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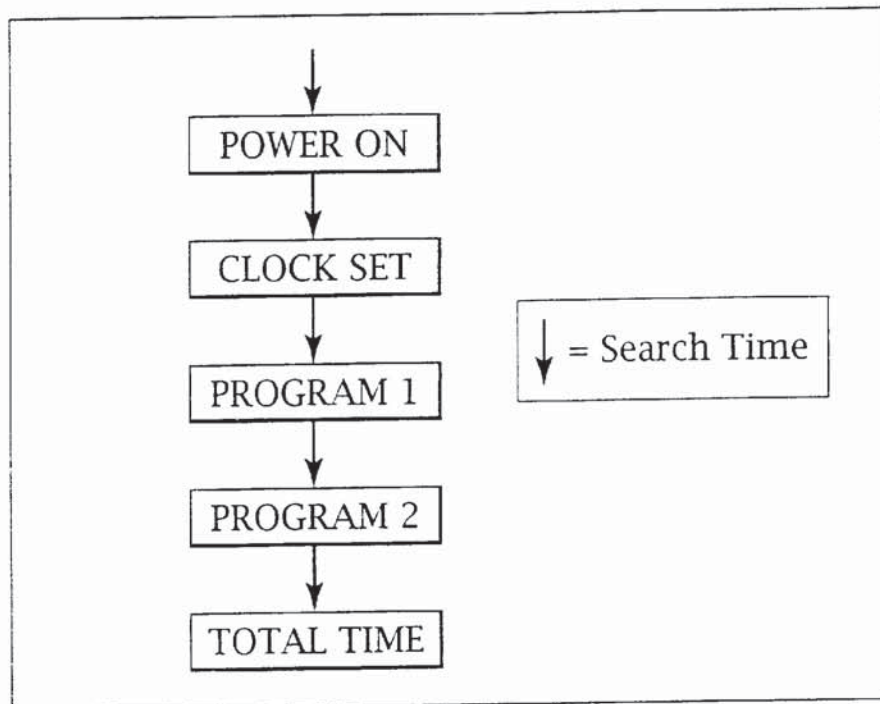
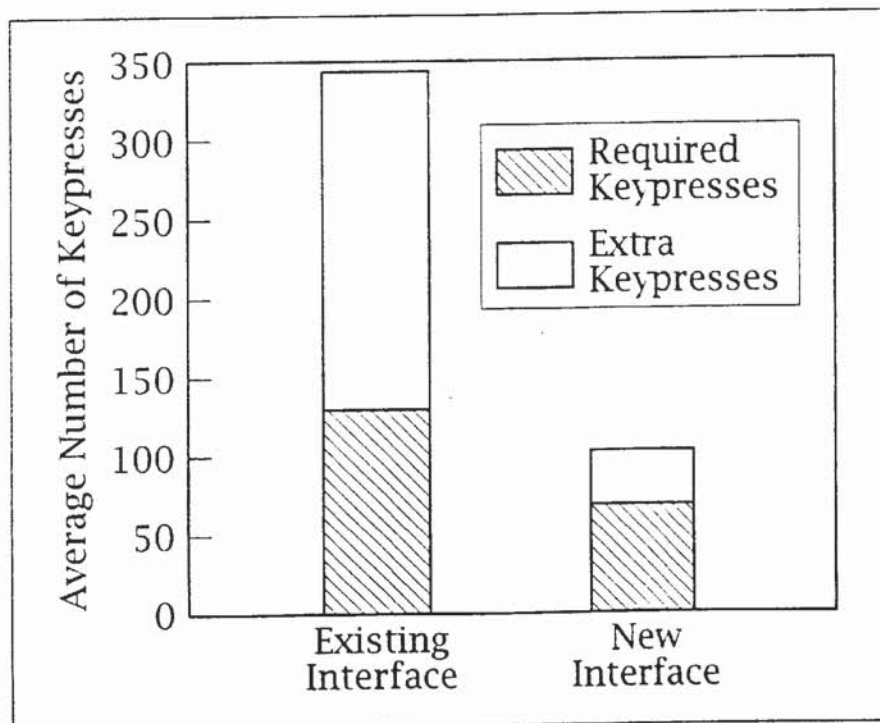
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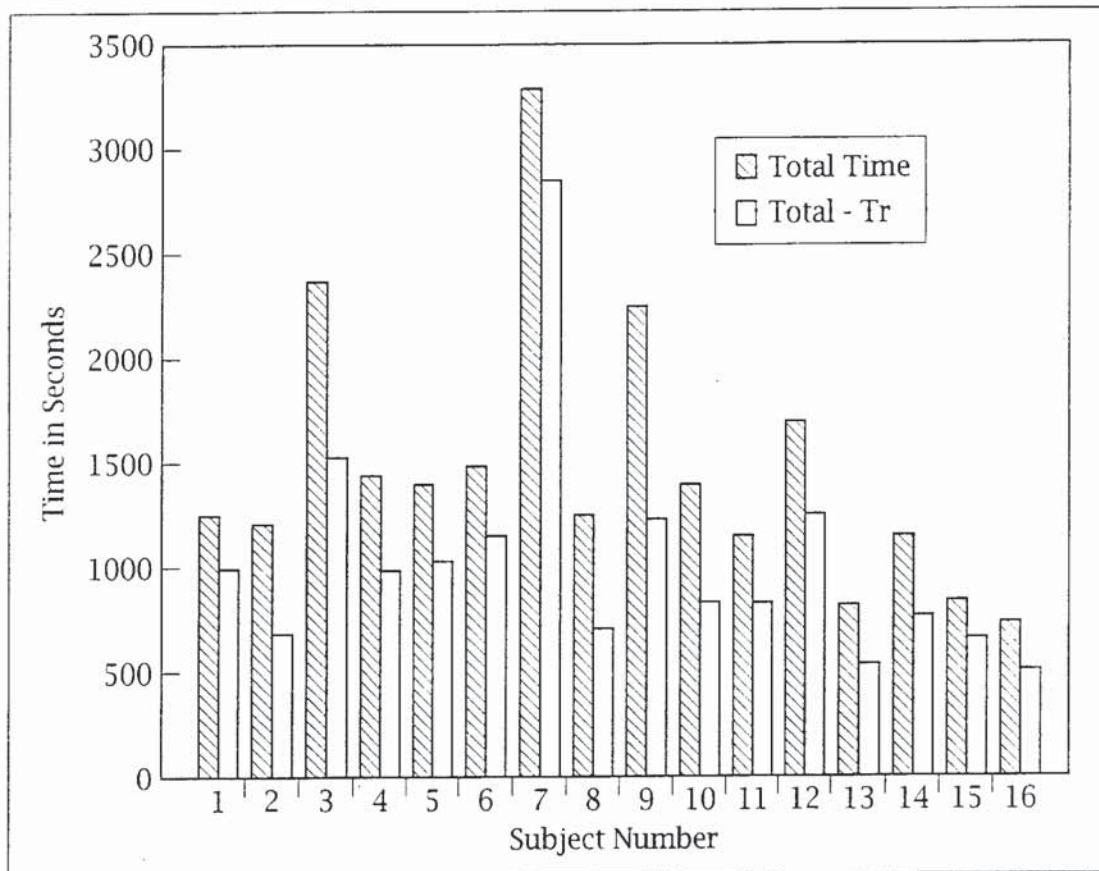
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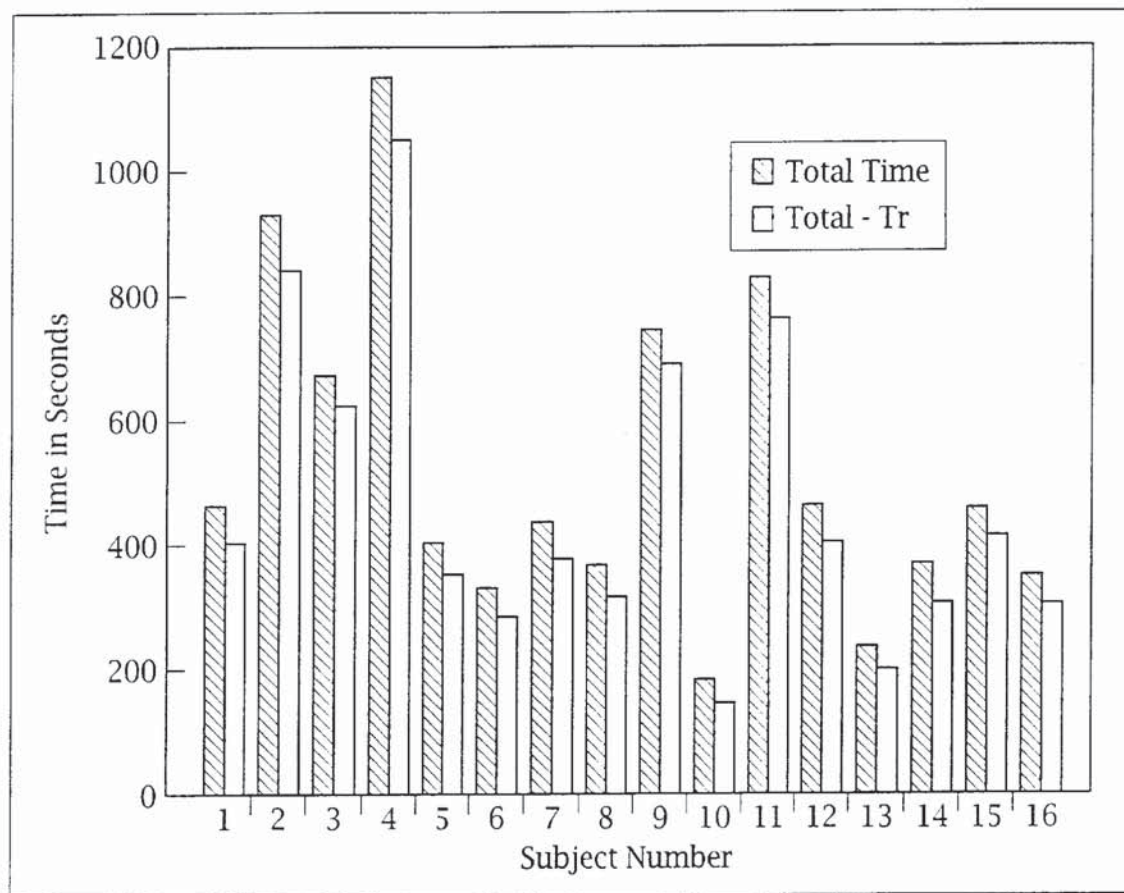
