

# **Mode Control in Multimode Optical Fibre and its Applications**

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**Doctor of Philosophy**

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# ABSTRACT

## MODE CONTROL IN MULTIMODE OPTICAL FIBRE AND ITS APPLICATIONS

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This thesis describes an investigation into methods for controlling the mode distribution in multimode optical fibres. The major contributions presented in this thesis are summarised below.

Emerging standards for Gigabit Ethernet transmission over multimode optical fibre have led to a resurgence of interest in the precise control, and specification, of modal launch conditions. In particular, commercial LED and OTDR test equipment does not, in general, comply with these standards. There is therefore a need for mode control devices, which can ensure compliance with the standards. A novel device consisting of a point-load mode-scrambler in tandem with a mode-filter is described in this thesis. The device, which has been patented, may be tuned to achieve a wide range of mode distributions and has been implemented in a ruggedised package for field use.

Various other techniques for mode control have been described in this work, including the use of Long Period Gratings and air-gap mode-filters. Some of the methods have been applied to other applications, such as speckle suppression and in sensor technology. A novel, self-referencing, sensor comprising two modal groups in the Mode Power Distribution has been designed and tested. The feasibility of a two-channel Mode Group Diversity Multiplexed system has been demonstrated over 985m.

A test apparatus for measuring mode distribution has been designed and constructed. The apparatus consists of a purpose-built video microscope, and comprehensive control and analysis software written in Visual Basic. The system may be fitted with a Silicon camera or an InGaAs camera, for measurement in the 850nm and 1300nm transmission windows respectively. A limitation of the measurement method, when applied to well-filled fibres, has been identified and an improvement to the method has been proposed, based on modelled Laguerre Gauss field solutions.

**Key words:** mode-scrambler, mode-filter, long period grating, optical sensing, mode group multiplexer.

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