control) which has merits of high transmission efficiency, reliability, and bit transparency is used[1,2]. Actually the experimental results of the running profile that explicitly reveal the data transmission from the car to the ground-site are presented in the real-time process.[3]

2. System Outline

2.1 Information transmission system

There are various methods of information transmission betweeen on-board and ground-site. In general, the methods of utilizing track circuit or inductive radio line are used. The method by inductive radio line has an advantage of having more exact transmission than that of track circuit. Especially the inductive method is suitable to MAGLEV system containing non-contact of rail and wheel for requiring safety, reliability, and high speed information transmission.

Fig. 1 shows the block diagram of information transmission system betweeen on-board and ground-site. It consists of three parts. First, the information transmission part detects the train position and speed, converts its signal to digital signal, and then transmits to PC. Second, HDLC controller makes role of transmitting the information with a specified HDLC format. And then the rest of this figure is corresponded to the modulator, the demodulator, and the information line assembly. The role of the modulator and the demodulator is to perform the D/A and A/D conversion. The information line assembly is the transmission line in order to transmit information between ground-site and on-board. The mutual transmission routine between

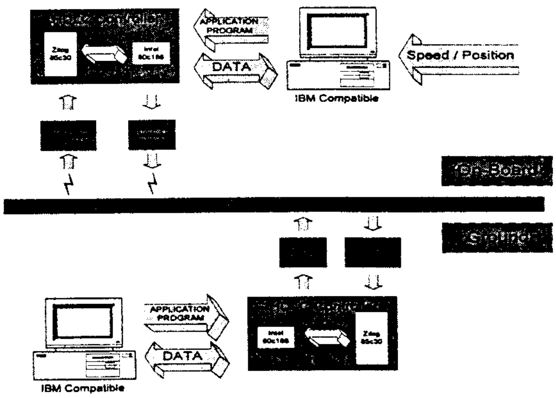


Fig. 1 Block diagram of information transmission system

ground-site and on-board in Fig. 1 shows that data is transmitted through the same information lines.

2.2 Transmission and detection

First of all, to obtain information such as position and speed of train, in this study oscillating signal is generated through the information line assembly involving the crossed inductive radio line, detects this signal from antenna attached on board, converts to the digital information, and transfers to PC.

Table 1. is the transmission specifications appllied to this study for information transmission. HDLC frame consists of 80 bits. 40 bits of the HDLC frame involving the position and speed of train are used as information bits. The transmission method is a full duplex using HDLC, which uses synchronous communication method. Considering full duplex structure, the information is modulated as it differentiates frequencies between ground-site and on-board into 70 khz and 90 khz each. Especially, the position and speed of the running train in very high speed must be transmitted into the ground-site continuously. Zero insertion at the transmitter and zero deletion at the receiver are used to distingush HDLC start and stop flag from the information flag.

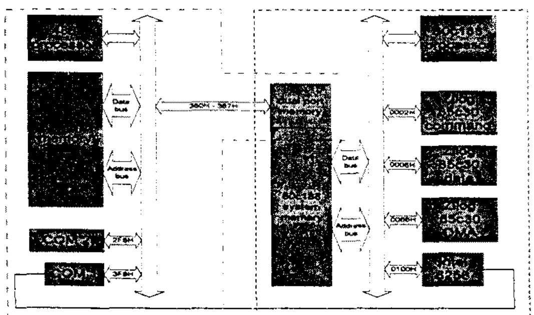
Table 1. Transmission specification

On-board ↕ Ground-site	Telegram length	80 bit(Information : 40 bit)
	Modulation frequency	70kHz ± 2kHz(Ground →On-board)
		90kHz ± 2kHz(On-board→Ground)
	Modulation	FSK modulation
	Transmission	Full Duplex by HDLC protocol
	Encoding	NRZI
	Error Checking	CRC-16(X16+X15+X2+1)
	Transmission speed	2400 bit/s

