Title:	Unravelling universal interferometers for ultra-precise probing of matter and realization of a new class of frugal photonic devices
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Abstract: In this thesis, we show a compact single-lens interferometer enabling a real-time self- calibrating picometer resolution on arbitrary surfaces. We demonstrate the performance of our interference lens (iLens) by first obtaining high-contrast fringes from a wide variety of common surfaces such as paper, cloth, cardboard, plastic, human skin, silk fiber, etc., and then we demonstrate a single-pixel based self-calibrated measurement of local surface displacement with sub-20 pm precision induced by another pump laser, for example. We have analyzed optimal design of our universal interferometer and show that it can be 3d printed for stand-alone precision applications offering advantages over conventional interferometers. Our compact iLens interferometer enables a new class of frugal optical devices matching or outperforming their state-of-the-art counterparts. We demonstrate three examples: (i) a paper-based picogram weighing balance which is 1000 times more precise and faster compared to a seven digit advanced digital balance, (ii) a cloth or hair based broadband acoustic sensor, and (iii) direct measurement of thermal diffusivity of various fragile biologi- cal surfaces. Furthermore, the iLens interferometer allows probing nanosecond dynamics of candle-flame plasma and micro-liter liquid droplets suggesting its wide applications in four phases of matter. Using structured light, in particular with light containing orbital angular momentum (OAM) and a cylindrical iLens, we devise a compact tiwsted interferometer with picometer scale. We exploited the phase-structure of OAM, a feasibility of real-time noise-compensation is demonstrated with our interferometer. Besides, cylindrical lens We also show ultrafast fabrication of large-area, high-fidelity surface nano-structuring of solid surfaces which could serve as optical components in optical devices. Finally, we discuss the future perspectives of our iLens probes as a generic ultra-sensitive tool to investigate dynamics properties of solids surfaces, complex liquids and gel, as well as precision fundamental physics experiments on nature of photons momentum in medium.