United States Patent [19]

Nadas et al.

[11] **Patent Number: 4,926,488**

[45] **Date of Patent: May 15, 1990**

[54] **NORMALIZATION OF SPEECH BY ADAPTIVE LABELLING**

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[73] Assignee: **International Business Machines Corporation**, Armonk, N.Y.

[21] Appl. No.: **71,687**

[22] Filed: **Jul. 9, 1987**

[51] **Int. Cl.**^{5} **G10L 5/04**; G10L 9/16

[52] **U.S. Cl.** **381/41**; 381/46

[58] **Field of Search** 364/513.5; 381/41-50

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[57] **ABSTRACT**

In a speech processor system in which prototype vectors of speech are generated by an acoustic processor under reference noise and known ambient conditions and in which feature vectors of speech are generated during varying noise and other ambient and recording conditions, normalized vectors are generated to reflect the form the feature vectors would have if generated under the reference conditions. The normalized vectors are generated by: (a) applying an operator function A_i to a set of feature vectors x occurring at or before time interval i to yield a normalized vector $y_i = A_i(x)$; (b) determining a distance error vector E_i by which the normalized vector is projectively moved toward the closest prototype vector to the normalized vector y_i; (c) up-dating the operator function for next time interval to correspond to the most recently determined distance error vector; and (d) incrementing i to the next time interval and repeating steps (a) through (d) wherein the feature vector corresponding to the incremented i value has the most recent up-dated operator function applied thereto. With successive time intervals, successive normalized vectors are generated based on a successively up-dated operator function. For each normalized vector, the closest prototype thereto is associated therewith. The string of normalized vectors or the string of associated prototypes (or respective label identifiers thereof) or both provide output from the acoustic processor.