3. Overview of the HDLC Controller

3.1 Hardware Structure

Fig. 2 represents the interface of PC and HDLC Controller with system block. Basically it is a full legth PC expansion card, and can be used in either 8 or 16 bit slots of an ISA bus. It is equipped with Intel 80c188 microprocessor, providing for high performance data transfer without monopolizing the resources of the host computer,and 1Mbyte



PC HDLC-Controller

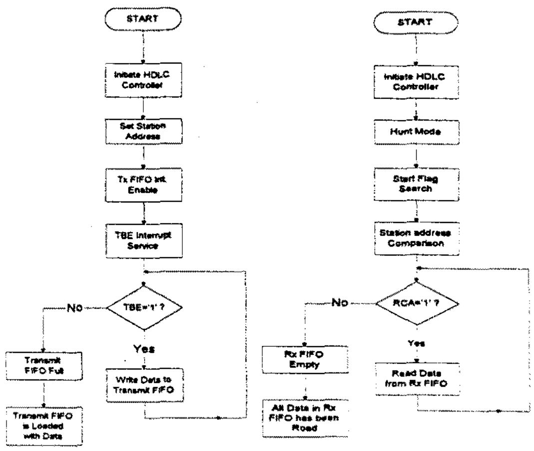
Fig. 2 Interface of HDLC Controller with PC

of dynamic ram that is used as the main memory for the system. This amount of memory spans the addressable range of the 80c188. Actual amount of main memory accessible to the microprocessor is decreased by 8 kbyte due to a block of static ram overlaid at the top of memory. Of this it is designed to transmit data in bi-direction, since it has the separated memory area of 4 kbyte each. That is, the host acknowledges this memory to I/O port, the 80c188 microprocessor to local memory.[4]

3.2 Information structures and algorithm

Fig. 3 shows the data transmission routine of the transmitter and the receiver. Fig. 3. (a) is the transmission routine at the transmitter. First z85c30 should be initialized and set the condition needed for data transmission. The station address at the transmitter, the second flag in HDLC frame, should be specified as the same station address at the receiver. Because it means the relationship of the transmitter and the receiver. The transmitting interrupt is generated when the entry position of the FIFO is empty, that is, more data can be written. If not so, data can't be written. The TBE(transmitting buffer empty) interrupt is generated when the transmitting FIFO is completely empty.[5]

Fig. 3(b) shows the receiving routine at the receiver. The receiver is usually in hunt mode to check the start flag automatically when waiting for a frame. Because the receiver always searches the receiving data stream for flags. The receiver assumes the first byte in an HDLC frame is the address of the secondary station for which the frame is intended. And comparing address station, only those whose address matches the address programmed will be transferred to the receiving data FIFO. If the address station does not match, the receiver returns to the hunt mode. The receiver reads the data from FIFO until the received character in FIFO does not exist.



(a) Transmitting routine (b) Receiving routine

Fig. 3 Transmitting and receiving routine

3.3 Synchronization

The transmitting and receiving of digital information are based on the clock to adjust for bit timing. The clock signal on the transmitter is used to notify the start and stop bit, and the clock on the receiver is used to notify the stop bit of received data and the start bit of the next received data. But unless given the same clock signal to both the transmitter and the receiver, it is very difficult for the clock signal of the transmitter and the receiver to coincide exactly. And clock drift may appear, which is caused by fast or late bit signal in ratio of certain clock speed.[2]

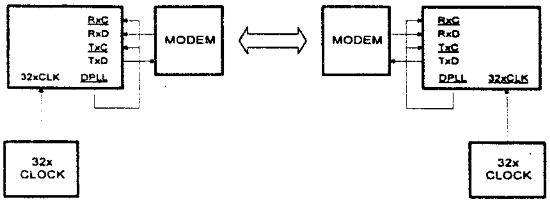


Fig. 4 Block diagram of a synchronization mode

Fig. 4 shows the method of synchronization between on-board and ground-site. In case of levitation type such as MAGLEV system, the clock for synchronous signal in the inductive radio line transmission between ground-site and on-board is necessary. Thus to provide another frequency bandwidth and to construct information line assembly are inefficient. This paper adopted the method that the transmitter and the receiver are synchronized with independent clocks each other.