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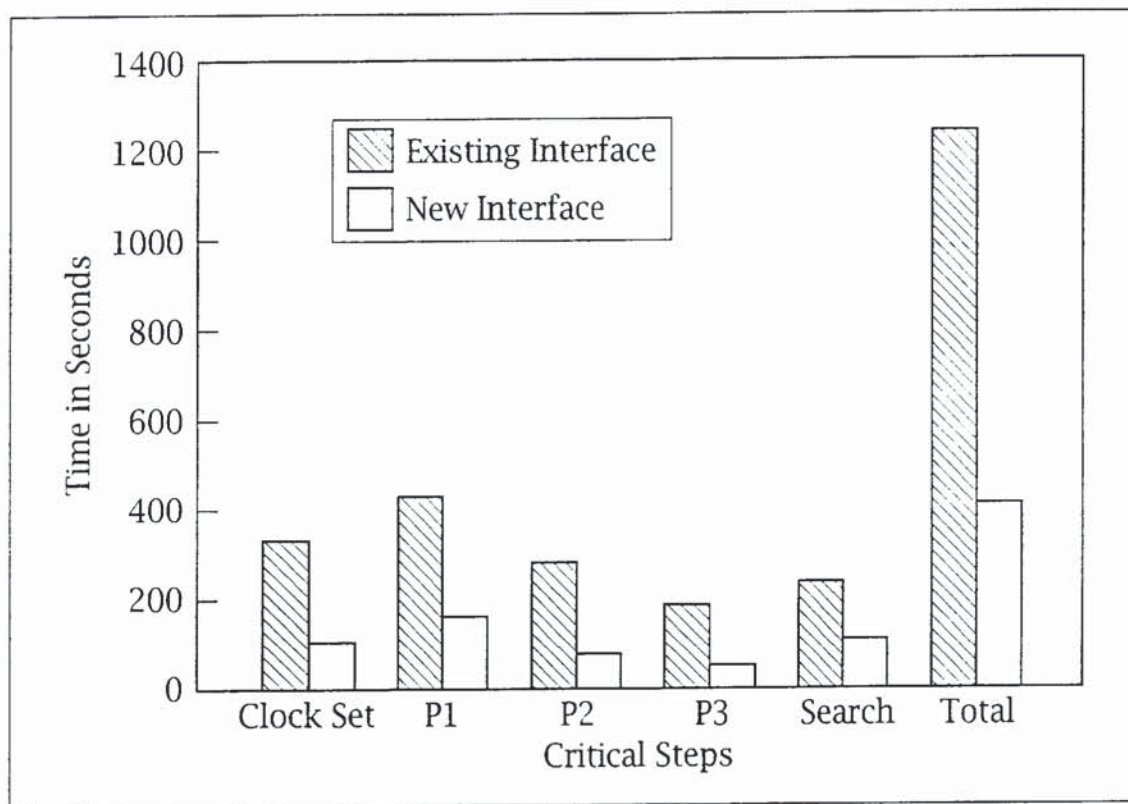
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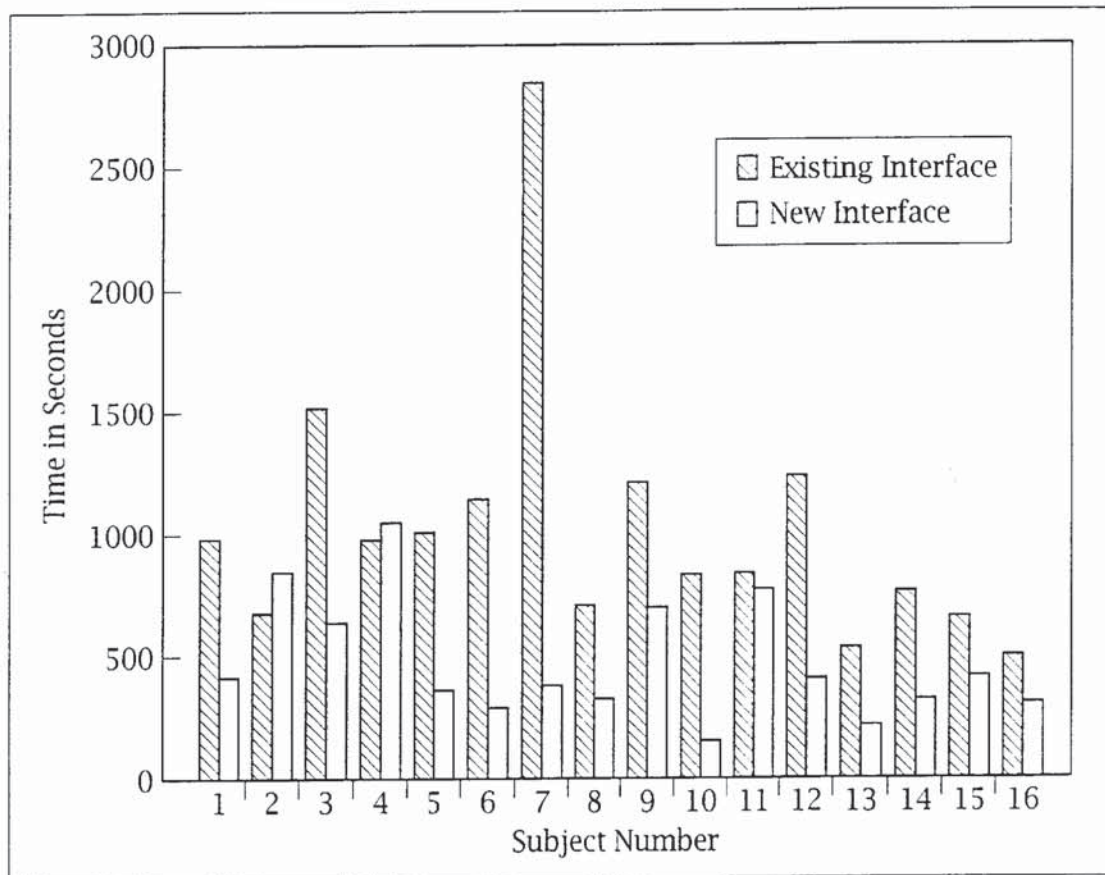
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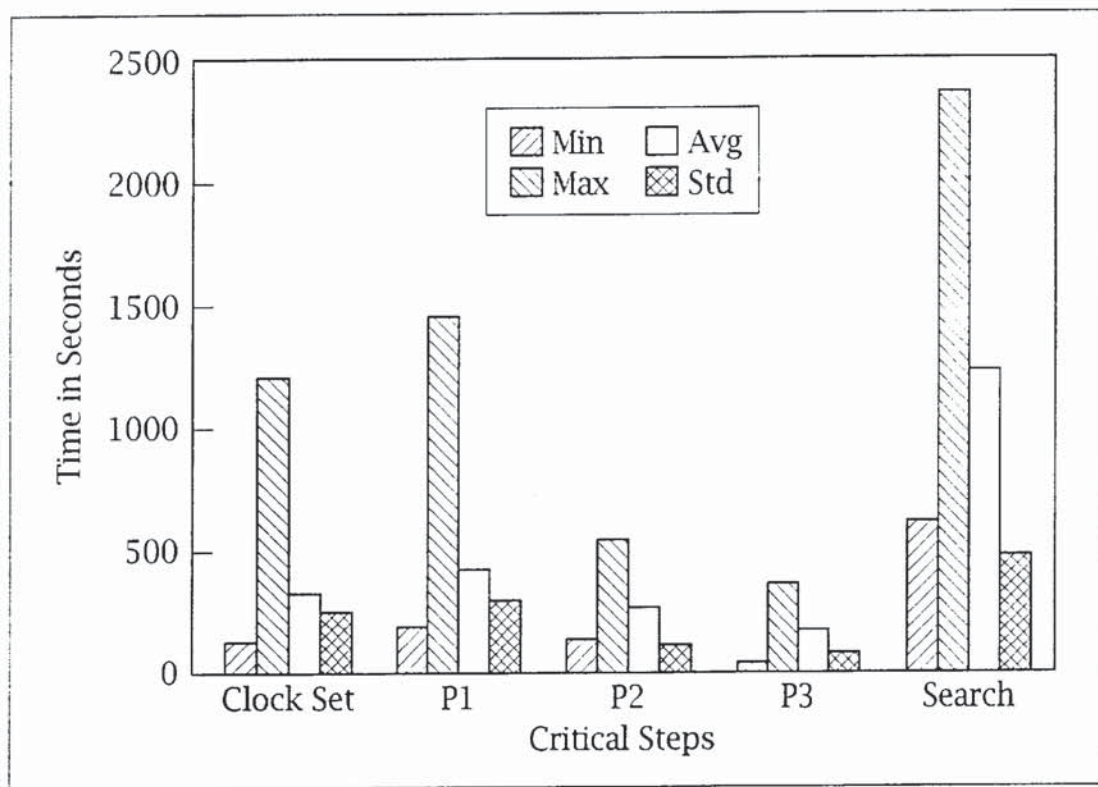
Fig. 1*Fig. 2*