8 Claims, 8 Drawing Sheets

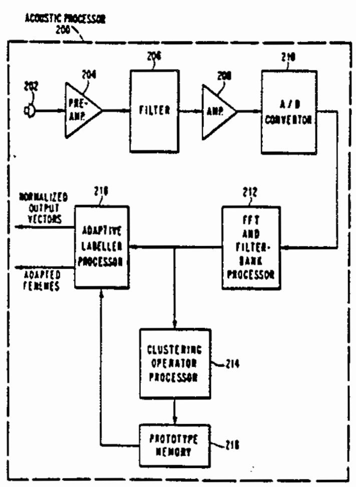


FIG. 1

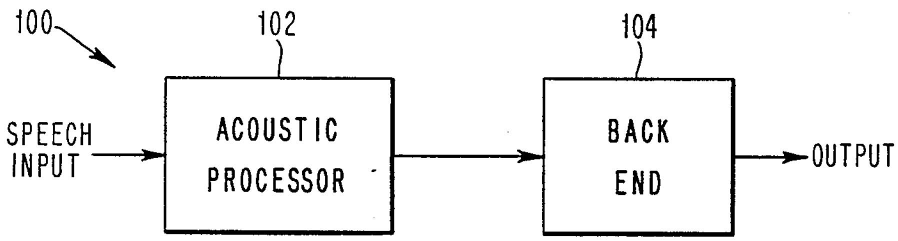

100
102
104
SPEECH INPUT
ACOUSTIC PROCESSOR
BACK END
OUTPUT

FIG. 2

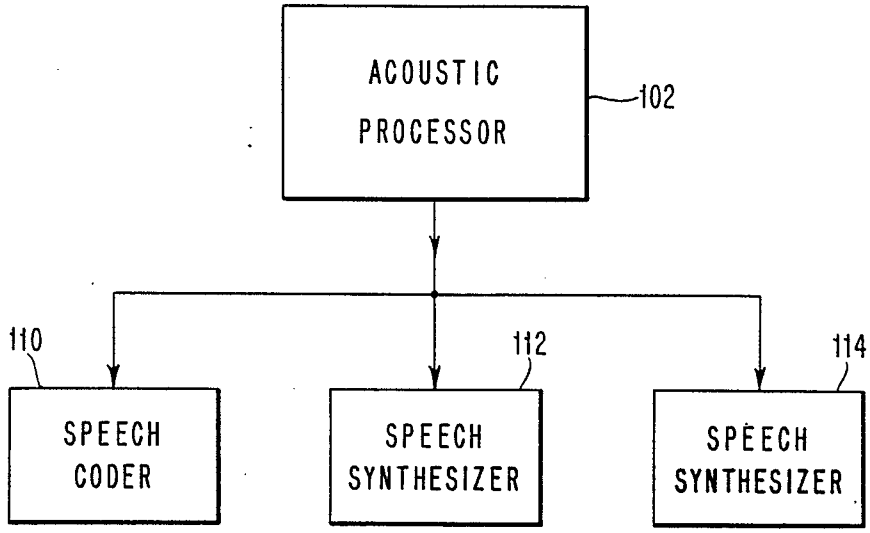
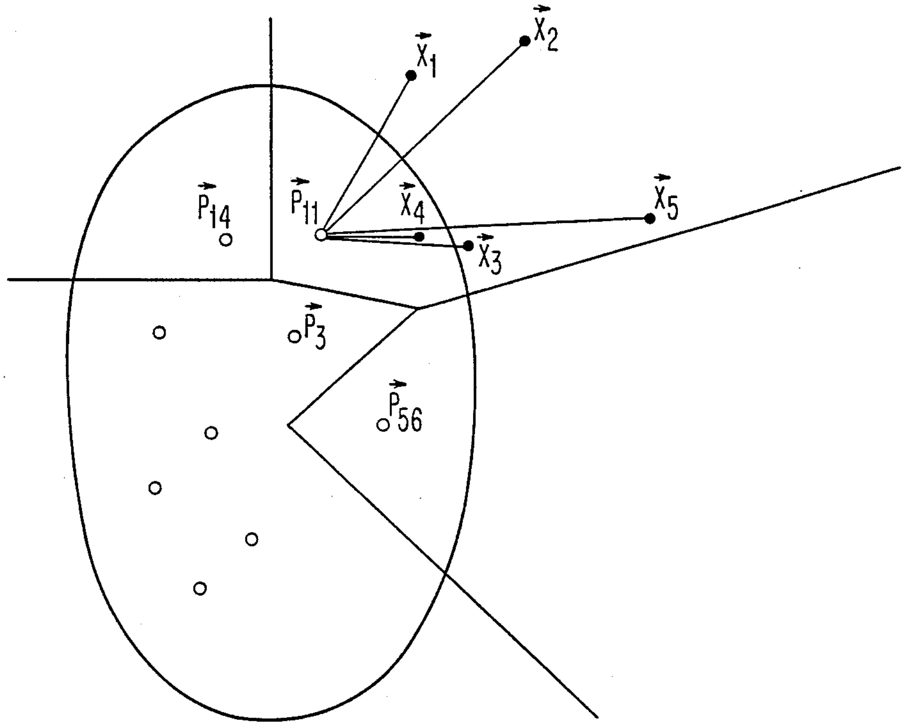

ACOUSTIC PROCESSOR
102
110
112
114
SPEECH CODER
SPEECH SYNTHESIZER
SPEECH SYNTHESIZER

FIG. 3



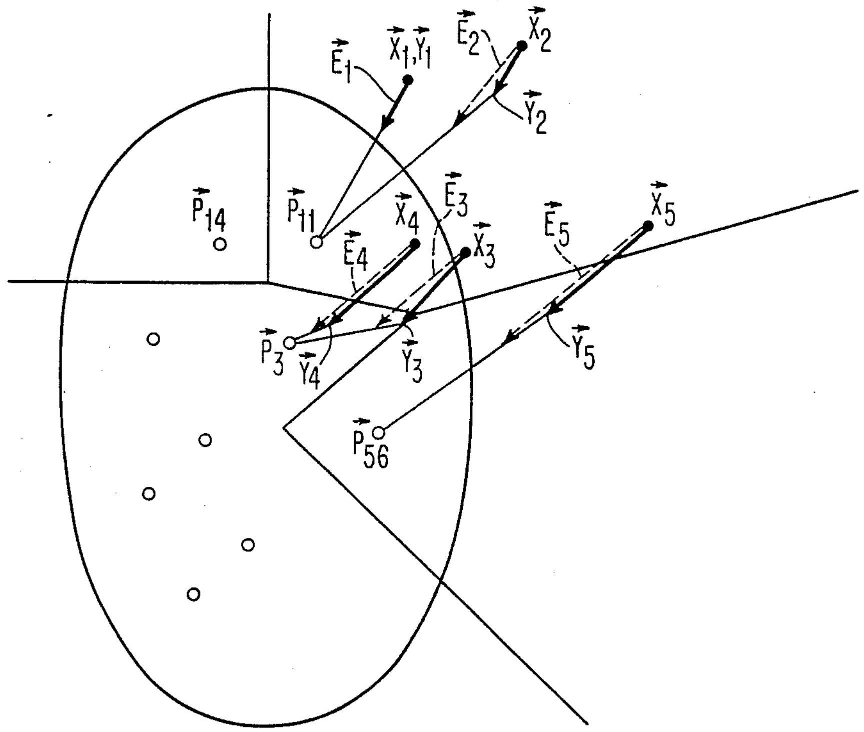
PROTOTYPE SPACE = $\{\vec{P}_1, \vec{P}_2, \ldots, \vec{P}_{200}\}$

INPUT FEATURE VECTORS = $\{\vec{X}_1, \vec{X}_2, \vec{X}_3, \vec{X}_4, \vec{X}_5, \ldots\}$

OUTPUT FEATURE VECTORS = $\{\vec{X}_1, \vec{X}_2, \vec{X}_3, \vec{X}_4, \vec{X}_5, \ldots\}$

