Direct and inverse problems of infrared tomography

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The problems of infrared tomography—direct (the modeling of measured functions) and inverse (the reconstruction of gaseous medium parameters)—are considered with a laboratory burner flame as an example of an application. The two measurement modes are used: active (ON) with an external IR source and passive (OFF) without one. Received light intensities on detectors are modeled in the direct problem or measured in the experiment whereas integral equations with respect to the absorption coefficient and Planck function (which yields the temperature profile of the medium) are solved in the inverse problem with (1) modeled and (2) measured received intensities as the input data. An axisymmetric flame and parallel scanning scheme of measurements considered in this work yield singular integral equations that are solved numerically using the generalized quadrature method, spline smoothing, and Tikhonov regularization. A software package in MATLAB has been developed. Two numerical examples—with modeled and real input data—were solved. The proposed methodology avoids the necessity of elaborate determination of the absorption coefficient by direct (point) measurements or calculation using spectroscopic databases (e.g., HITRAN/HITEMP). (C) 2015 Optical Society of America