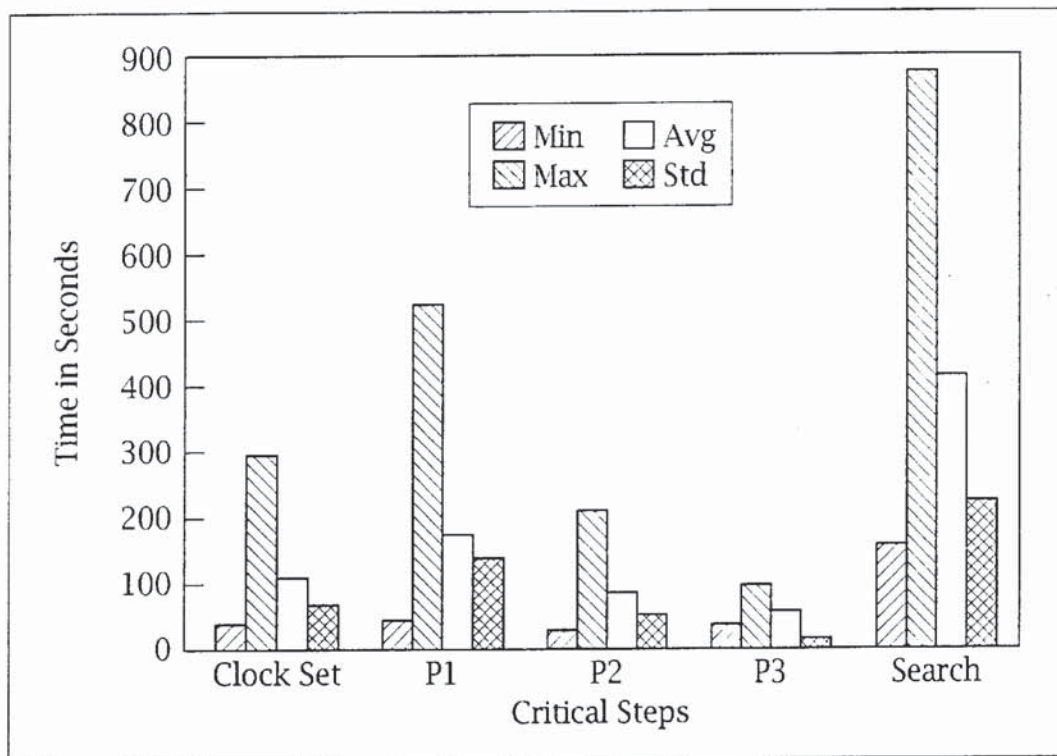
*Fig. 3*

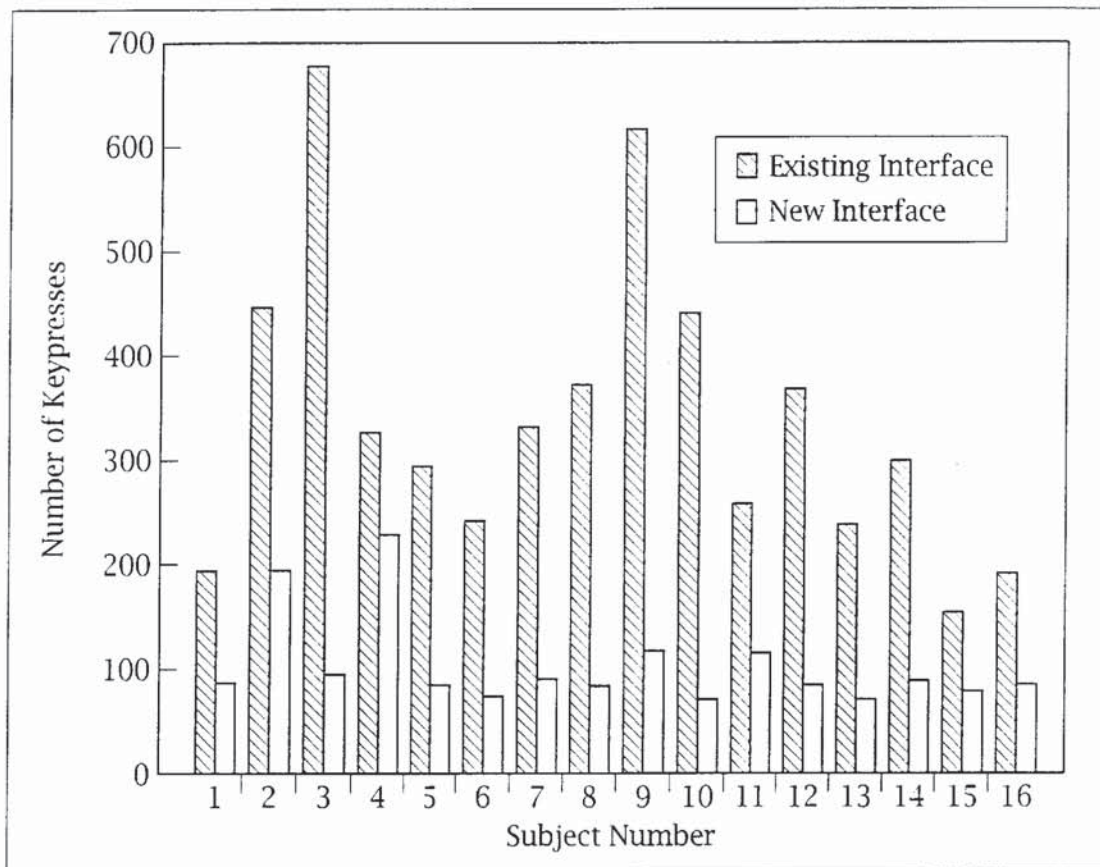
*Fig. 4*

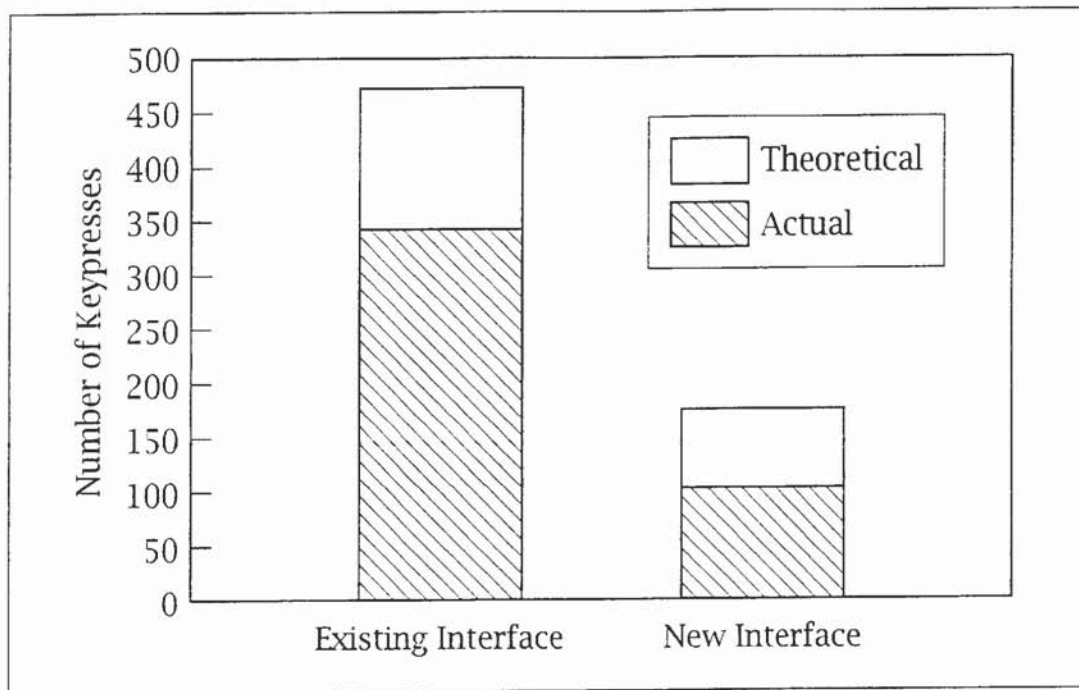
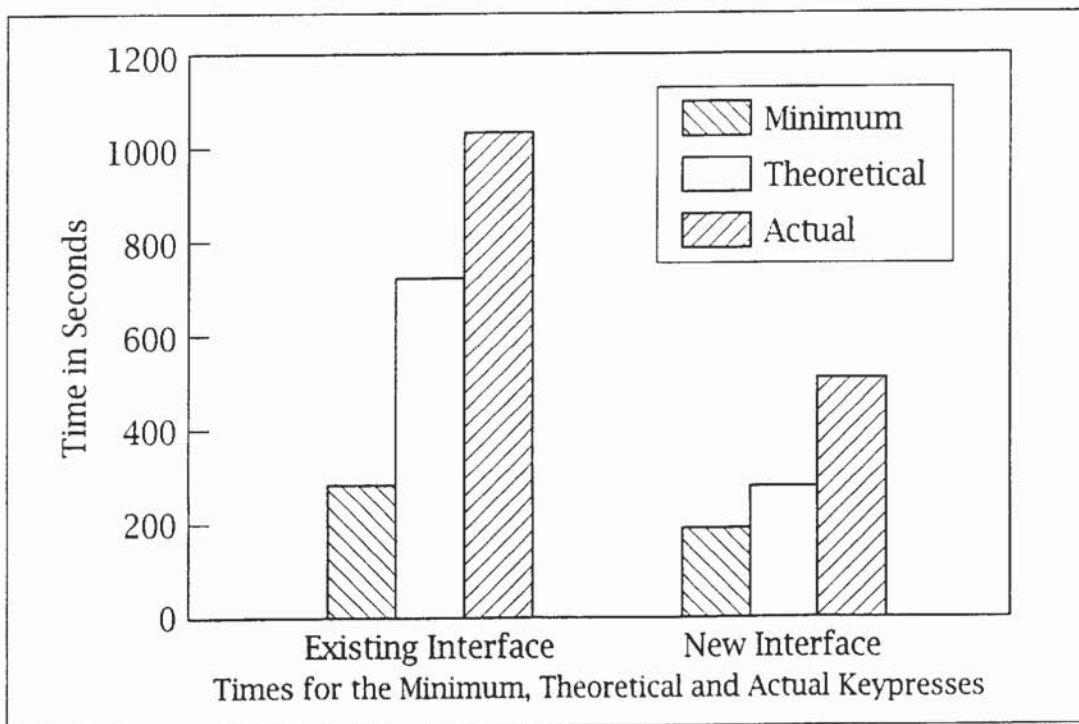
*Fig. 5*

