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(54) **Title:** FULLY AUTOMATIC PROGRAMMING OF AN ENHANCED UNIVERSAL REMOTE CONTROL

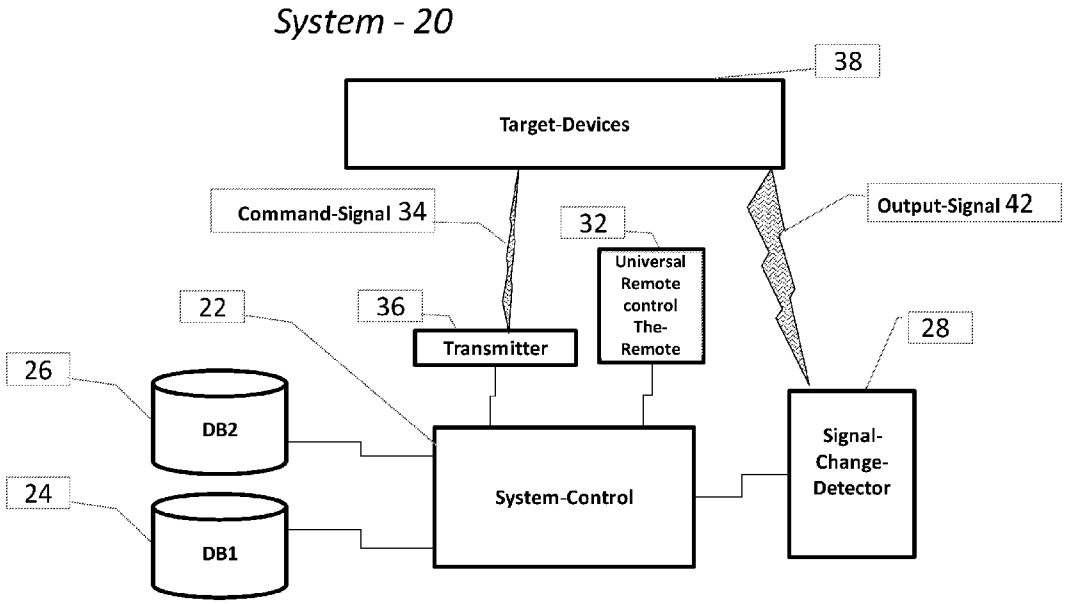

Fig. 1

(57) **Abstract:** A system for automatically programming a universal remote control, comprising: a universal remote control device; a database storing data related to a plurality of target device types which may be controlled by said one universal remote control device and data required for automatically programming said universal remote control device; a transmitter configured to transmit command signals towards at least one target device; a signal change detector configured to automatically detect changes in output signals of said at least one target device; a system control unit communicating with said universal remote control device, said transmitter and said signal change detector, said system control unit connected with said database, said system control unit configured to execute automatic programming of said universal remote control device.

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FULLY AUTOMATIC PROGRAMMING OF AN ENHANCED UNIVERSAL REMOTE CONTROL

TECHNICAL FIELD

The present disclosure relates to an apparatus and method for programming a universal remote control and, more particularly, to programming a universal remote control in a fully automated manner, without manual operation, using time-optimized techniques for detection of changes of output signals, signals which are generated by the to-be-controlled target devices.

CROSS-REFERENCE TO RELATED PATENT APPLICATIONS

This patent application claims priority from and is related to U.S. Provisional Patent Application Serial Number 62/381,639, filed 08/31/2016, this U.S. Provisional Patent Application incorporated by reference in its entirety herein.

BACKGROUND AND RELATED ART

Devices that utilize remote controls are found nearly everywhere. A single home will often have several devices, each requiring a different remote, for example, a television, stereo, DVD player, surround sound system, and even curtains or lighting. This can often create frustration and confusion since many remote controls will look similar, and often remote controls will be placed in different areas of a home, making it difficult to find a particular remote control.

