c) subsequent use of deconvolution and smoothing approximation.

Optionally, at least one of the following methods may be used for determining other parameters of the operator R:

a) a direct transformation of the parameters of the operator G;

b) the minimization of any norm of the solution $\|P_P\|$ under constraints imposed on another norm of the disrepancy $\|s(\lambda;l^{cal},a^{cal})-R\,[\{\tilde{y}_n^{\,cal}\};P_R]\|$

c) the minimization of any norm of the disrepancy $\|s(\lambda;l^{cal},a^{cal})-R\,[\{\tilde{y}_n^{\,cal}\};P_R]\|$ under constraints imposed on another norm of the solution $\|P_R\|$.

Optionally, at least one of the following methods is used for estimation of magnitudes a of peaks, given the estimates $\hat{l}$ of their positions l:

$$\hat{a}=arg_a inf\{\|\{\tilde{y}_n\}-G\,[s(\lambda;\hat{l},a);P_G]\|_q | a\epsilon A\};$$

and

$$\hat{a}=arg_a inf\{\|\hat{s}(\lambda)-s(\lambda;\hat{l},a)\|_q | a\epsilon A\}$$

with A—being a set of feasible solutions; options; q=2 and $A\subset R^k$; q=∞ and $A\subset R^k$; q=2 and $A\subset R_+^{\,k}$; q=∞ and $A\subset R_+^{\,k}$. Some examples of algorithmic solutions are given in Deming S. N., Morgan S. L.: *Experimental Design: A Chemometric Approach*, Elsevier 1987; Fraser R. D. B., Suzuki E.: "Biological Applications". In: *Spectral Analysis—Methods and Techniques* (ed by J. A. Balckburn), M. Dekker, 1970, pp. 171–211; Fister III J. C., Harris J. M.: "Multidimensional Least Squares Resolution of Excited State Raman Spectra", *Anal. Chem.,* Vol. 67, No. 4, 1995b, pp. 701–709; Fister III J. C., Harris J. M.: "Multidimensional Least Squares Resolution of Raman Spectra from Intermediates in Photochemical Reactions", *Anal. Chem.*, Vol. 67, No. 8, 1995a, pp. 1361–1370; Goodman K. J., Brenna T.: "Curve Fitting for Restoration of Accuracy of Overlapping Peaks in Gas Chromatography/Combustion Ratio Mass Spectrometry", *Anal. Chem.*, Vol. 66, No. 8, 1994, pp. 1294–1301; Miekina et al. "Incorporation of the Positivity Constraint into a Tikohonov-method-based Algorithm of Measurand Reconstruction". *Proc. IMEDO-TC*1*&TC*7 *Colloquium* (Londin, UK. Sep. 8–10, 1993), pp. 299–304 and so forth. A particularly effective solution of the above optimization problem is based on a non-stationary Kalman filter or an adaptive LMS algorithm as described in Ben Slima M., Szczecinski L., Massicotte D., Morawski R. Z., Barwicz A.: "Algorithmic Specification of a Specialized Processor for Spectrometric Applications", *Proc. IEEE Instrum. & Meas. Technology Conf.* (Ottawa, Canada, May 19–21, 1977), pp. 90–95 and in Ben Slima M., Morawski R. Z., Barwicz A.: "Kalman-filter-based Algorithms of Spectrophotometric Data Correction—Part II: Use of Splines for Approximation of Spectra", *IEEE Trans. Instrum. & Meas.*, Vol. 46, No. 3, June 1997, pp. 685–689.

Optionally, methods for estimation of the magnitudes a are used for iterative correction of estimates of magnitudes a and positions l of the peaks. Known methods include the following:

$$\hat{l}=arg_1 inf\,\{\|\{\tilde{y}_n\}-G\,[s(\lambda;l,\hat{a});p_G]\|_q | l\epsilon L\}$$

and,

$$\hat{l}=arg_1 inf\,\{\|\hat{s}(\lambda)-s(\lambda;l,\hat{a})\|_q | l\epsilon L\}$$

with L being a set of feasible solutions; options: q=2 and $L\subset R^k$; q=∞ and $L\subset R^k$; q=2 and $L\subset R_+^{\,k}$; q =∞ and $L\subset R_+^{\,k}$.

According to the method set out above, the data are pre-processed. The pre-processing is performed according to known techniques and for known purposes with relation to the methods selected for augmenting resolution of the spectral data and the sensor with which the pre-processing is used. Optionally, one of the following methods is used for normalization of the data:

a) the linear or nonlinear transformation of the λ-axis, aimed at diminishing the non-stationarity effects in the data;

b) the linear or nonlinear transformation of the y-axis, aimed at diminishing the non-linearity effects in the data;

c) the linear or nonlinear transformation of the λ-axis and y-axis, aimed at diminishing the non-stationarity and non-linearity effects in the data.

Optionally, one of the following methods may be used for smoothing the data:

a) the linear, FIR-type or IIR-type, filtering;

b) the median filtering;

c) the smoothing approximation by cubic splines;

d) the deconvolution with respect to an identity operator.

Baseline correction is performed according to standard known techniques such as those described in Brame E. G., Grasselli, J., *Infrared and Raman Spectroscopy*, Marcel Dekker 1976.

Though the method of augmenting resolution and accuracy of a spectrum from a low resolution captured spectrum according to the invention is described with reference to any hardware implementation of this method, it is preferred that the method is implemented in an integrated hardware device as described herein.

Referring to FIG. **17**, a summary of potential applications of the IISS/T in various fields of application is presented. The IISS/T (in the center of the figure) is applied using different spectrometric techniques, which are used in analytical laboratories. The use of an IISS/T according to the invention facilitates application of spectrum-measurement-based methods in real-time environmental, agricultural, medical, and industrial monitoring. It also facilitates use of a hand-held spectrometer designed for specific applications or for a variety of applications.

The proposed invention permits implementation of sensors that are advantageous in many ways including the following. The proposed IISS/T is autonomous in the sense, that it is capable of producing output measurement results without external operations and/or computing. The IISS/T architecture supports manufacturing of various low-price intelligent spectrometric probes and held-held spectrometric instruments without some of the technological problems inherent in high-resolution optical processing spectrometers. The proposed IISS/T is easily adapted to diverse applications by reprogramming the specialized digital signal processor. The proposed method for spectrum measurement is particularly advantageous for integrated miniature implementation of the IISS/T. The IISS/T is robust to mechanical, electromagnetic, chemical and biological influences, due to its compact packaging and integrated design. Further, it is less cumbersome for transport, installation, testing, and repair.

In a pre-defined specialized application, the metrological parameters—variety and ranges of measured quantities, as well as accuracy of measurement—of the IISS/T are comparable to those of a general-purpose laboratory spectrophotometers; yet, the IISS/T has a significantly lower manufacturing cost. Using current technology, an IISS/T is