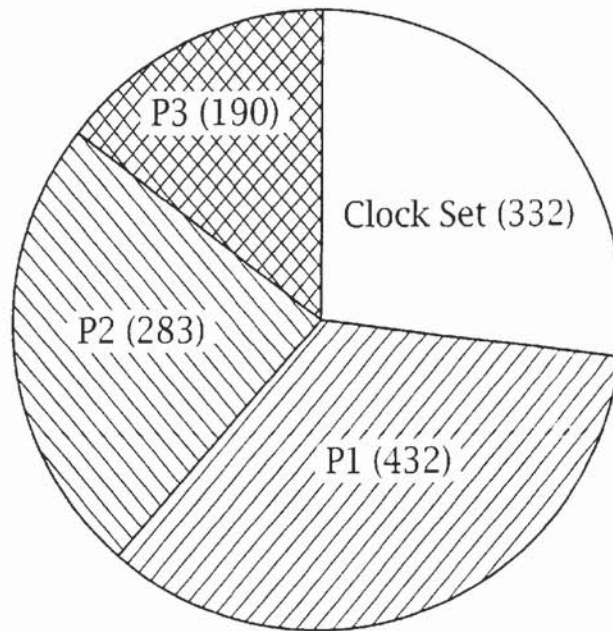
*Fig. 6*

*Fig. 7*

*Fig. 8*

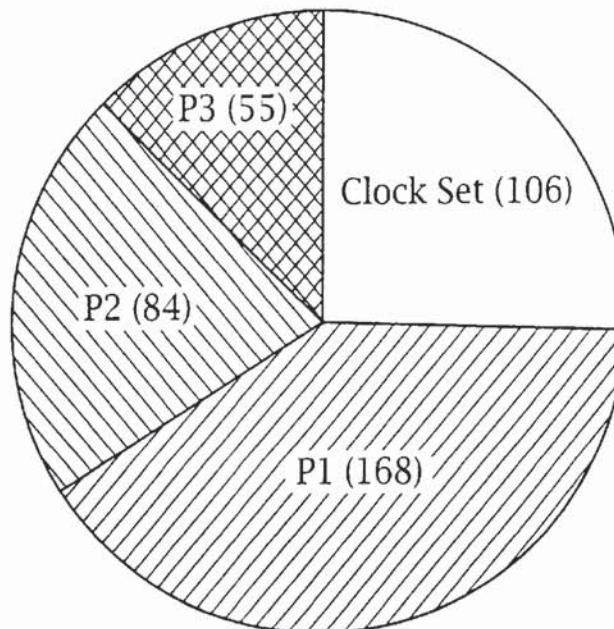
*Fig. 9*

*Fig. 10**Fig. 11*



Existing Interface

Fig. 12a



New Interface

Fig. 12b

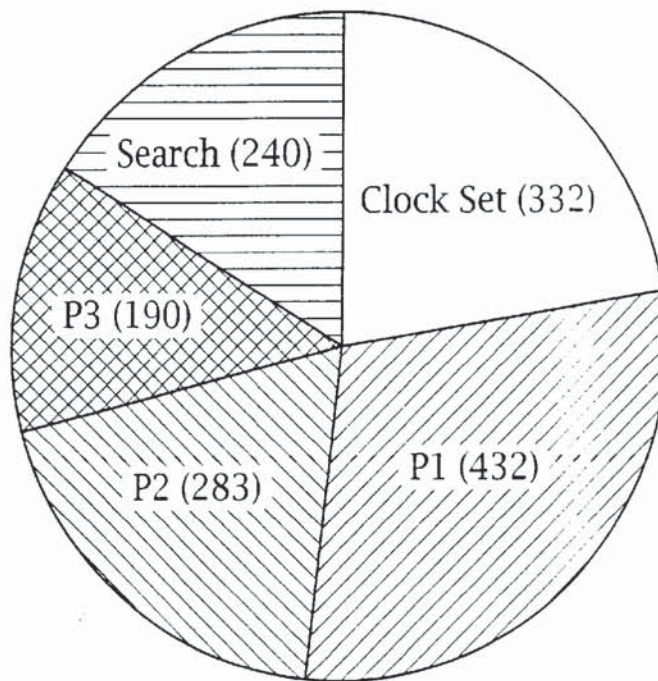


Fig. 13

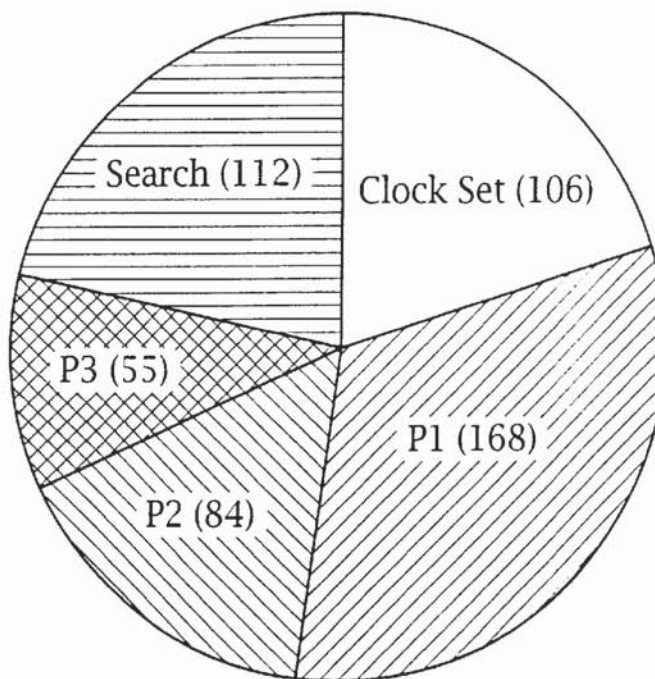


Fig. 14

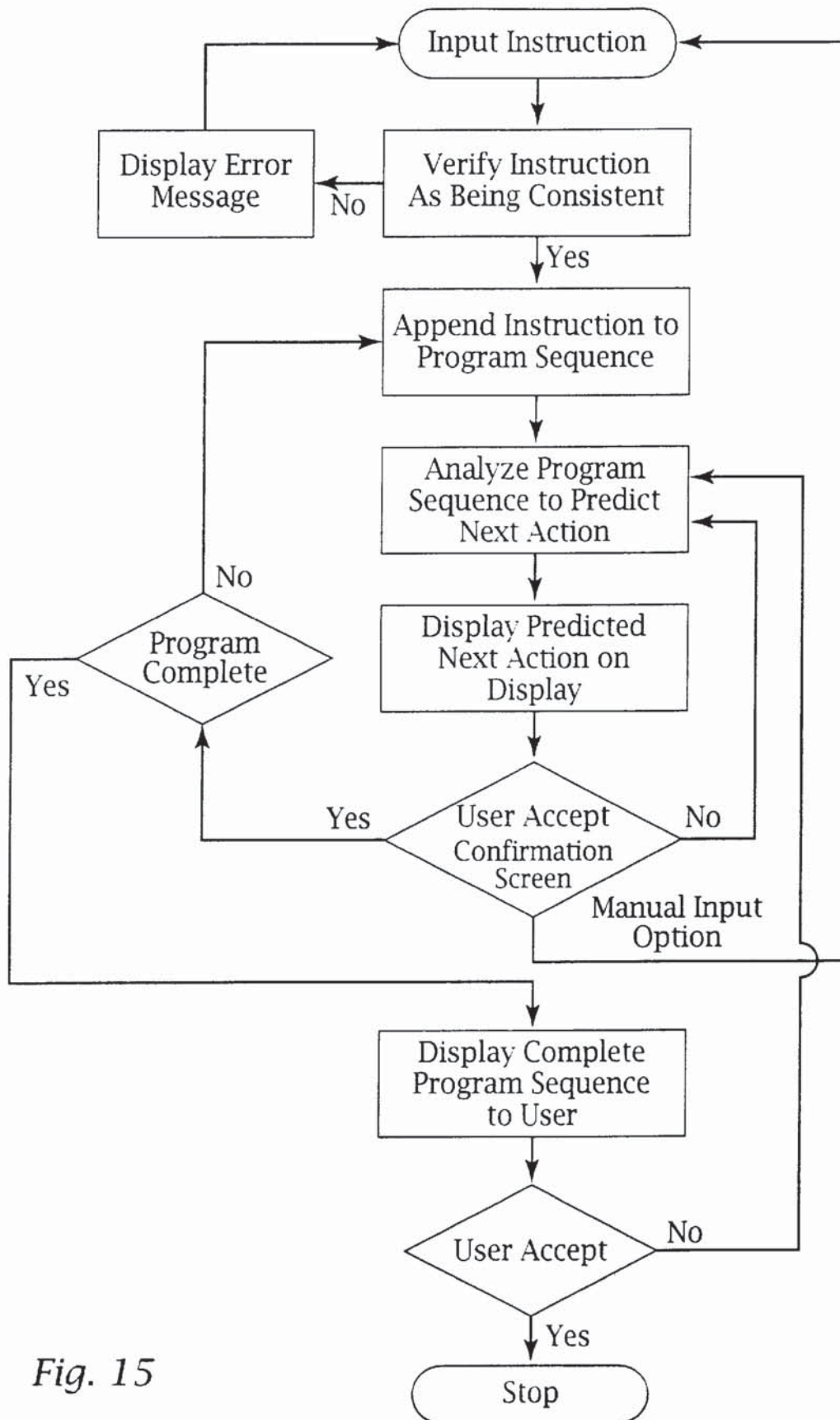
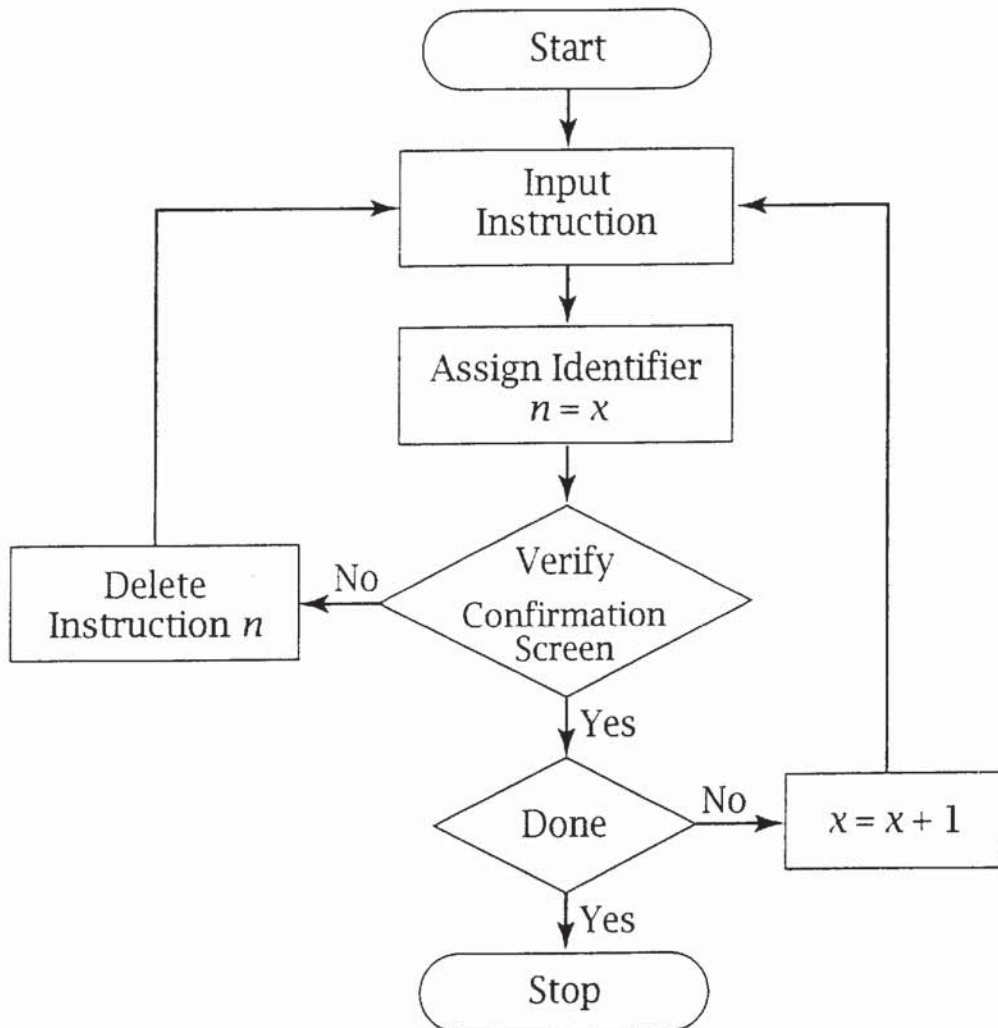
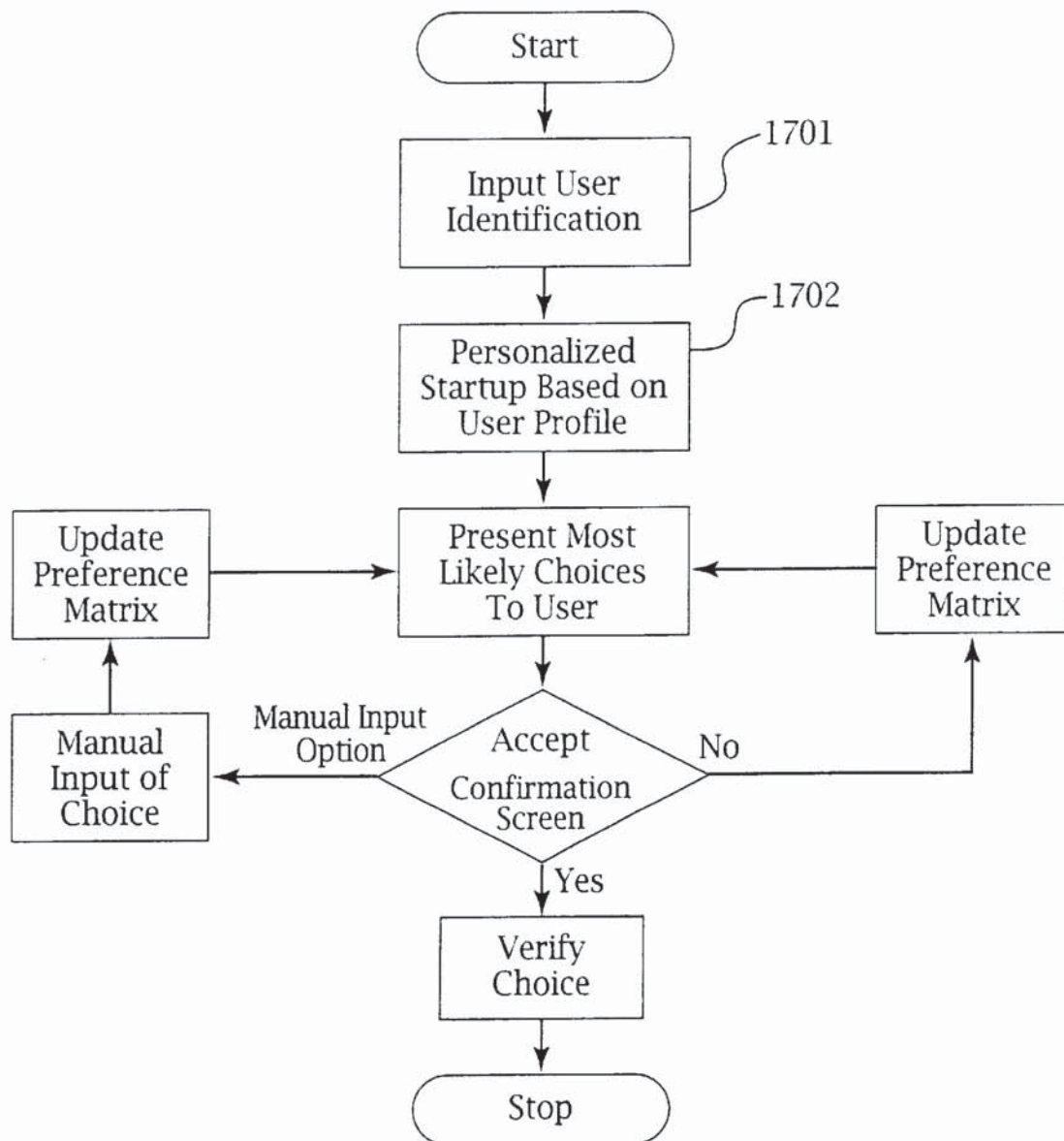