Universal remote controls have long been used to solve the problem of having a large number of different remote controls. A universal remote control can generally be used for a wide range of devices, eliminating the need for separate remotes. However, universal remote controls still present a considerable amount of frustration and confusion during the programming of a user's individual devices. A universal remote control needs to be customized to function with each of a user's particular devices, all of which will require a different remote control programming code to be programmed into

the remote. Customization of a universal remote control has generally been performed by having a look up table, in which a user manually looks up their particular device model, and then inputs several possible codes which correspond to that device, testing each code to find the correct one. However, for many users, knowledge of the exact make and model of all of their devices can be cumbersome.

The problem of manual look up has been addressed partially by online databases of remote control programming codes, wherein a user looks at pictures to match their current remote or current device. However, this still creates the problem of manual look up and entry of remote control programming codes, and still requires a user to sift through dozens or perhaps hundreds of pictures to match their device. Other attempts to alleviate the problem of manual entry have come in the form of "wizards" for remote control programming code identification. The wizard will guide the user through a series of questions in order to select the remote control programming code. These wizards may be either on the remote control, or on a user's computer, and entry of the code can be manual or through an interface such as USB. However, these wizards still do not solve the problem of requiring a user to find a code through specific knowledge of their devices. Many modern devices are complex audio/video equipment that were installed or selected by someone other than the user, making using the wizard difficult or impossible for an average user. In addition, a common audio/video system may include many devices, such as a display screen from one manufacturer, a set of speakers from another manufacturer, with a Blu-Ray, DVD and set-top box all from different manufacturers.

The universal remote control is programmed to control a device by using a remote control programming code, with each code being programmed to control one of the devices. For example, to control a Model X 48" Television, the universal remote control may use the code number 29852 as a programming code, while a Model Y Blu-Ray Player may have the programming code number 05039. Each code corresponds to a specific set of remote control signals which are programmed to control a given device.

Once the universal remote control has been programmed with a certain remote control programming code, it will be capable of transmitting signals that the device will recognize, in order to control the device.

Another method of programming a universal remote control is termed learning: The learning universal remote control learns the signals of each command, by receiving those signals from the original remote control.

The remote control signals are specific signals that are received by a device, and instruct the device to perform a certain function. For example, when a power button is pressed in a remote, the device that is controlled by that remote receives the signal that has been transmitted from the remote, and interprets that signal to toggle the power of the device. Each device, and original remote, has a unique set of signals that are used to perform the various functions of the device. Some devices may have the same or similar control signals, for example, the mute signal of a first device will also be the mute signal of a second device. However, the devices will also have some unique signals, for example, the channel up signals will not be the same.

It is very important to understand the above and realize that there is no method, no consistency, and no standard for allocating sets of signals to remote control commands.

All known to date universal remote control programming operations involve user operations, which often cause errors, confusion, frustration and failure to setup. This significantly reduces the adoption and use of universal remote controls.

Related Art:

US Patent No. 9202372(B2) discloses a remote control device may include: first circuitry to control a function of a first electronic device; second circuitry to be set to control a function of a second electronic device; and a setup controller to set the second circuitry to control a function of a target electronic device based on a code received from a separate device. An electronic device to be controlled by a remote control device may include: an input device to receive a signal from the remote control device; an output

device to send a signal to the remote control device; and a processor coupled to the input and output devices, and configured to access a database of codes and to selectively provide codes from the database to the remote control device, the codes configured to set circuitry of the remote control device to control a function of the electronic device and/or an auxiliary electronic device.

US Patent No. 6774813(B2) discloses a universal programmable remote is programmed for being used with a specific apparatus. A sequence of test codes is sent to the apparatus until the apparatus responds. The test codes comprise tags that are sent along. The tags fall all within a same narrow frequency band. An STB that is eavesdropping on the transmission is receptive to that band. The STB identifies the last tag and enables a server to identify the complete set of codes for the apparatus based on the tag. Thereupon the set is downloaded and programmed in the remote.

