Laser Monitoring System for Crossing Border Based on the Short Message Service

Wen-jin Zhu*, Dao-qing Zhou, and Lu-jun Zhou

China Satellite Maritime Tracking and Controlling Department, Wuxi, Jiangsu, China, 214431

*Corresponding author: z041230@163.com

Abstract. A warning system applied to long-distance crossing-border monitoring by the technology SMS and IR(infrared) laser was introduced. Master station, which was based on PC and module TC35i, would transmit or receive short message by COM communication. Monitoring station watched the forbidden zone produced by an IR warning apparatus. CMOS chip AT89C52 incepted the warning information, and transmitted out a warning message by module TC35i. Circumstance of hardware and software was provided and programming was described also. The system overcame the shortages and restrictions on conventional communication and monitoring system.

1. Preface
Traditionally, radio station was used often to receive and dispatch data or digital command in the system of the wireless monitoring and controlling [1]. Because of its inherent weaknesses such as short transmitting distance (up to 30–50km), complex of debugging and maintenance, costly operating, lack of frequency resources, and the instability of long-term running, the applications of wireless measuring and controlling system in engineering were restricted seriously. Meanwhile, when visible light, camera, and heat-sensor were used generally in the supervision system, the shortcomings of
short monitoring distance, small coverage, and low definition owing to low visibility will lead to a high false alarm rate. Therefore, difficulties such as the monitoring range cannot meet the requirements, signal transmission and processing are awkward, and being of high producing cost are generally have to faced with when it comes to cross-border alarm in remote areas, long distance and large range.

Now, we combined the data business of the GSM network with monitoring system properly, and designed a monitoring system for crossing border which based on the technique of message service and IR laser. This system overcame the restrictions on conventional method effectively and had advantages such as long warming distance, large-range signal transmission, accuracy and timeliness, simple operation, and flexibility of assembling and extending.

2. Theory and method

2.1. System theory
The monitoring system introduced in this paper observes the principle and function exhibited as Fig.1.

![Figure 1. Function of system](image)

Master station system was constituted by the module TC35i and the PC. Spot station, that is IR Laser Monitoring station, was constituted by module TC35i, PLC and laser transmit-receiving equipment. Semi-conductor laser transmitter send out an IR laser light which form an invisible guard line. And laser receiver could receive the IR laser persistently. When someone went through the guard area, laser light was cut off and the signal of receiver changed correspondingly. The change was distinguished by electric circuit, and the information was coded by PLC. Finally, the message was sent to manager or master station by module to display warning consent. So a complete set of monitoring system of supervising and auto warning was realized.

2.2. Extending of monitoring station

2.2.1. Discrimination of Cross-in or Cross-out Border
Cross border detection was realized by a pair of laser transmitter and a pair of laser receiver. The infrared laser transmitter sent out two beams of laser, forming an invisible warning line, and make up a few hundred meters of the warning area. The laser receiver receives the two laser beams. In general
situation, the two optical paths is unobstructed. When someone is trying to go through the warning area illegal, laser path would be cut off. Laser receiver could detect the order of block of the two laser beams. Identification circuit would judge the information, and PLC would process and coding the information. Communication module emits the alarm message to master station or manager and display relevant information. Double laser beam also provides a guarantee for reducing the false alarm rate which could cause by leaves and other accidental factors.

2.2.2. Independent monitoring unit
By means of dual laser beams, transmitter No.1 and transmitter No.2 share one receiver which contains a short message sending and receiving device of GSM module controlled by a PLC. Such scheme is conducive to extend system and save costs. One receiver receives four beams simultaneously, analyze the change of lights, and send out warning message based on some judgments. According to the telephone number and message data, manager could acquire the information such as the warning occurring location or person’s departing and entering. The sketch of single monitoring unit was displayed as follows:

![Figure 2. Monitoring unit](image)

2.2.3. Monitoring system after extending
According to actual situation and demand, monitoring unit can extend freely as the following figure.