FENEME STRING = $\{P_{11}, P_{11}, P_{11}, P_{11}, P_{11}, \ldots, P_{11}\}$

FIG. 4



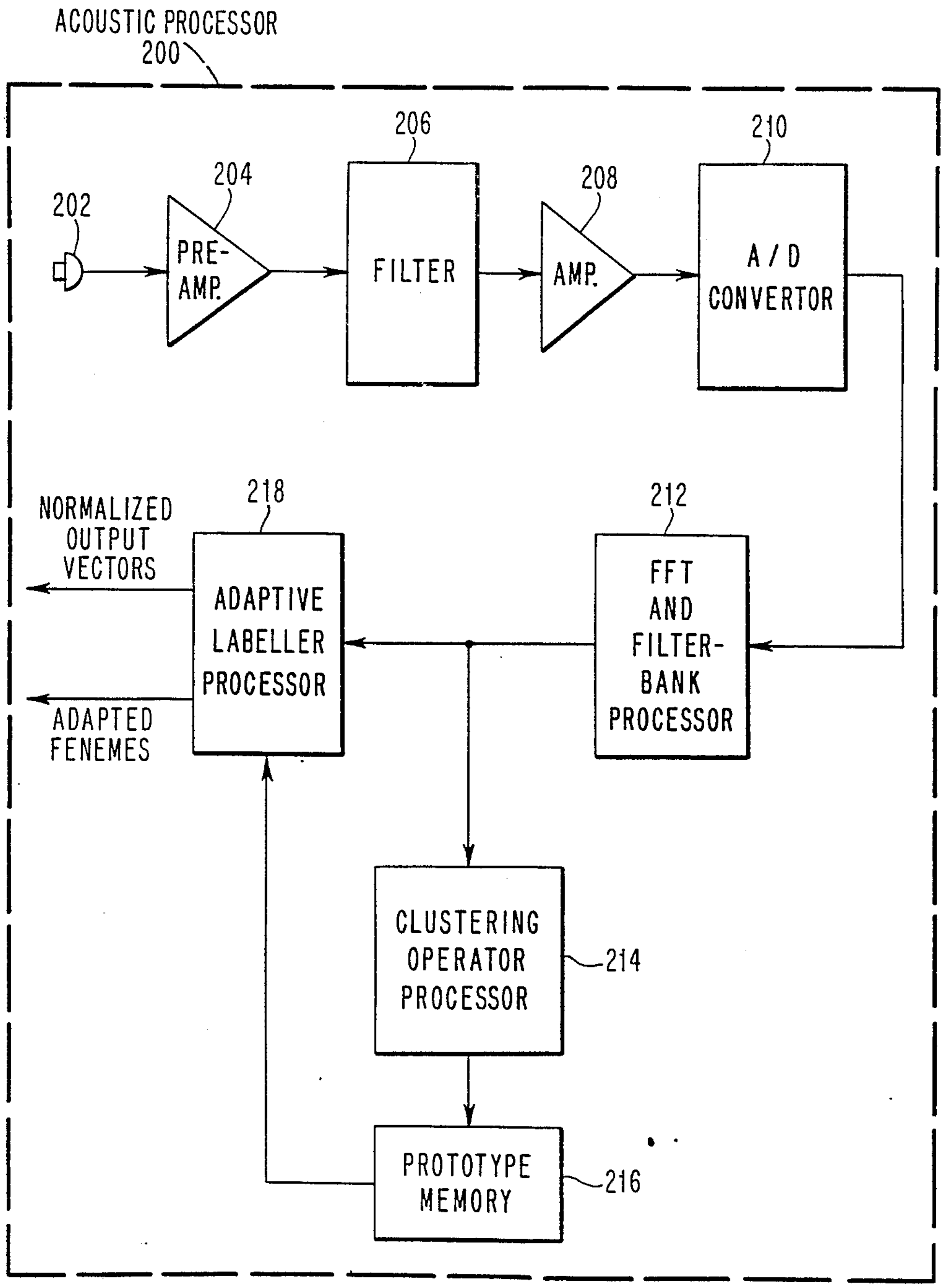
PROTOTYPE SPACE = $\{\vec{P}_1, \vec{P}_2, \ldots, \vec{P}_{200}\}$

INPUT FEATURE VECTORS = $\{\vec{X}_1, \vec{X}_2, \vec{X}_3, \vec{X}_4, \vec{X}_5, \ldots\}$

OUTPUT FEATURE VECTORS = $\{\vec{Y}_1, \vec{Y}_2, \vec{Y}_3, \vec{Y}_4, \vec{Y}_5, \ldots\}$

FENEME STRING = $\{P_{11}, P_{11}, P_3, P_3, P_{56}, \ldots\}$

FIG. 5


ACOUSTIC PROCESSOR
200
202
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PRE-AMP.
206
FILTER
208
AMP.
210
A / D CONVERTOR
212
FFT AND FILTER-BANK PROCESSOR
218
ADAPTIVE LABELLER PROCESSOR
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