US Patent No. 5819294(A) discloses a programmable remote controller is programmed by a PC that has an onboard data base for sets of codes used by a variety of commercially available remote controllers. The data base contains sets of compressed codes. In order to program the remote, the user lets the PC find a match between a single pulse-code transmitted by a specific known controller on the one hand and an item in the data base on the other hand. Upon finding the match, the set containing the matching item is stored in the programmable controller as corresponding to the particular apparatus that is controllable via the specific remote.

US Published Application No. 2008174467(A1) discloses an apparatus and method for programming a universal remote control. The method includes receiving a transmitted signal of unknown modulation technique from a native remote control and characterizing the received signal in parameters of a pre-determined modulation technique.

US Patent No. 7562128(B1) discloses a set top box (STB) is marketed together with a programmable remote. The remote has a dedicated button to connect the STB to a specific server on the Internet. The consumer can notify the server of his/her other CE equipment, which he/she desires to be controllable through the same remote as the one that came with the STB. The server downloads to the STB data representative of the relevant control codes. The STB is provided with means to program the remote with these codes. In return the server has obtained detailed and accurate information about this consumer's equipment. A reliable customer base can thus be built for streamlining Help Desk operations.

SUMMARY

The invention disclosed herein may be embodied as a system and method for automatically, without human intervention, programming a universal remote control device based on general knowledge of target devices in the market place and their commands, time-optimized DB scanning techniques and signal-change-detection techniques of output signals generated by those target devices.

The entire system is based on an enhanced universal remote control and, optionally, additional external units.

According to a first aspect of the present invention there is provided a system for automatically programming at least one universal remote control, comprising: at least one universal remote control device; at least one database storing data related to at least one target device type which may be controlled by said at least one universal remote control device and data required for automatically programming said at least one universal remote control device; at least one transmitter configured to transmit at least one command signal towards at least one target device; at least one signal change detector configured to automatically detect changes in output signals of said at least one target device; and a system control unit communicating with said at least one universal remote control device, said at least one transmitter and said at least one signal change detector, said system control unit connected with said at least one

database, said system control unit configured to execute automatic programming of said at least one universal remote control device.

Each one of said at least one universal remote control device may be configured to operate in at least one operating mode.

Each one of said at least one universal remote control device may comprise, for each one of said at least one operating mode, mapping of buttons to command names.

Each one of said at least one universal remote control device may comprise, for each one of said at least one operating mode, mapping of soft buttons to buttons characteristics.

The data stored in said at least one database may comprise target device codes and corresponding target device types, target device names, command names, command signals and command descriptions.

The data stored in said at least one database may comprises: at least one universal remote control device model ID; at least one operating mode corresponding to each one of said at least one universal remote control device model ID; at least one target device code; usage statistics of each target device code per geo location; and signal influencing commands comprising parameters required for detecting signal change.

The at least one database may further comprise data related to TV operators; said data related to TV operators describing each of said TV operator's channel lineups, comprising: channel name, channel description, channel logo channel category and popularity statistics of channel per geo location.

The system may further be configured to automatically program favorite channel buttons using said popularity statistics of channel per geo location and per TV operator.

The parameters may comprise: signal type, measured property, minimal change, time window size and counter command name.

At least one of said at least one database, system control unit, signal change detector, transmitter and at least one universal remote control device may be embodied as at least one application on a mobile computing device.

At least one of said at least one database, system control unit, signal change detector, transmitter and at least one universal remote control device may be embodied as at least one application on one of a home computing device, an office computing device and an industrial computing device.

At least one of said at least one database, system control unit, signal change detector and transmitter may be embodied as an integral part of said at least one universal remote control device.

At least one of said at least one database, system control unit, signal change detector and transmitter may be embodied as an integral part of one or more target devices.

At least one of said at least one database, system control unit, signal change detector, transmitter and at least one universal remote control device may be embodied as a stand-alone device.

The at least one database, system control unit, signal change detector, transmitter and at least one universal remote control device may be packaged in any packaging combination.

The at least one database may reside in one of a local storage unit and a remote storage unit.

The at least one universal remote control device may comprise a plurality of universal remote control devices and said system may be configured to automatically program in parallel said plurality of universal remote control devices.