Fig. 15

*Fig. 16*

*Fig. 17*

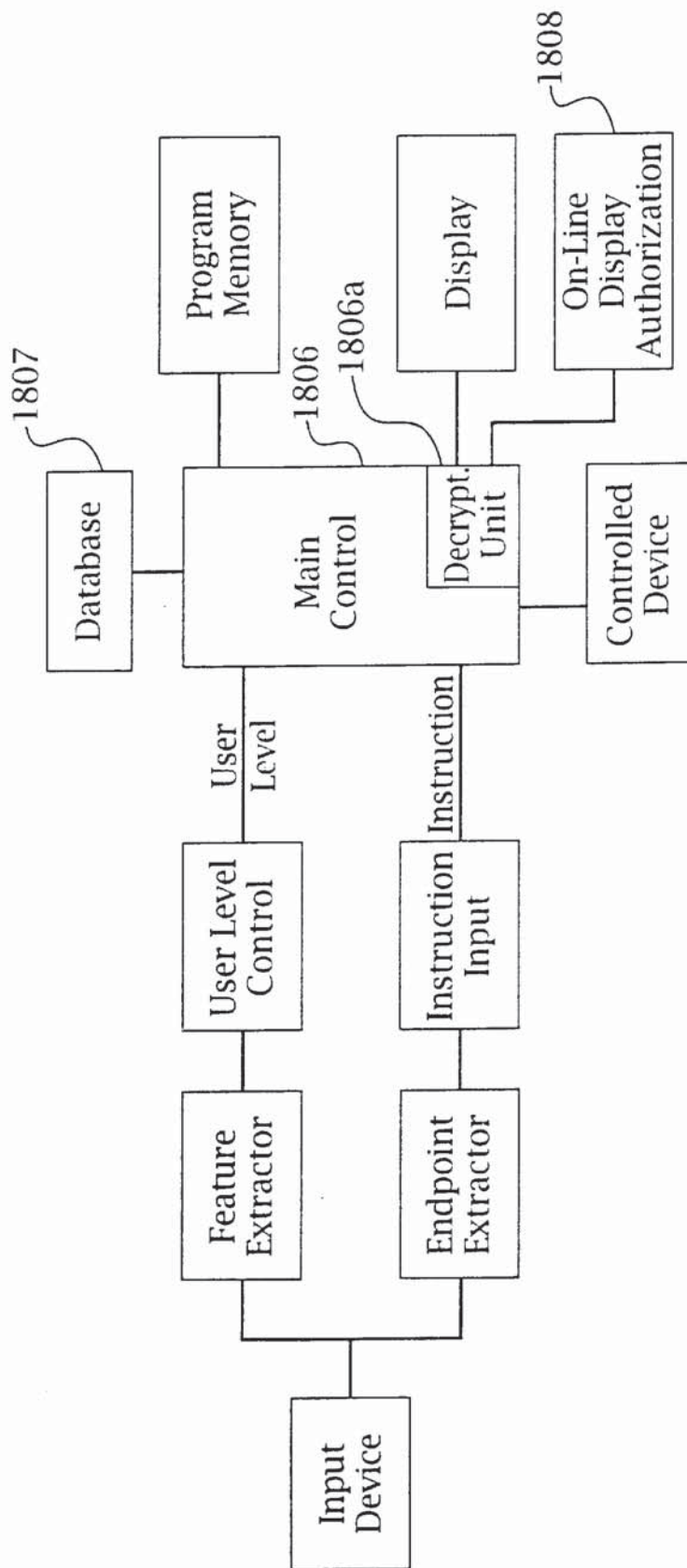


Fig. 18

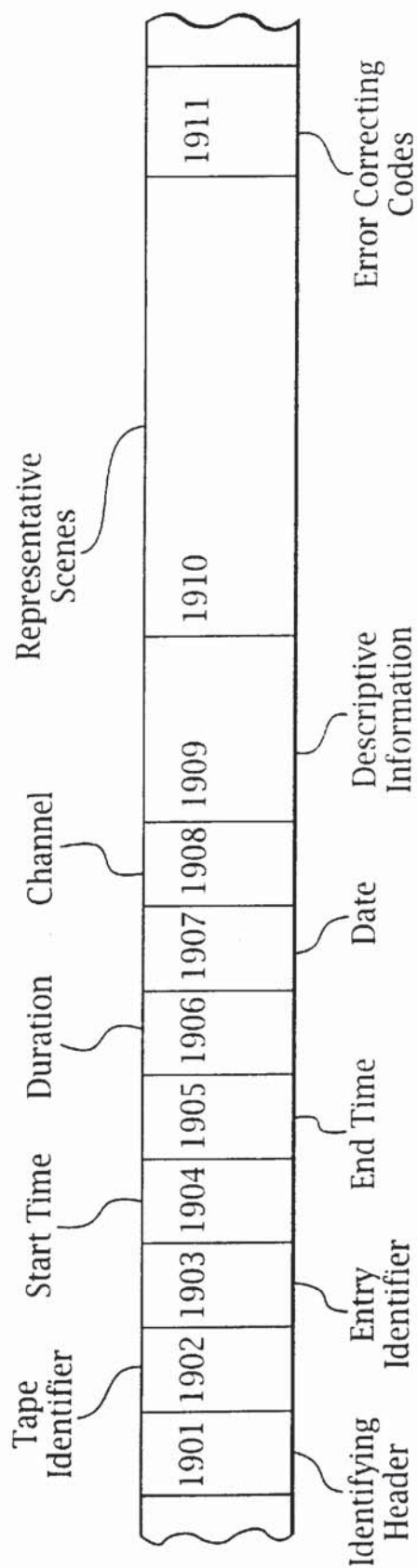


Fig. 19

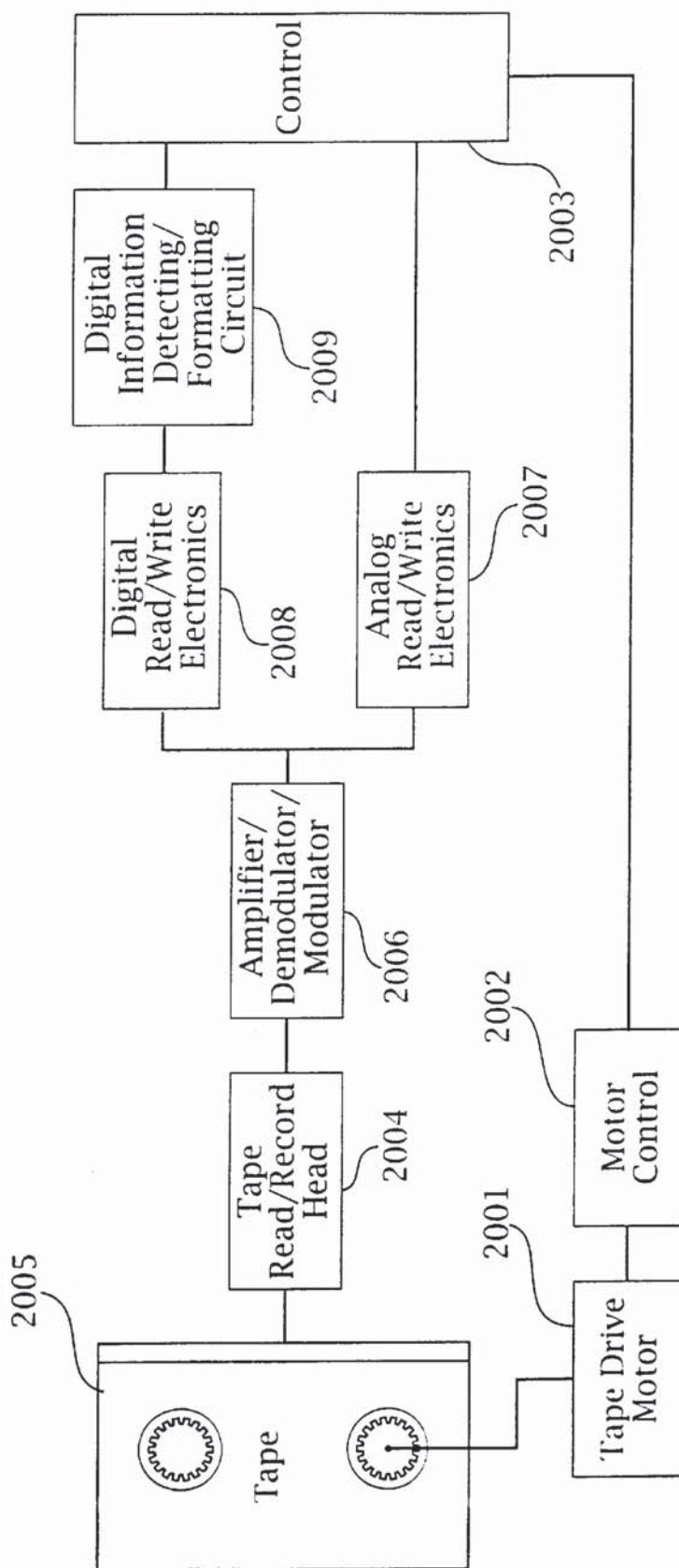


Fig. 20

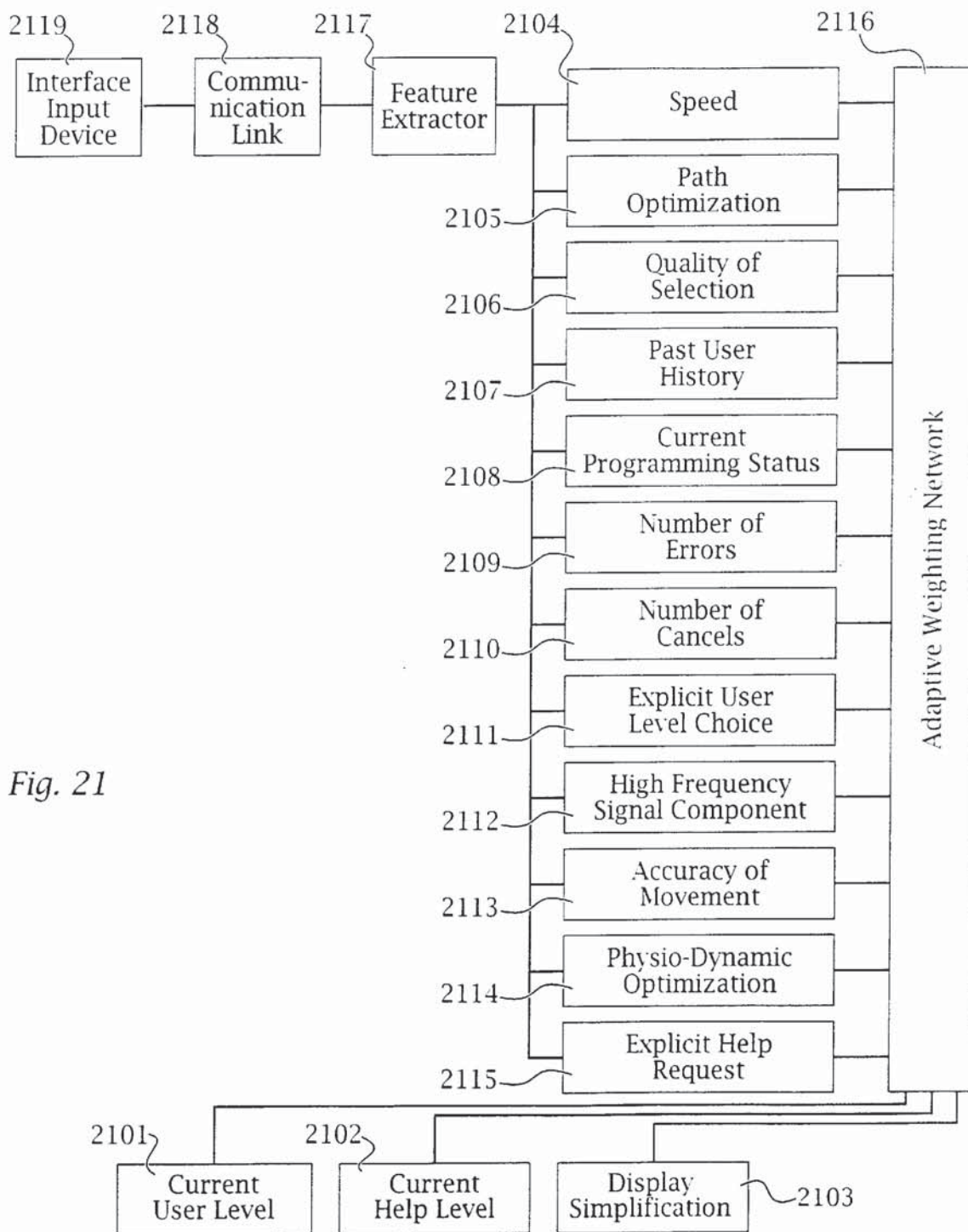


Fig. 21

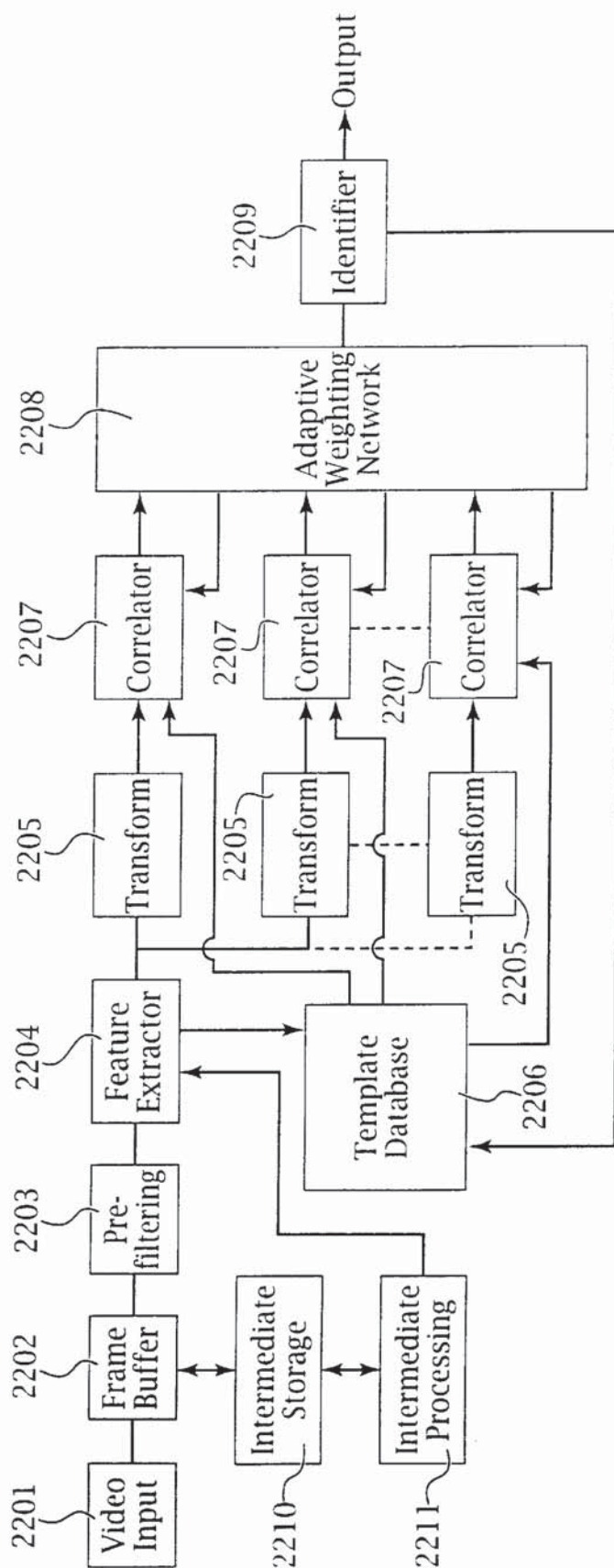
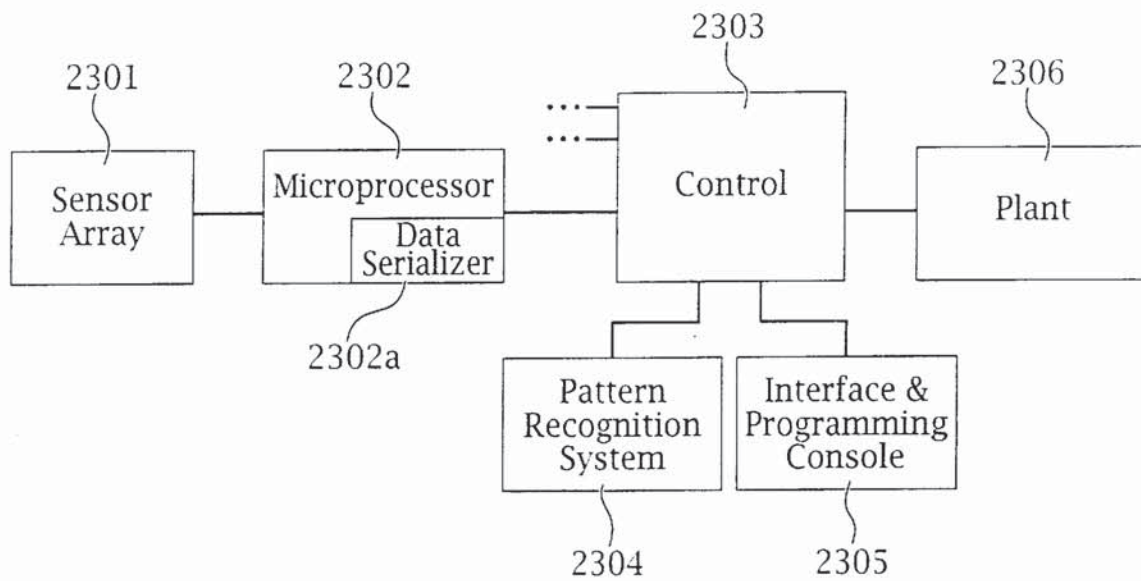


