**Non Patent Literature**

[0018] NPL 1 : Bons M., Deville Y., Schang D. 1994. Non-intrusive electrical load monitoring using Hidden Markov Models. Third international Energy Efficiency and DSM Conference, October 31, Vancouver, Canada., p. 7

NPL 2 : Hisahide NAKAMURA, Koichi ITO, Tatsuya SUZUKI, "Load Monitoring System of Electric Appliances Based on Hidden Markov Model", IEEJ Transactions B, Vol. 126, No. 12, pp. 12231229, 2006

**Summary of Invention**

**Technical Problem**

[0019] However, in the NILM using a simple HMM, if the number of household electrical appliances increases, the number of states of the HMM becomes enormous, and thus implementation thereof is difficult.

[0020] Specifically, for example, in a case where an operating state of each household electrical appliance is two states of ON and OFF, the number of states of the HMM necessary to represent (a combination of) operation states of M household electrical appliances is $2^M$, and the number of transition probabilities of states is $(2^M)^2$ which is a square of the number of the states.

[0021] Therefore, even if the number M of household electrical appliances in a household is, for example, 20, although it cannot be said that there are many household electrical appliances recently, the number of states of the HMM is $2^{20}$=1,048,576, and the number of transition probabilities is 1,099,511,627,776 corresponding to the square thereof, which is more enormous in a tera-order.

[0022] At present, there is a demand for proposal of an NILM technique capable of easily and accurately obtaining power consumption or the like of a household electrical appliance of which operating states are not only two states of ON and OFF, that is, each electrical appliance such as a household electrical appliance (variable load household electrical appliance), for example, an air conditioner of which power (current) consumption varies depending on modes, settings, or the like.

[0023] Embodiments of the present invention enable power consumption of each electrical appliance to be easily and accurately obtained.

**Solution to Problem**

According to an aspect of the present invention, there is provided a data processing apparatus, comprising: a data acquisition unit configured to obtain data representing a mixed audio signal of two or more time series signals; a state estimation unit configure to estimate a parameter for modeling a time series signal with a stochastic dynamics model;, wherein the state estimation unit is configured to estimate the parameter under a specific restriction; wherein the specific restriction is a state transition restriction and the number of factors of which a state transitions for one time point is restricted to one ~~state~~ or less factors.

[0024] Disclosed herein is a method for estimating current consumption of an electrical device, including: obtaining data representing a sum of electrical signals of two or more electrical devices, the two or more electrical devices including a first electrical device; processing the data with a Factorial Hidden Markov Model (FHMM) to produce an estimate of an electrical signal of the first electrical device; and outputting the estimate of the electrical signal of the first electrical device, wherein the FHMM has a factor corresponding to the first electrical device, the factor having three or more states.

[0025] In some embodiments, the three or more states of the factor correspond to three or more respective electrical signals of the first electrical device in three or more respective operating states of the first electrical device.

[0026] In some embodiments, the method further includes: restricting the FHMM such that a number of factors of the FHMM which undergo state transition at a same time point is less than a threshold number.

[0027] Disclosed herein is a monitoring apparatus, including: a data acquisition unit for obtaining data representing a sum of electrical signals of two or more electrical devices, the two or more electrical devices including a first electrical device; a state estimation unit for processing the data with a Factorial Hidden Markov Model (FHMM) to produce an estimate of an operating state of the first electrical device, the FHMM having a factor corresponding to the first electrical device, the factor having three or more states; and a data output unit for outputting an estimate of an electrical signal of the first electrical device, the estimate of the electrical signal being based at least in part on the estimate of the operating state of the first electrical device.

[0028] Disclosed herein is a monitoring apparatus, including: a data acquisition unit for obtaining data representing a sum of electrical signals of two or more electrical devices, the two or more electrical devices including a first electrical device; a state estimation unit for processing the data with a Factorial Hidden Markov Model (FHMM) to produce an estimate of an operating state of the first electrical device, the FHMM having a factor corresponding to the first electrical device, the factor having three or more states; a model learning unit for updating one or more parameters of the FHMM, wherein updating the one or more parameters of the FHMM comprises performing restricted waveform separation learning; and a data output unit for outputting an estimate of an electrical signal of the first electrical device, the estimate of the electrical signal being based at least in part on the estimate of the operating state of the first electrical device.

**Advantageous Effects of Invention**

[0029] According to embodiments of the present invention, it is possible to easily and accurately obtain power consumption of each of electrical appliances.

**Brief Description of Drawings**

[0030] [fig. 1] Fig. 1 is a diagram illustrating an outline of an embodiment of a monitoring system to which a data processing apparatus of the present technology is applied.

CLAIMS

1. A data processing apparatus, comprising:

a data acquisition unit configured to obtain data representing a mixed audio signal of two or more time series signals;

a state estimation unit configured to estimate a parameter for modeling a time series signal with a stochastic dynamics model;

wherein the state estimation unit is configured to estimate the parameter under a specific restriction,

wherein the specific restriction is a state transition restriction and the number of factors of which a state transitions for one time point is restricted to one ~~state~~ or less factors.

2. The data processing apparatus of claim 1, wherein the stochastic dynamics model is FHMM (Factorial Hidden Markov Model).

3. The data processing apparatus of claim 1, wherein the state estimation unit is configured to estimate the parameter under the specific restriction by controlling the data to be additive data of positive factors.

4. The data processing apparatus of claim 1, wherein the state estimation unit is configured to estimate the parameter under the specific constraint controlling at least one state of factors to output zero signals.

5. The data processing apparatus of claim 1, wherein the state estimation unit is configured to estimate the parameter under the specific constraint controlling to minimize the probability of selecting non-zero state of factors.

6. The data processing apparatus of claim 2, wherein the state estimation unit is configured to estimate the parameter under the specific restriction by restricting the FHMM such that a number of factors of the FHMM (Factorial Hidden Markov Model) which can undergo state transition at a same time point is less than a threshold number.

7. The data processing apparatus of claim 1, wherein the state estimation unit is configured to estimate the parameter under the specific restriction by restricting the estimated parameter to one or more combinations of a plurality of predetermined parameters.

8. The data processing apparatus of claim 1, wherein the state estimation unit is configured to estimate the parameter under the specific restriction by restricting the estimated parameter to one or more combinations of a plurality of time series signals.

9. The data processing apparatus of claim 2, wherein the state estimation unit is configured to estimate the parameter under the specific restriction by:

calculating a variance of the data representing the mixed signal of the two or more time series signals; and

using the calculated variance as a parameter of the FHMM (Factorial Hidden Markov Model).