Fibre-Optic Scrambler for Homogeneous Laser Illumination

A fibre-optic based system for effective scrambling at speeds far higher than the resonant frequency of the electroactive transducer

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IP Status

Provisional patent

Seeking

Licensing

About **University of Birmingham**

At the University of Birmingham our research leads to new inventions and fuels innovation and business growth.

Tech Overview

Unwanted speckle and interference make homogeneous laser illumination hard to achieve over a short timescale

With existing fibre-optic mode scramblers homogenisation requires timescales of the order of milliseconds, whereas some applications require exposure times of the order of microseconds.

Researchers at the University of Birmingham have developed a fibre-optic based system for effective scrambling at speeds far higher than the resonant frequency of the electroactive transducer (Figure 1).

Further details:

Table 1

Stage of development:

Technology demonstrated in a laboratory environment.

Benefits

Optimal scrambling with an averaging speed far higher than the transducer resonant frequency alone (already high, i.e. 32 kHz).

Applications

Laser illumination is widely used in scientific and commercial applications, mainly because of its narrow spectral width and high radiance. However, the coherence properties of laser light also leads to unwanted interference fringes and speckle, making homogeneous illumination hard to achieve. Beam homogenisers may be used to overcome this drawback. These generally work by dynamically scrambling the wave front, resulting in fast moving speckle patterns that average out in time as well in space (e.g. in the case of a digital camera, over the exposure time and pixel area). Most beam homogenisers however, including commercial devices, operate in free space with mechanically moving parts, limiting the device to integration times of the order of milliseconds. Devices based on moving turbid fluids can achieve high speeds but suffer from high power losses as they scatter the incident power almost isotropically. Beam homogenisers based on fibre-optic mode scramblers, in contrast, reduce the radiance of the incoming laser only as much as given by the fibre core diameter and numerical aperture, can move at high frequency due to the small mass involved, and can facilitate in guiding the scrambled light to where it is needed. However, a problem with existing fibre-optic mode scramblers is that the timescales required for homogenisation are generally too long for short exposure times.

Academics at the University of Birmingham have tackled these problems by actuating a whole length of fibre (typically about a centimeter) with an enclosed-type ultrasonic transducer whose loose contact pressure is found by maximising the audible noise emitted during operation.

This arrangement results in optimal scrambling with an averaging speed far higher than the transducer resonant frequency alone (already high, i.e. 32 kHz).

Opportunity

Seeking licensors.

ZSR1005

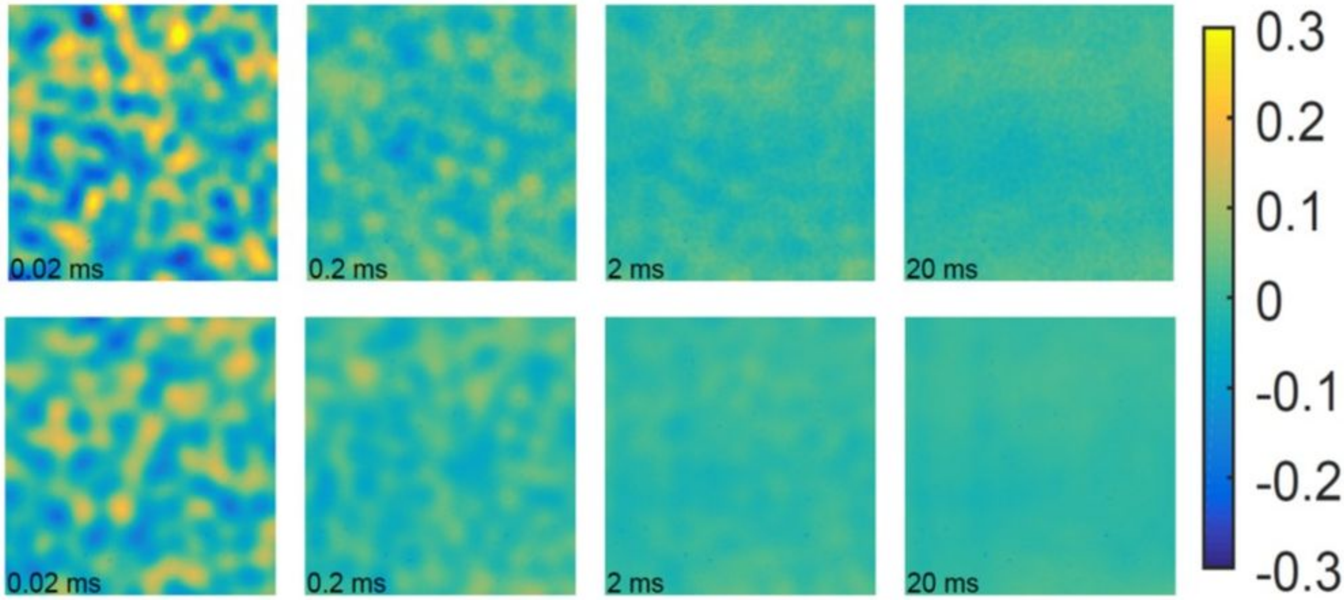
Patents

- Provisional GB application 1720770.5, filed 13 December 2017

Appendix 1

Figure 1

Uniformity at sub-ms scrambling times. Polarised measurements (top row); unpolarised measurements (bottom row).



Appendix 2

Table 1

Feature	Value
Operating Wavelength Range	400 – 2200 nm (depends on fibre)
Fibre type	200/230 µm hard polymer clad (other types may be available)
Fibre NA	0.37 ... 0.48 (current prototype)
Scrambling frequency	32 kHz (current prototype)
Insertion loss	2 dB at 780 nm including in/out facets
Maximum ripple	Approx. 1% rms at 2 ms integration, 780 nm
Optical Power Handling	500 mW tested; fibre spec 200 W
Spectral broadening	2.5 MHz FWHM for single-frequency input
Spectral shape	Pseudo-thermal
First-order correlation time	0.11 µs (-3 dB of $g^{(1)}$)