![Figure 3. Monitoring system after extending](image)

IR laser signal could be received stably at the scope of about 500 meters with the semiconductor IR laser transmitter of power 15mW. So a single monitoring unit could create a guarding distance of 1 kilometer. If master station runs a system of 40 units, the guarding area will enlarge to 40 kilometers.

3. Electric circuit design

3.1. Circuit realization of master station
Master station adopts the new Siemens wireless module TC35i and its accessories. Around the module, there are some interfaces and conjunctions should be designed respectively such as chip ZIF40, SIM card, power supplying, data communicating connection, and other outer peripheral circuits [2].

The power supply circuit uses the mobile phone charging power, which is input 220V AC and output 5V regulated voltage and maximum 2A current.

In order to make the module normal start to run, a low voltage signal of at least 100ms must be input to “IGT” pin. And the signal’s fall time must be less than 1ms. Therefore, the starting circuit should be composed by open drain pole triode and power on reset circuit. After start-up, the pin should remain high voltage.

Emergency shutdown circuit would work only if the module cannot complete soft power-off and other fault conditions. The circuit also uses open drain triode to connect the “PowerDown” pin to the ground and a low voltage signal more than 3.2S is required to put on the pin.

The light-emitting diode circuit is used to indicate the working status of the module such as being shutdown (or sleep) / network logon / standby, etc..

TC35i’s serial port uses CMOS level (high level 2.65V), while the PC serial port uses RS232 level. So chip SP3238EEY of Siper could used here to realize the level conversion and serial communication function. SP3238EEY has properties of low power consumption, high data rate, enhanced ESD protection, etc..

3.2. Circuit realization of monitoring station

Monitoring station system is exhibited as follow figure:

Monitoring station system is mainly consists of semiconductor IR laser generator, laser receiver, PLC of chip AT89C52, module TC35i, interface circuit, power supply circuit and chips 24LC65, 3904, 7407 etc..

Laser receiver detects the infrared laser from laser generator and changes of optical signal will be input to PLC. PLC will determine whether to send text messages through a simple algorithm.

Chip AT89C52 of PLC connected to module TC35i’s data interface through serial port which complete the level conversion by OC gate of chip 7407. Then PLC initializes the module and realizes control of SMS transceiver through the AT command.

Some initial information and the default values of the system are stored in the E2PROM 24LC65 of PLC.
The power supply circuit provides power of requested voltage and current for each component.

4. Software design and programming

4.1. Software and programming of PC
A suit of program which is simple but functional was realized at PC by programming language VC++ 6.0. The program is flexible and easy to extend function when it’s necessary. Controller MSCOMM was adopted to realize short messages sending or receiving [3].

Program has following characteristics: supporting hardware of Modem GSM and standard AT instruction [4]; supporting for sending Chinese or English message; supporting for receiving message real-time; extendible function of phone book operation; open AT instruction interface through which users can program custom AT instruction and extend component; attribute, method and event are reasonable and concise and easy to understand and use; event driven mode take up less system resources and running efficiently.

4.2. Software and programming of PLC
Language C51, which was compiled under the Keil µVision2, was used in PLC system. The HEX documents were produced and written into the chip AT89C52 of PLC by compiler SUPERPRO/LX of XELTEK [5].

5. Conclusions
There were successful applications at the border defense in the field of crossing border warning based on radio and visible laser. As monitoring system this paper elaborated is based on the short message service and invisible laser, it has more advantages as follow:

- Long distance and big area of guarding: Tens to hundreds kilometres after system extending.
- Instant and remote supervising: There was no restriction of distance as long as GSM network covers the stations.
- Energy conservation: Module TC35i consumes much less power than radio communication.
- Easy to carry out: This project save work largely of spreading wire out when it’s comparing to wire network, and also leave load out of building antenna, obtaining admission of radio frequency when it’s comparing to radio station.
- The system is easy to extend or upgrade on the function or scale.

For a monitoring station with single laser generator and receiver, experiment has testified monitoring alarm and short message sending and receiving were all reliable and stable enough to meet the design requirement; If it can be extended and devoted into application, the problem of border guarding to key areas would been solved effectively. All in all, the whole system has large practical value and a favorable applying prospect.

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