In this Thesis, we present an excessive study of the dynamics of quantum fluids employing the detectors in the form of mechanical resonating structures with characteristic dimensions below 1 mm. We operate the devices in normal and superfluid liquid phases of both helium isotopes scanning the wide range of temperatures between 2.17 K and $\approx$ 150 μK. We show, that the detectors in the form of quartz tuning forks and superconducting vibrating wires are suitable probes in both hydrodynamic and ballistic regimes of superfluids, described by two-fluid model. These devices can be used to initiate and observe turbulent transition in quantum fluids leading to the generation of quantum turbulence. The same devices can work as detectors of externally driven turbulent flows. The phenomenon of quantum turbulence, representing any turbulent flow of quantum fluids, is discussed in more detail. We further report observation of turbulent onset in mechanically and thermally driven oscillatory flows. This transition can have origin in both of the components of superfluid ^{4}He, leading to either classical-like instability or "quantum" instability connected with the generation of quantized vortices. Finally, we discuss the properties and potential of the MEMS and NEMS devices, advancing from much smaller dimensions, fabricated via custom cleanroom processes and we report the manufacture of our own device. Such detectors are able to probe the quantum fluids on the scale of a single quantized vortex, studying its detailed dynamics and should lead to more information about the energy dissipation in zero temperature limit.