Fig. 22

*Fig. 23*

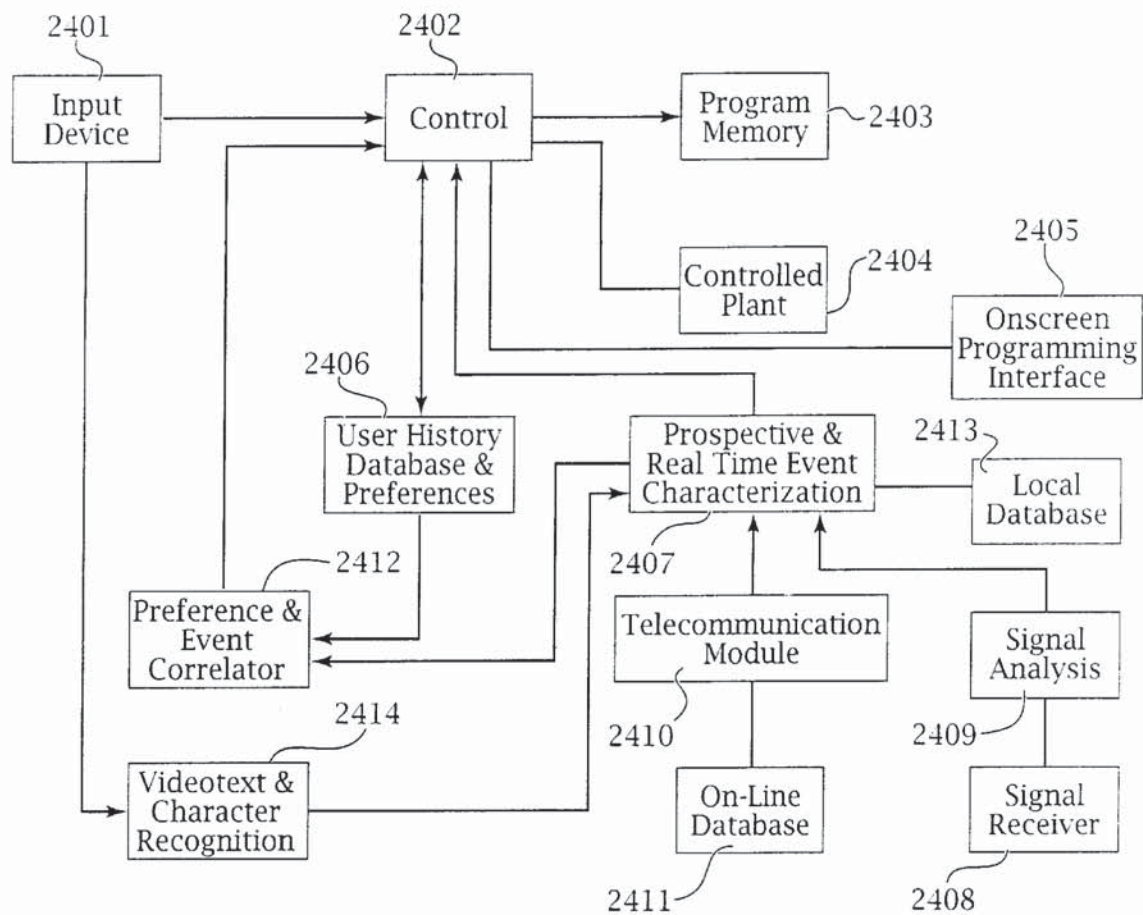


Fig. 24

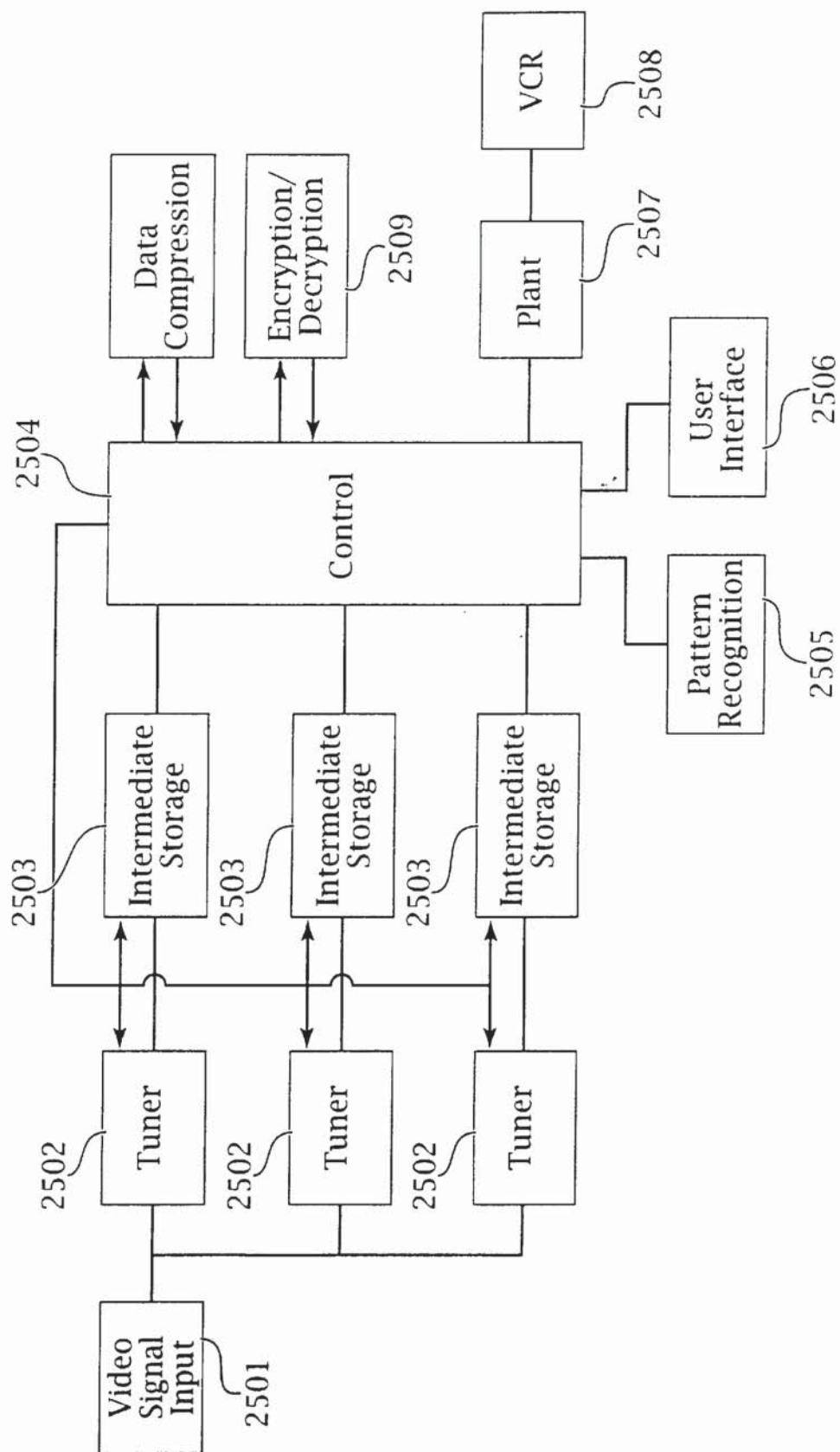
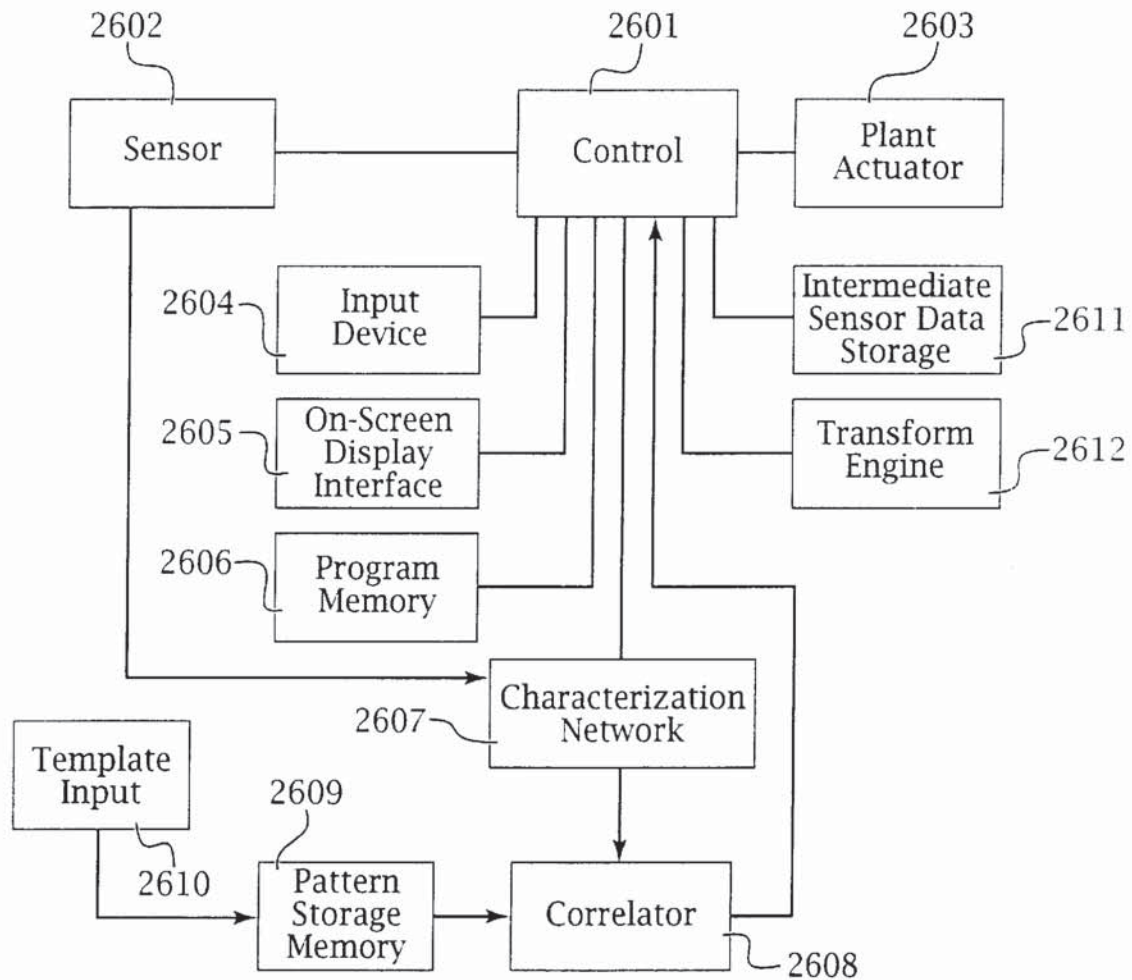
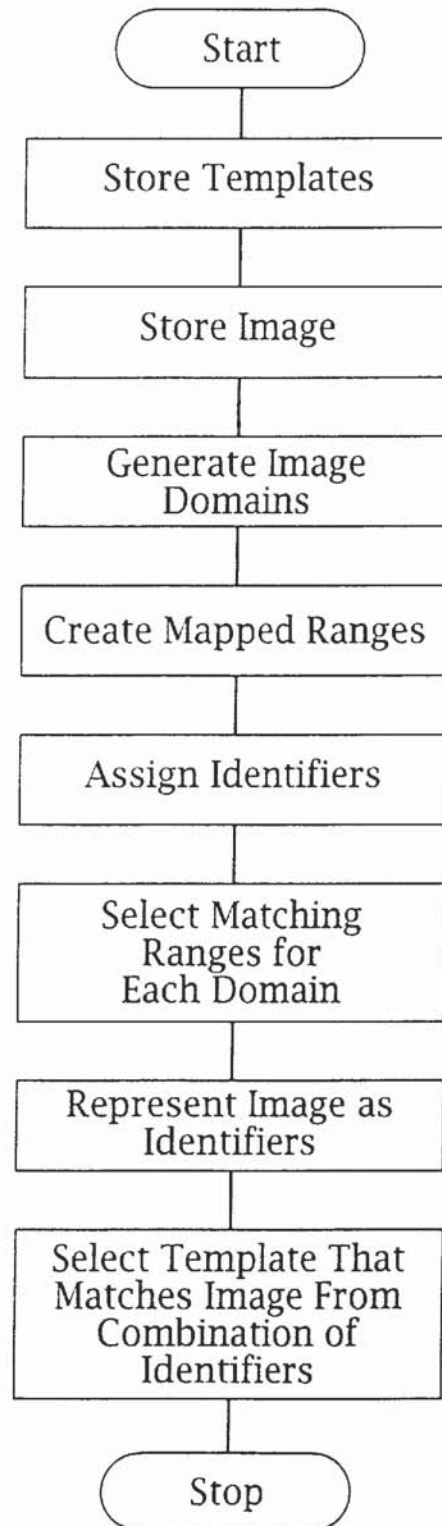
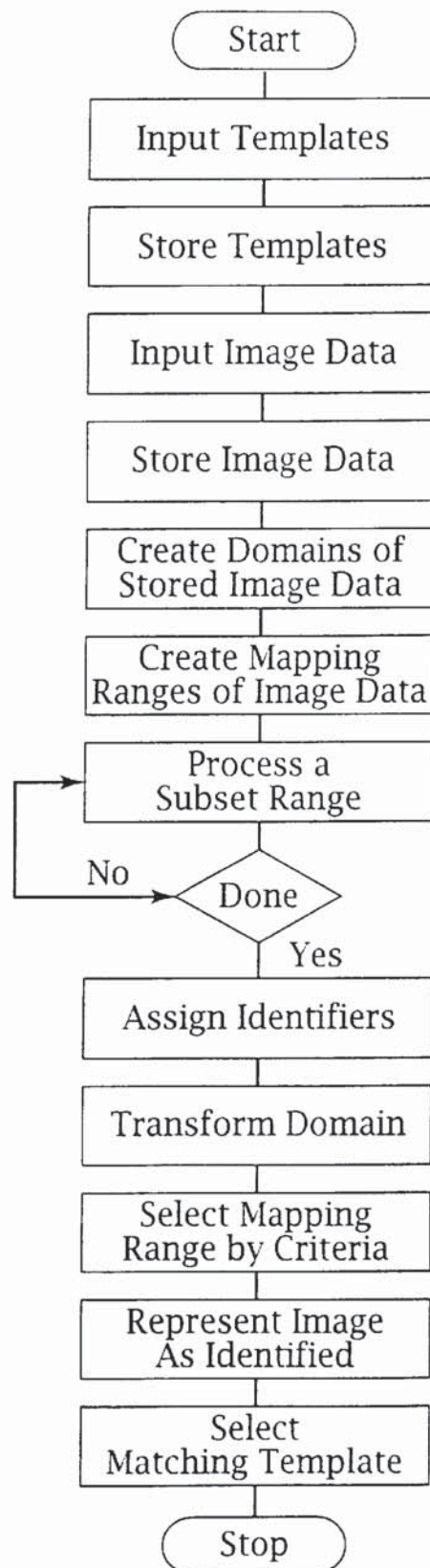
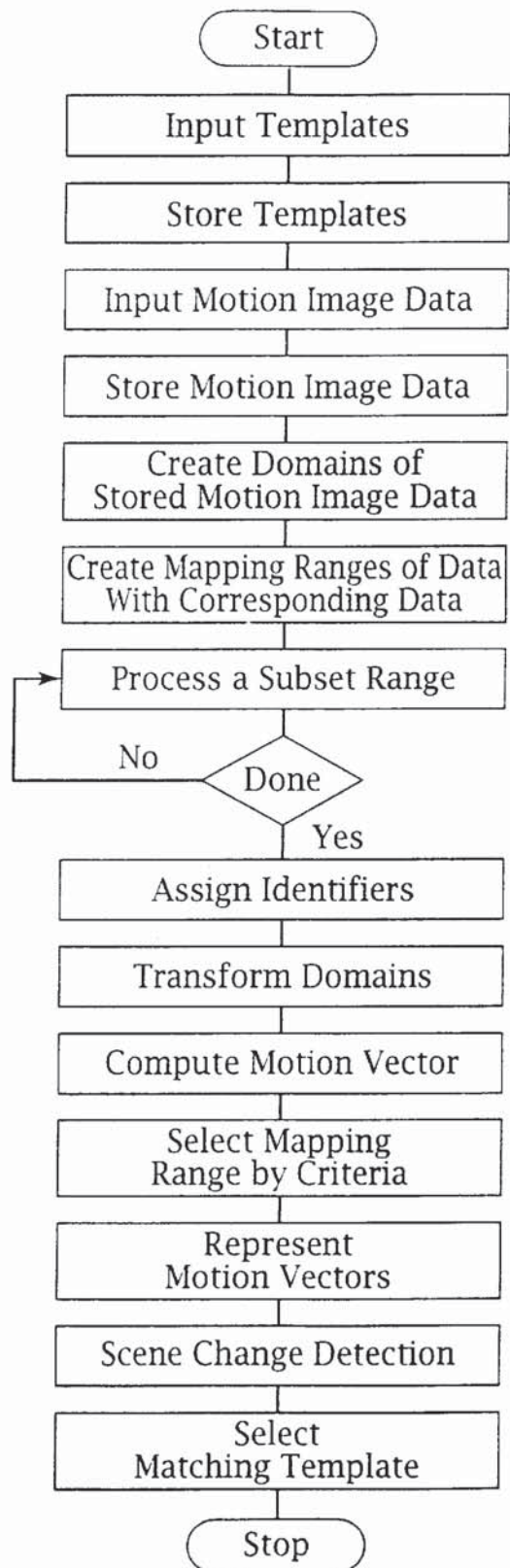


