Optical Rain Gauge

1. INTRODUCTION

In recent years, flood and water immersion damages caused by local downpour have been occurring in a wide range due to a trend of having heavier rainfall in Japan. As a countermeasure against this unexpected local downpour, demand for acquiring more accurate rain information by installing rain gauges more densely, has been increasing.

We have developed and commercialized an optical rain gauge which can be installed inexpensively and is highly reliable. This optical rain gauge has obtained an approval from the Japan Meteorological Agency for the first time in the industry using optical fiber sensor technology.

(a) Sensor unit.

(b) Signal processing unit.

Figure 1 Appearance of optical rain gauge.

2. CHARACTERISTICS

2.1 Reduction of Installation and Maintenance Costs

As Figure 1 shows, the optical rain gauge consists of a sensor unit which includes only optical components and a signal processing unit. It reduces installation costs to a greater extent because, with this optical rain gauge, ancillary facilities including a power unit necessary for an electric rain gauge are not necessary at the observation point. In addition, a large reduction of ancillary facilities contributes to a reduction of maintenance costs because the frequency of equipment checkups and the number of the periodical replacement parts can be reduced.

2.2. Improvement of reliability

The sensor unit installed at the observation point generates no equipment trouble caused by electric outage, lightning interference, etc. because it consists only of optical components and, no electric components. Therefore, a highly reliable system can be achieved. Especially, because it is not site-dependent, it can be used in mountain areas where thunder is frequent, roads, rivers etc. with security.

2.3. Electric Power Saving

Because no power source is necessary at the observation point, power source construction and a power delivery contract are not necessary. Thus, electricity can be totally saved.

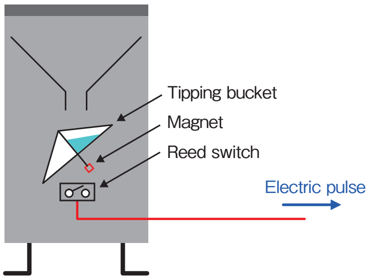
2.4. Long-distance Measurement

For the communication between the sensor unit and the signal processing unit, existing optical fiber transmission channels which have been laid for road and river management, community informatization, railways, sewage lines, etc. can be used. Therefore, rain measurement at a distant point is possible only with this optical rain gauge, not requiring special transmission channels and transmission equipment.

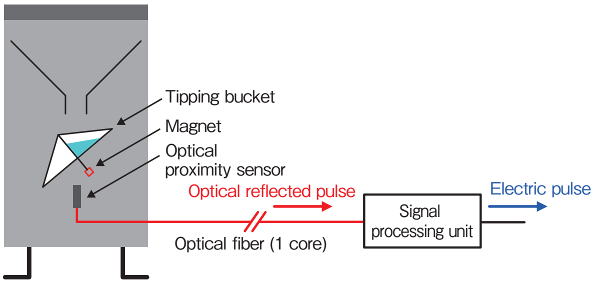
3. MEASUREMENT PRINCIPLE

For the sensor unit of the optical rain gauge where rainfall is measured, the same structure as the existing tipping bucket rain gauge (it measures rainfall by counting the times that the tipping gauge tips over from side to side) is used.

In the existing tipping bucket rain gauge, electric pulse is put out when the magnet attached to the tipping bucket passes above the reed switch. On the other hand, in the developed sensor unit, the optical proximity sensor is used to put out reflected pulse instead of a reed switch. The optical reflected pulse is measured and transformed in the signal processing unit, and the electric pulse similar to that of the existing gauge is put out from it (Figure 2).



(a) Electric rain gauge (existing).



(b) Optical rain gauge.

Figure 2 Measurement principles.

4. SYSTEM CONFIGURATION

Figure 3 shows the system configuration of the optical rain gauge.

The sensor unit must be installed at the observation point. The signal processing unit can be installed even at a distant point. A single-mode optical fiber (1 core) is used for the transmission channel. Existing optical fiber transmission channels for communication can also be used for it.

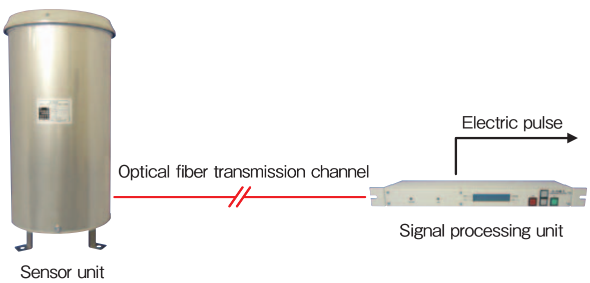


Figure 3 System configuration.

5. MAIN FUNCTIONS

The detection range (rainfall per tip) of the optical rain gauge is 1.0 mm. Electric pulse is put out from the signal processing part along with the tipping action of the tipping bucket.

In addition to the electric pulse, a function of "hourly rainfall alarm" is mounted. The function sounds an alarm when measured hourly rainfall exceeds or equals a preset determined value. Using this function, simple operations are also possible. The determination values of hourly rainfall can be set arbitrarily.

6. PRODUCT SPECIFICATIONS

Table 1 shows the basic specifications of the optical rain gauge.

Table 1 Basic specification.

Item	Specification
Sensor unit	
Water receiving gauge diameter	ϕ200 mm
Resolution	1.0 mm per tip
Accuracy	Rainfall less or equal to 40 mm : ±1.0 mm Rainfall over 40 mm : ±3%
Cable composition	Optical fiber cord (with SC connector), Resin tube
Size	Approx. ϕ 222 mm×450 mm (not including protuberance)
Signal processing unit	
Optical input and output terminal	SC connector adapter (input and output in common)
Applied fiber	SM type optical fiber
Transmission channel condition	Transmission loss: less or equal to 7 dB Transmission channel return loss: greater or equal to 36 dB (termination without reflection)
Output	Electric pulse signal ・normally open contact ・Contact closure time : 100-200 ms Hourly rainfall alarm ・normally open contact Equipment trouble alarm ・normally open contact
Contact rating	Less or equal to DC 30 V, less or equal to 50 mA M3 terminal block
Power source	DC 12 V (10-17 V) M3 terminal block
Size	EIA 1 U Approx. W410 × D100 × H43 mm (not including protuberance)

7. CONCLUSION

This optical rain gauge can be installed inexpensively and is highly reliable because it is not affected by lightning interference, etc. It is applicable to a wide range of sites such as in a mountain area where the existing products have difficulties being installed.

In the future, by taking advantages of the characteristics of optical fiber sensor technologies, we are planning to develop and apply them to various fields.

We have already commercialized this product in December, 2011.

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