Spectral broadening of femtosecond pulses in holey fibers

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Holey fibers [1] is a new promising type of waveguides where electromagnetic waves are guided along a defect in a two-dimensional photonic band-gap structure consisting of a periodic array of air holes in a silica fiber. The missing hole in such a structure forms a defect in a two-dimensional photonic-crystal lattice, while the remaining part of the structure serves as a photonic crystal cladding, allowing robust low-loss single-mode waveguiding within a broad frequency range. Such fibers open a way to extend many ideas of the physics of photonic band-gap (PBG) structures to the optical range. At the same time, remarkable waveguiding properties of such fibers make it possible to form single waveguide modes with effective areas considerably exceeding those typical of conventional fibers.

In this paper, we investigate the spectral broadening of 150-fs pulses of a Ti:sapphire laser propagating through holey fibers with PBG-structure pitches varying from 1.4 to 32 μm . These studies demonstrate that the use of holey fibers allows the efficiency of spectral broadening of ultrashort pulses to be considerably increased (Fig. 1), which may have important implications in pulse compression and which opens a way of creating new efficient supercontinuum-generating sources for various ultrafast-spectroscopy applications.

Fig. 3. Spectral broadening of a femtosecond light pulse in a holey fiber: (a) the spectrum of a 150-fs Ti:sapphire laser output pulse and (b) the broadened spectrum of the pulse at the output of the holey fiber with a pitch of the PBG cladding equal to 1.7 μm .

References

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Lasers for Robot Control:

Navigation, telecommands and sensor needs for the future

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Summary:

For designing robots, nature is a large source of inspiration. Since lasers does not exist in nature they offers new challenging possibilities for robot control. In this paper we outline two cases: laser based beacon navigation used in industry and current effort for fusing laser and vision so as to get reliable navigation in unstructured environments.

For robot navigation consider a workspace with beacons consisting of stripes of identical retroreflecting tapes. A laser/receiver measures the directions to these beacons with high signal to noise ratio. The navigation does *not* include a compass. At 1 m/s the navigation repeatability is within millimetres relative to the reflector map. This is a robust mature technology with >1500 units in industry and an accumulated run time >20 000 000 robot hours (giving approx. 500 rotations around the globe). More recent results are automatic map generation and a teach-in procedure for path specification. Also, the same principle used in mines; a 50 ton LHD-vehicle is navigating at 20 km/h and is repeatable within a few centimetres. More details on industrial Laser Guided Vehicles (LGV's) are at <http://www.ndc.se>.

Next, we consider telecommands for high level control of remotely located robots or robots in contaminated areas. The used non-contact sensors are range measuring lasers and video cameras. Each telecommand is then executed autonomously by closing the feedback loop between the robot and the surrounding objects. Three examples are gripping and/or docking to irregular objects as pointed out by the operator, to follow along a curved surface at a pre-specified distance, to align and/or place a probe on a surface. Some generic findings are:

- The camera is efficient for the operator to interpret the objects in the remote scene.
- The laser is much better than the camera for motion control i.e. for feedback when the telecommands are executed.
- The Range Weighted Radon / Hough transform is very robust for finding plane surfaces / line elements in the laser scans.

Research goals are towards model based control and information systems. Self monitoring systems with 'local intelligence' and graceful degradation are required

More material on these and related results are at <http://www.sm.luth.se/csee/ra/>, especially under tutorials of lasers in robotics. Some animated plots are from a spiral staircase, a laboratory with a crane and from trees in a forest. Under telerobotics there are authentic data when the robot LuSAR, in Sweden, was operated from Singapore.

Keywords: Model based sensor fusion, motion control, sensor feedback