4. Experimental results of an application on MAGLEV

4.1 Contents of information

Fig. 5 is the menu screen on the PC of ground-site and on-board, and shows the contents of the information that is transmitted through transmission line such as Fig. 1. The detected speed and position information at the on-board is displayed in the menu of right side of the screen at the ground-site, and the input information by operator is transmitted into the ground-site. On the contrary, the information on the left side at the ground-site is transmitted to the monitoring PC of the on-board. The mutually transmitted information is essential for train operation, and includes train speed, position, levitation condition, operation mode, and operation direction etc.

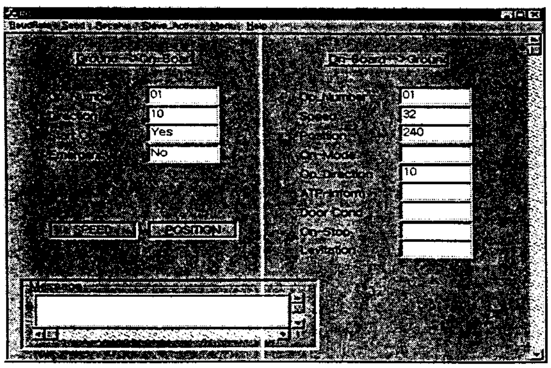


Fig. 5 Monitor screen of information processing

4.2 Real-time speed profile by the received information

The objective of this study is the effective information transmission between ground-site and on-board. Thus we have obtained the following results using the related factors mentioned until now.

Fig. 6 shows the speed profile with position detected by the crossed inductive radio line. A train can be controlled by this speed for the safety and high speed operation.

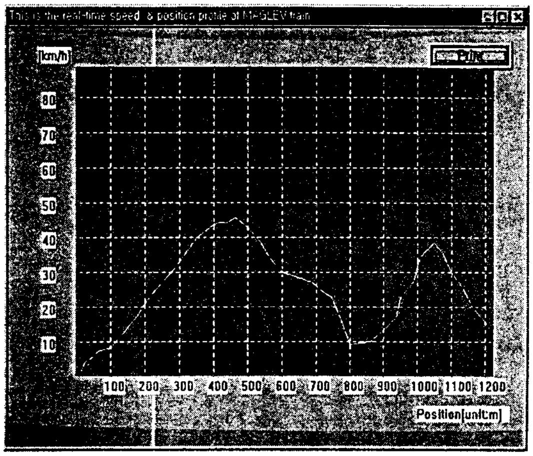


Fig. 6 Real-time speed and position profile

5. Conclusion

This study dealt with the information transmission on the MAGLEV train system. To perform this study, a test track of 1.1 km length and information-line assembly had been constructed. In considering relationship between train speed and massive information and construction of information system, a micro-based system was selected.

Several information transmitted from the car is displayed on the PC screen of the ground-site. So this monitoring system is helpful to operator's works and train operations. By the presentation of train running profile in real-time and the experiment using HDLC Controller, it was ascertained that HDLC protocol had the reliability to the transmission of the information and FSK was strong with noise immunity. Also the algorithm for the transmitter and the receiver on MPI-600 was introduced. As a result, the exact and fast information transmission and the intelligent information system of train could be realized.

[References]

[1] Fred Halsall, "Data Communication Computer Networks and Open Systems",Addison-Wesley, pp.89-141, 1994.

[2] C.O. Kang, "Data Communication", Dae Young, pp.99-120, 1995.

[3] J.S. Park, and Y.M. Kim, "A Digital Signal Transmission Using FSK Method in Train System", Proc., of ITC-CSCC'96, July 15-17,Vol.2, pp.792-795, 1996.

[4] MPI-600 Intelligent Multi-Protocol Adapter User's Manual, Quatech Corp, pp.1-5, 1996.

[5] Serial Communication Controllers Product Specifications Databook, Zilog, pp. 2.1-2.23, 1996.