Brillouin scattering distributed fiber optic sensor-
From static to dynamic

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OBJECTIVE

To develop a robust distributed fiber optic sensor
➢ Accurate distributed strain/temperature profile
➢ Dynamic sensing
➢ Low cost system
➢ Long lifetime
➢ Whole life cycle sensing and assessment

BACKGROUND

BOTDR analyser

Accuracy distributed strain/temperature profile
2.5kHz sampling rate
existing BOTDR

civil

acoustic

30

Spatial resolution

wave

SPWV
both

0.52

35

a

50

the

15

fiber

a

ZAM

1.67

we

Because the signal to noise ratio is

1.72

application

Dynamic sensing

The uncertainty is

Readout: every 20mm

along

the

is

15

Longer

Whole life cycle sensing and assessment

FPDA

RF
Optics (two-layer)

Prototype A

Detects Brillouin scattered light

The frequency shift of the Brillouin scattered light is proportional to the strain.

Laser pulse is sent from the analyzer. When the pulse interacts with the acoustic wave on the fiber at different location, a small volume of light will be scattered back with shifted frequency depending on different frequency and energy of the acoustic wave. By examining the shifted frequency, the strain/temperature along the fiber can be monitored.

However, current system is both expensive and has low resolution, especially in the dynamic measurement. Therefore, we need to design a suitable analyzer for civil engineering application.

STATIC SENSING - PROTOTYPE A

Performance

➢ Length: 8 km
➢ Readout: every 20mm
➢ Data amount: up to 50,000 data pts/km
➢ Resolution: 20 µε / 1 ℃

Feature

➢ Digital based - Low cost
➢ Advanced signal processing – High performance
➢ Dynamic sensing – Better engineering assessment

DYNAMIC SENSING - PROTOTYPE A

Experiment

➢ Shaker vibration at 60Hz with 2mm movement
➢ 6m fiber vibrated at the end of 1 km fiber
➢ 2.5kHz sampling rate

Result

➢ Different power gives different vibration profile
➢ In 3.12W, the resolution is about 80 µε
➢ 60 Hz is clearly showed in the frequency domain.

CONCLUSIONS

➢ A small gain STFT-BOTDR has been developed.

Performance in prototype A:

Length 8 km, Readout 20mm, resolution 20 µε / 1 ℃, gauge length 1m, up to 1.5 kHz theoretically and 10-60 Hz has been proved.

Further developed versions:

➢ HNLF: Length 1km, readout 20mm, resolution 8 µε / 0.4 ℃
➢ SPWV: Length 8km, readout 20mm, resolution 10 µε / 0.5 ℃
➢ ZAM: Length 9km, readout 20mm, resolution 34 µε / 1.72 ℃, spatial resolution 0.03m

ACKNOWLEDGE

➢ University of Cambridge: Dr Xiaomin Xu, Dr Yifei Yu, Bo Li
➢ University of Southampton: Dr Jiae Yan, Dr Francesca Parmigiani
➢ EPSRC (EP/K000314/1)