Fig. 25

*Fig. 26*

*Fig. 27*

*Fig. 28*

*Fig. 29*

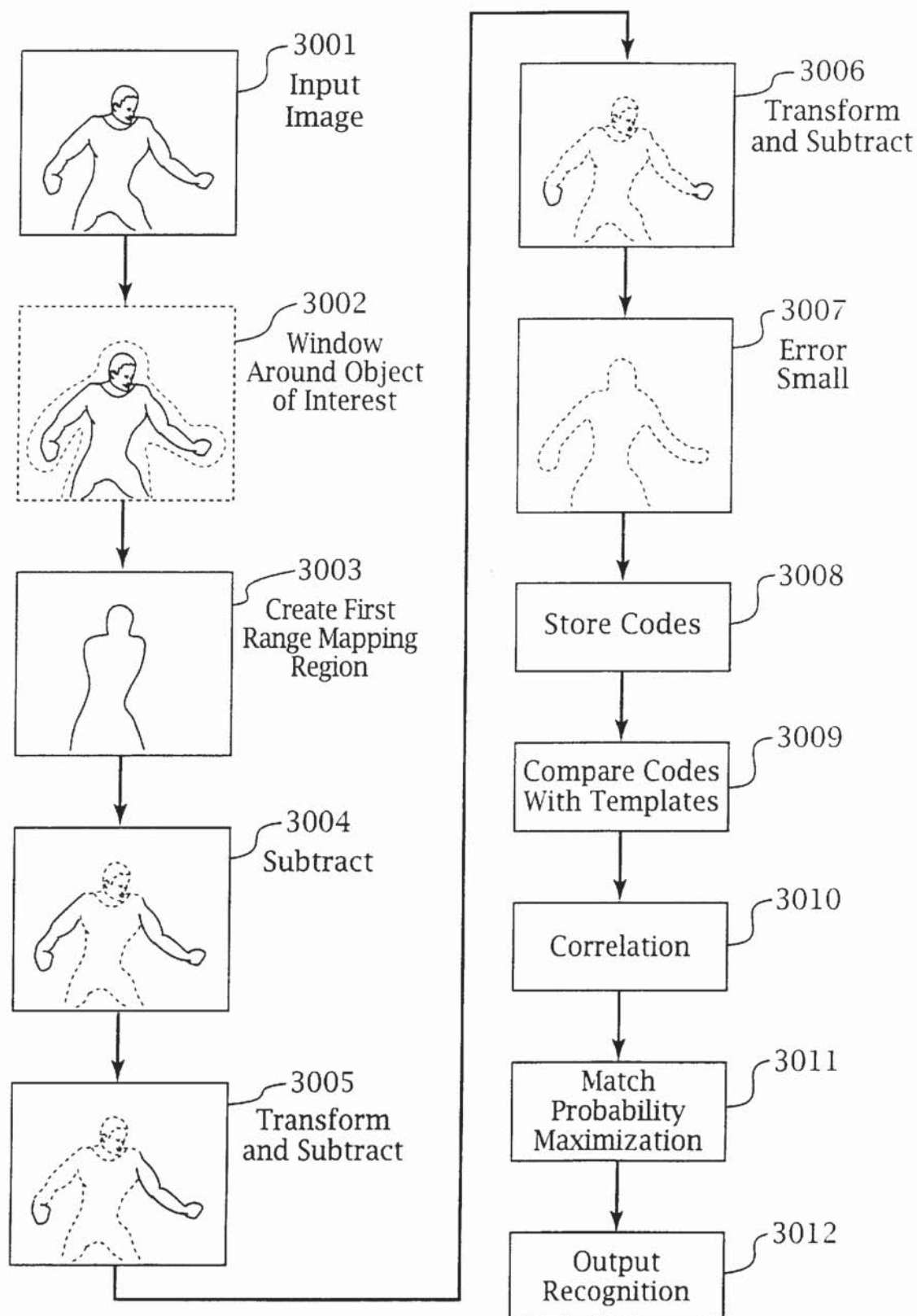


Fig. 30

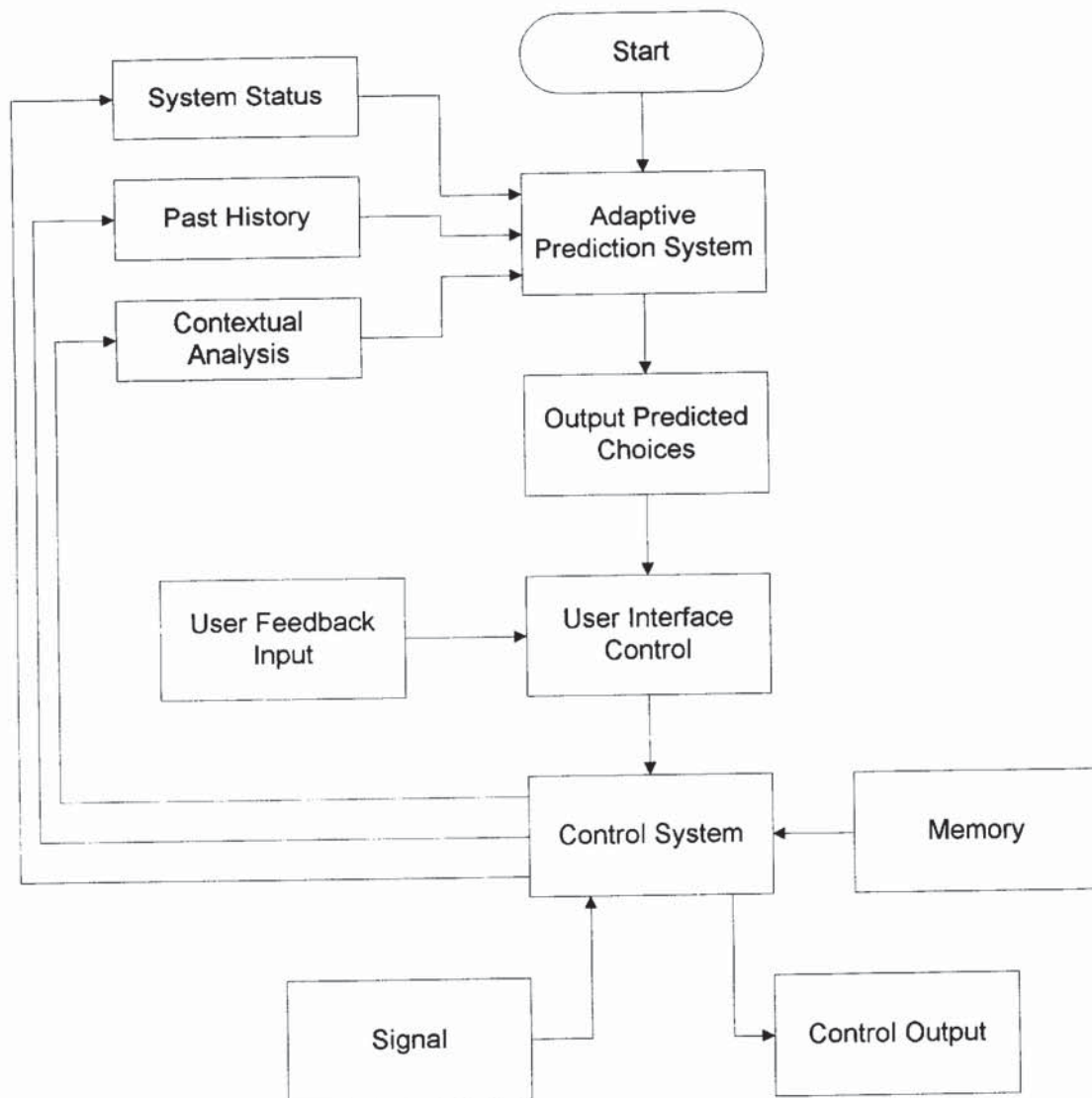


Fig. 31

HUMAN FACTORED INTERFACE INCORPORATING ADAPTIVE PATTERN RECOGNITION BASED CONTROLLER APPARATUS

RELATED APPLICATIONS

The present application of a Continuation of U.S. patent application Ser. No. 07/812,805 filed Dec. 23, 1991.

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FIELD OF THE INVENTION

The present invention relates to the field of programmable sequencing devices, or, more particularly, the field of remote controls for consumer electronic devices. The present invention provides an enhanced interface for facilitating human input of a desired control sequence in a programmable device by employing specialized visual feedback. Some of the most popular programmable products include video cassette recorders (VCRs), answering machines, microwave ovens, alarm clocks, thermostats, cameras, home security systems, lighting systems, and automobiles.

BACKGROUND OF THE INVENTION

Significant difficulties are experienced by users when programmable complex devices are infrequently used or programmed, or when a user attempts to use uncommon functions of these devices, such as, for example video cassette recorders (hereinafter "VCRs"). Studies have concluded that 80% of users cannot correctly program their VCRs. This has been due, in part, to the fact that manufacturers continue to add more features to existing devices, without simplifying those which already exist.

People learn most efficiently through the interactive experiences of doing, thinking, and knowing. For ease-of-use, efficiency, and lack of frustration of the user, utilizing the device should be intuitive. Users should be able to operate the device without referring to an instruction manual. Well-designed products should contain visual clues which prompt and convey their meanings, however, prior art devices do not always live up to this ideal. This problem is accentuated by various manufacturers and designers who focus on the production and design of feature-rich systems, rather than on ones which are also "User Friendly" and thus easier to use. Therefore, many products are extremely complex and thus difficult to use, thereby preventing all but the most technically advanced people from using them.

The act of programming, or determining a sequence of operations to be performed by, for example, a VCR, several steps are required. In addition to setting the clock, the user must assign a program number, set the current date and current time, select the start and stop times, choose the channel from which to record, and choose a tape speed. These actions require a minimum of four actuators ("Program", "+", "-", and "Enter"). Presently, some VCR controls contain up to 123 buttons, double function keys, and symbols which are-not immediately recognized by the user.

In order to simplify commonly-used functions, a number of methods have been devised. Certain VCRs employ a

bar-code reader in order to allow entry of programming steps from a menu of functions, or from an encoded description of an event to be programmed. However, this method suffers from the limitation that the channel, time and duration must be available in encoded form, otherwise the use of the device will not simplify the use or programming of the VCR. These machines come with a laminated sheet of bar codes. In order to program the VCR, the user must press a button on a wand, which lights its tip, and then run or pass the tip over a bar-code, to set each step separately. Finally, when all the information has been scanned in, the user must press the "Transmit" button. The "VCRplus+" is a device which allows the entry of a code representing a channel, time, date and duration of a program to be recorded, which when entered into the remote control device, is translated into commands for programming the VCR, and transmitted through an infrared link to the VCR, thus programming the VCR. This system has the limitations that the published codes must be available, and manually entered, which may be thus be erroneously entered, and the system does not allow for rescheduled programs, so that any variation in schedule will result in a defective recording. The time and date in the VCR device must also be set accurately for this system to operate.

On-screen programming systems exist; however, these generally require the user to scroll through menus and option choices without allowing direct entry of programming information. Direct-entry systems are available with, for example, programmable controllers with keypad entry. However, these do not generally have full information visual displays, meaning that all vital information is not or cannot be simultaneously displayed, and must be "multiplexed", meaning that data must share display space with other data, displayed at different times. In a VCR with on-screen programming, all programming information feedback is displayed on the television screen, and prompts are provided to guide the user through the necessary steps. Some VCRs have numeric keypads to enter the information, while others allow choices to be entered by the selection method, which depends on the use of "up" and "down" arrow keys to select a desired option.

The other major presently used method, which is available on most VCRs, as well as other types of programmable devices, is Display Panel Programming. This method is generally inadequate because full instructions are not normally available on the display panel, and the amount of information simultaneously displayed is limited. Users do not need a television set to see the displayed information, but they might have trouble reading the small, usually multi-functional multiplexed display and keypad. When programming the VCR, information may be entered on the display panel using the selection method, with either the "up" key or both "up" and "down" keys, or by direct entry in devices that support such a system.

The remote control device of a VCR is often the primary input device, and it sometimes has control functions not accessible from a keypad input present on the VCR itself. Remote controls often contain many buttons, which may be found overwhelming and confusing by the user. This results in under-utilization of the various actuators or buttons, and consequently, various useful features are unused or inaccessible, or the programming operation is inefficient. The extra clutter results in a greater "search time", the time needed to locate and execute a desired function, and thus it takes longer to program the VCR. The general structure of the search time in programming a VCR is shown diagrammatically in FIG. 1. Other problems arise from the layout

and coding of the buttons. A study performed by Kamran Abedini and George Hadad in 1987 entitled "Guidelines for Designing Better VCRs", Report No. IME 462, Feb. 4, 1987, California State Polytechnic University, incorporated herein by reference, has shown that varying the shape of the remote control device is more effective than varying its size. In addition, they found that color coding and adequate contrast can effect a significant improvement in programming performance. Abedini and Kamran, in "An Ergonomically-improved Remote Control Unit Design", Interface '87 Proceedings, 375-380 (1987), incorporated herein by reference, found that 78% of the people surveyed favored direct entry numbers (0-9) in addition to labels, symbols, discrete volume switches, and channel up/down buttons for casual searching. In addition, the people surveyed preferred remote controls which fit comfortably into their hand.

Many techniques have been used to facilitate the programming of devices such as VCRs, including:

Display Panels (1982)—Programmed with the aid of an light emitting diode (LED) display panel on the front of the machine.

Programming Via Remote Control (1983)—Programmed using a remote control device with keys for input.

On-Screen Displays (1984)—Programmed by a series of menus on the television screen.

Bar Code Scanners (1987)—Programmed by a wand passing over a series of lines, which are decoded and then transmitted to the VCR.

Light Pens (1987)—Programmed by aiming a pointing device with a light beam sensor at the television screen, which allows timing signals to be extracted to determine the position of the device with respect to the screen, and hence, the intended instruction.

Video Program System Signal Transmitters (1988)—The VCR is programmed by entering the unique code number of a desired program to record, which is emitted by television stations in West Germany as videotext digital signals associated with each program.

Phone Lines (1989)—Programmed over a telephone line at from a remote location. The numeric keys on the phone are the input keys.

Video Memories (1989)—Programmed by a computer from a remote location. For example, a user contacts a service, who then records certain programs at a user's request. These can be characterized in a number of ways, e.g. comedies, movies, etc. and the service will then manually scan the broadcast schedules for these provided characterizations and record the desired programs.

Voice Coaches (1990)—Programmed by responding to voice instructions, e.g. speech prompts, from the remote control.

As the technology becomes more mature, and VCRs and other types of programmable consumer electronic devices become less expensive, a proportionally less-educated segment of society will be confronted with these devices. While education and ability to program a VCR are not necessarily correlated, the present invention is directed toward improving the interface to allow all segments of the population to effectively interface with these programmable devices. By making the user interface more intuitive, and facilitating program entry by all levels of users, the present method and apparatus allow a manufacturer to produce a single device, without regard to the ability of the user to learn the programming steps. It is also noted that, because of their previous inability to provide a programmable consumer

electronic device with various user interface levels, manufacturers have had to compromise the programming power of their user interface to allow less than advanced users to program it, or to compromise the usability of the device in order to make the full programming power available.

TECHNOLOGY FOR IMPLEMENTING THE HUMAN INTERFACE, IMAGE PROCESSING AND DECISION MAKING METHODS OF THE PRESENT INVENTION

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The following cited patents and publications are relevant to pattern recognition and control aspects of the present invention, and are herein expressly incorporated by reference:

U.S. Pat. No. 5,067,163, incorporated herein by reference, discloses a method for determining a desired image signal range from an image having a single background, in particular a radiation image such as a medical X-ray. This reference teaches basic image enhancement techniques.

U.S. Pat. No. 5,068,664, incorporated herein by reference, discloses a method and device for recognizing a target among a plurality of known targets, by using a probability based recognition system. This patent document cites a number of other references, each incorporated herein by reference, which are relevant to the problem of image recognition:

Vannicola et al, "Applications of Knowledge based Systems to Surveillance", *Proceedings of the 1988 IEEE National Radar Conference*, 20-21 Apr. 1988, pp. 157-164;

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Jeffrey, R. J., "The logic of decision", *The University of Chicago Press, Ltd., London* (1983)(2nd Ed.);

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Kaufmann, A., "Introduction a la theorie des sous-ensembles flous", Vol. 1, 2 et 3-Masson-Paris (1975);

Sugeno, M., "Theory of fuzzy integrals and its applications", *Tokyo Institute of Technology* (1974);

Bellman, R. E., L. A. Zadeh, "Decision making in a fuzzy environment", *Management Science*, 17(4) (December 1970);

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Dubois, D., "Modeles mathematiques de l'imprecis et de l'incertain en vue d'applications aux techniques d'aide a la decision", *Doctoral Thesis*, University of Grenoble (1983);

Dubois, D., N. Prade, "Theorie des possibilites: application a la representation des connaissances en informatique", *Masson*, Paris (1985).

Thus, the image or object recognition feature of the present invention may be implemented in the manner of U.S. Pat. No. 5,068,664. Further, it is clear that this recognition feature may form an integral part of certain embodiments of the present invention. It is also clear that the various features of the present invention would be applicable as an adjunct to the various elements of the system disclosed in U.S. Pat. No. 5,068,664.

U.S. Pat. Nos. 5,065,447, and 4,941,193, both incorporated herein by reference, relate to the compression of image data by using fractal transforms. These are discussed in detail below. U.S. Pat. No. 5,065,447 cites a number of references, all incorporated herein by reference, relevant to the use of fractals in image processing:

U.S. Pat. No. 4,831,659;

Barnsley et al., "Hidden Variable Fractal Interpolation Functions", School of Mathematics, Georgia Institute of Technology, Atlanta, Ga. 30332, Jul., 1986;

Barnsley, M. F., and Demko, S., "Iterated Function Systems and The Global Construction of Fractals", Proc. R. Soc. Lond., A399:243-275 (1985);

Barnsley, M. F., Ervin, V., Hardin, D., Lancaster, J., "Solution of an Inverse Problem for Fractals and Other Sets", Proc. Natl. Acad. Sci. U.S.A., 83:1975-1977 (Apr. 1986);

"A New Class of Markov Processes for Image Encoding", School of Mathematics, Georgia Inst. of Technology (1988), pp. 14-32;

"Fractal Modelling of Biological Structures", Perspectives in Biological Dynamics and Theoretical Medicine, Koslow, Mandell, Shlesinger, eds., Annals of New York Academy of Sciences, vol. 504, 179-194 (date unknown);

Elton, J., "An Ergodic Theorem for Iterated Maps", Journal of Ergodic Theory and Dynamical Systems, 7 (1987);

"Construction of Fractal Objects with Iterated Function Systems", Siggraph '85 Proceedings, 19(3):271-278 (1985);

"Fractal Modelling of Real World Images, Lecture Notes for Fractals: Introduction, Basics and Perspectives", Siggraph (1987);

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"Fractal Geometry-Understanding Chaos", Georgia Tech Alumni Magazine, p. 16 (Spring 1986);

"Fractals-A Geometry of Nature", Georgia Institute of Technology Research Horizons, p. 9 (Spring 1986);

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Barnsley et al., "A Better Way to Compress Images", Byte Magazine, Jan. 1988, pp. 213-225;

Derra, Skip, "Researchers Use Fractal Geometry, . . .", Research and Development Magazine, Mar. 1988;

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Baldwin, William, "Just the Bare Facts, Please", Forbes Magazine, Dec. 12, 1988;

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Barnsley et al., "Chaotic Compression", Computer Graphics World, Nov. 1987;

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Mandelbrot, B., "The Fractal Geometry of Nature", W. H. Freeman & Co., San Francisco, Calif., 1982, 1977; and

Barnsley, M. F., "Fractals Everywhere", Academic Press, Boston, Mass., 1988, both of which are also incorporated herein by reference.

U.S. Pat. No. 5,063,603, incorporated herein by reference, relates to a dynamic method for recognizing objects and image processing system therefor. This reference discloses a method of distinguishing between different members of a class of images, such as human beings. A time series of successive relatively high-resolution frames of image data, any frame of which may or may not include a graphical

representation of one or more predetermined specific members (e.g., particular known persons) of a given generic class (e.g. human beings), is examined in order to recognize the identity of a specific member; if that member's image is included in the time series. The frames of image data may be examined in real time at various resolutions, starting with a relatively low resolution, to detect whether some earlier-occurring frame includes any of a group of image features possessed by an image of a member of the given class. The image location of a detected image feature is stored and then used in a later-occurring, higher resolution frame to direct the examination only to the image region of the stored location in order to (1) verify the detection of the aforesaid image feature, and (2) detect one or more other of the group of image features, if any is present in that image region of the frame being examined. By repeating this type of examination for later and later occurring frames, the accumulated detected features can first reliably recognize the detected image region to be an image of a generic object of the given class, and later can reliably recognize the detected image region to be an image of a certain specific member of the given class. Thus, the personae recognition feature of the present invention may be implemented in this manner. Further, it is clear that this recognition feature may form an integral part of certain embodiments of the present invention. It is also clear that the various features of the present invention would be applicable as an adjunct to the various elements of the system disclosed in U.S. Pat. No. 5,063,603.

U.S. Pat. No. 5,055,658, incorporated herein by reference, relates to a security system employing digitized personal characteristics, such as voice. The following cited references are incorporated herein by reference:

Naik et al., "High Performance Speaker Verification . . .", ICASSP 86, Tokyo, CH2243-486/0000-0881, IEEE 1986, pp. 881-884;

"Voice Recognition and Speech Processing", Elektor Electronics, Sep. 1985, pp. 56-57;

Shinan et al., "The Effects of Voice Disguise . . .", ICASSP 86, Tokyo, CH2243-4/86/0000-0885, IEEE 1986, pp. 885-888.

Parts of this system relating to speaker recognition may be used to implement a voice recognition system of the present invention for determining an actor or performer in a broadcast.

U.S. Pat. No. 5,067,164, incorporated herein by reference, relates to a hierarchical constrained automatic learning neural network for character recognition, and thus represents an example of a trainable neural network for pattern recognition, which discloses methods which are useful for the present invention. This Patent cites various references of interest, which are incorporated herein by reference:

U.S. Pat. Nos. 4,760,604, 4,774,677 and 4,897,811;

Rumelhart, D. E., et al., Parallel Distr. Proc.: Explorations in Microstructure of Cognition, vol.1, 1986, "Learning Internal Representations by Error Propagation", pp. 318-362;

Lippmann, R. P., "An Introduction to Computing with Neural Nets", IEEE ASSP Magazine, 4(2):4-22 (Apr. 1987);

LeCun, Y., Connectionism in Perspective, R. Pfeifer, Z. Schreter, F. Fogelman, L. Steels, (Eds.), 1989, "Generalization and Network Design Strategies", pp. 143-55;

LeCun, Y., et al., "Handwritten Digit Recognition: Applications of Neural . . .", IEEE Comm. Magazine, pp. 41-46 (Nov. 1989).

U.S. Pat. Nos. 5,048,100, 5,063,601 and 5,060,278, all incorporated herein by reference, also relate to neural net-

work adaptive pattern recognition methods and apparatuses. It is clear that the methods of U.S. Pat. Nos. 5,048,100, 5,060,278 and 5,063,601 may be used to perform the adaptive pattern recognition functions of the present invention. More general neural networks are disclosed in U.S. Pat. Nos. 5,040,134 and 5,058,184, both incorporated herein by reference, which provide background on the use of neural networks. In particular, U.S. Pat. No. 5,058,184 relates to the use of the apparatus in information processing and feature detection applications.

U.S. Pat. No. 5,058,180, incorporated herein by reference, relates to neural network apparatus and method for pattern recognition, and is thus relevant to the intelligent pattern recognition functions of the present invention. This patent cites the following documents of interest, which are incorporated herein by reference:

U.S. Pat. Nos. 4,876,731 and 4,914,708;

Computer Visions, Graphics, and Image Processing 1987, 37:54-115;

Jackel, L. D., H. P. Graf, J. S. Denker, D. Henderson and I. Guyon, "An Application of Neural Net Chips: Handwritten Digit Recognition," ICNN Proceeding, 1988, pp. II-107-15;

Carpenter, G. A., S. Grossberg, "The Art of Adaptive Pattern Recognition by a Self-Organizing Neural Network," IEEE Computer, Mar. 1988, pp. 77-88;

Pawlicki, T. F., D. S. Lee, J. J. Hull and S. N. Srihari, "Neural Network Models and their Application to Handwritten Digit Recognition," ICNN Proceeding, 1988, pp. II-63-70;

Gullichsen E., E. Chang, "Pattern Classification by Neural Network: An Experiment System for Icon Recognition," ICNN Proceeding on Neural Networks, Mar. 1987, pp. IV-725-32;

Grossberg, S., G. Carpenter, "A Massively Parallel Architecture for a Self-Organizing Neural Pattern Recognition Machine," Computer Vision, Graphics, and Image Processing (1987, 37, 54-115), pp. 252-315;

Lippman, R. P., "An Introduction to Computing with Neural Nets," IEEE ASSP Magazine, Apr. 1987, pp. 4-22.

U.S. Pat. No. 5,067,161, incorporated herein by reference, relates to a video image pattern recognition system, which recognizes objects in near real time.

U.S. Pat. Nos. 4,817,176 and 4,802,230, both incorporated herein by reference, relate to harmonic transform methods of pattern matching of an undetermined pattern to known patterns, and are useful in the pattern recognition method of the present invention. U.S. Pat. No. 4,998,286, incorporated herein by reference, relates to a harmonic transform method for comparing multidimensional images, such as color images, and is useful in the present pattern recognition methods.

U.S. Pat. No. 5,060,282, incorporated herein by reference, relates to an optical pattern recognition architecture implementing the mean-square error correlation algorithm. This method allows an optical computing function to perform pattern recognition functions. U.S. Pat. No. 5,060,282 cites the following references, incorporated herein by reference, which are relevant to optical pattern recognition:

Psaltis, D., "Incoherent Electro-Optic Image Correlator", Optical Engineering, 23(1):12-15 (Jan./Feb. 1984);

Kellman, P., "Time Integrating Optical Signal Processing", Ph. D. Dissertation, Stanford University, 1979, pp. 51-55;

Molley, P., "Implementing the Difference-Squared Error Algorithm Using An Acousto-Optic Processor", SPIE, 1098:232-239, (1989);

Rhodes, W., "Acousto-Optic Signal Processing: Convolution and Correlation", Proc. of the IEEE, 69(1):65-79 (Jan. 1981);

Vander Lugt, A., "Signal Detection By Complex Spatial Filtering", IEEE Transactions On Information Theory, IT-10, 2:139-145 (Apr. 1964);

Psaltis, D., "Two-Dimensional Optical Processing Using One-Dimensional Input Devices", Proceedings of the IEEE, 72(7):962-974 (Jul. 1984);

Molley, P., et al., "A High Dynamic Range Acousto-Optic Image Correlator for Real-Time Pattern Recognition", SPIE, 938:55-65 (1988).

U.S. Pat. No. 5,063,602, incorporated herein by reference, also relates to an optical image correlators.

U.S. Pat. No. 5,067,160, incorporated herein by reference, relates to a motion-pattern recognition apparatus. The apparatus recognizes a motion of an object which is moving and is hidden in an image signal, and discriminates the object from the background within the signal. The apparatus has an image forming unit comprising non-linear oscillators, which forms an image of the motion of the object in accordance with an adjacent-mutual-interference-rule, on the basis of the image signal. A memory unit, comprising non-linear oscillators, stores conceptualized meanings of several motions. A retrieval unit retrieves a conceptualized meaning close to the motion image of the object. An altering unit alters the rule, on the basis of the conceptualized meaning. The image forming unit, memory unit, retrieval unit and altering unit form a holonic-loop. Successive alterations of the rules by the altering unit within the holonic loop change an ambiguous image formed in the image forming unit into a distinct image. U.S. Pat. No. 5,067,160 cites the following references, incorporated herein by reference, which are relevant to the task of discriminating a moving object in a background:

U.S. Pat. No. 4,710,964;

Shimizu et al, "Principle of Holonic Computer and Holovision", Journal of the Institute of Electronics, Information and Communication, 70(9):921-930 (1987);

Omata et al, "Holonic Model of Motion Perception", IEICE Technical Reports, 3/26/88, pp. 339-346;

Ohsuga et al, "Entrainment of Two Coupled van der Pol Oscillators by an External Oscillation", Biological Cybernetics, 51:225-239 (1985).

It is clear that U.S. Pat. No. 5,067,160 discloses an adaptive pattern recognition system that may be useful in various embodiments of the present invention. It is also clear that the interface and control systems of the present invention provide useful adjuncts to the elements disclosed in U.S. Pat. No. 5,067,160.

U.S. Pat. No. 5,065,440, incorporated herein by reference, relates to a pattern recognition apparatus, which compensates for, and is thus insensitive to pattern shifting, thus being useful for decomposing an image into its structural features and recognizing the features.

U.S. Pat. No. 5,065,440 cites the following references, incorporated herein by reference, which are also relevant to the present invention: U.S. Pat. Nos. 4,543,660, 4,630,308, 4,677,680, 4,809,341, 4,864,629, 4,872,024 and 4,905,296.

U.S. Pat. No. 5,067,166, incorporated herein by reference, relates to a pattern recognition system, in which a local optimum match between subsets of candidate reference label sequences and candidate templates. It is clear that this method is useful in the pattern recognition aspects of the present invention. It is also clear that the interface and