Each one of said at least one universal remote control device may comprise a universal remote control model ID, a unique serial number and at least one set of logical elements, each set of logical elements configured to implement a given operating mode and to control one or more target device types, said at least one set of logical elements

comprising at least one of: a plurality of commands comprising all the commands for implementing said given operating mode in said universal remote control model ID, each command associated with a command name and with a command signal; a plurality of buttons, each designated by a button ID; buttons command mapping configured to map said plurality of buttons to a plurality of command names and command signals, said buttons comprising soft buttons; a plurality of look and feel characteristics of said soft buttons; and buttons look and feel mapping configured to map each one of said soft buttons to said look and feel characteristics, wherein said universal remote control device is configured to receive said at least one set of logical element from said at least one database.

The commands may comprise basic commands and macro commands, said macro commands comprising a sequence of at least two basic commands.

The system control unit may comprise: a processor; control memory comprising run-time calculation data structures configured to be populated with data from said at least one database, said data relating to target devices; at least one command transmit interface configured to communicate between said processor and said at least one transmitter; at least one signal change detector interface configured to communicate between said processor and said at least one signal change detector; a database interface configured to retrieve data from said at least one database; at least one programming interface configured to send commands, command signals and look and feel data from said control memory to said at least one universal remote control device; at least one indicator interface configured to indicate the status of ongoing programming of said at least one universal remote control device; and a geo location module.

The system control unit may further comprise internet connection means.

Each one of said at least one signal change detector may comprise: change detector memory; a signal receiver configured to receive said output signals from said at least one target device; a signal recorder configured to receive said output signals from said signal receiver and record them in said change detector memory; a signal analyzer configured to analyze said received output signals according to predefined parameters;

a detector control unit configured to control operation of said signal receiver, said signal recorder and said signal analyzer; and a system control interface configured to communicate between the signal change detector and said system control unit.

The predefined parameters may comprise measured property, minimal change and time window size.

The data required for automatically programming said at least one universal remote control device may comprise data related to one or more operating modes and one or more target device types.

The at least one target device type may comprise at least one of the group consisting of: TV, Display, Projector, Set-Top-Box (STB), Streamer, Speakers, Amplifiers, Radios, Air-Conditions, Fans, Lights, Shades, Cameras and Smart Home devices.

The data stored in said at least one database may comprise a streaming and web sites table.

The data stored in said at least one database may comprise a remote customization table.

The automatic programming may be configured to be done without human intervention.

The at least one universal remote control device may comprise a plurality of universal remote control devices and at least one of said plurality of universal remote control devices may have a model ID different than the model ID of the other universal remote control devices in said plurality.

According to another aspect of the present invention there is provided a method of automatically programming a universal remote control device, comprising: transmitting at least one basic command signal toward at least one target device to be controlled by said universal remote control device, said at least one basic command signal configured to modify the state of said target device; detecting at least one change in said at least one target device's at least one output signal in response to said sent at least one basic

command signal; and programming said at least one command in said universal remote control device for controlling said at least one target device.

The method may further comprise obtaining at least one operating mode of said universal remote control, wherein said at least one target device comprises a target device type; said at least one basic command signal belongs to one signal influencing command for said target device type; and said programming comprises programming said at least one command for said universal remote control device for controlling said at least one target device.

Transmitting at least one basic command signal may comprise transmitting in a calculated order configured to minimize said programming time.

Detecting changes may comprise identifying the basic command signal that caused said changes.

The method may further comprise obtaining look & feel buttons data for said programmed at least one command.

The at least one target device and said at least one basic command signal may be selected from a database.

The automatic programming may be done without human intervention.

The at least one signal influencing command may be selected from a database, based on a calculated order configured to minimize said programming time.

The method may further comprise calculating an order of said signal influencing commands using cost related with executing each one of said signal influencing commands

The at least one basic command signal order may be calculated during said programming.

The at least one signal influencing command order may be calculated during said programming.

Calculating may comprise using data related to the popularity of devices of said target device type in a geo-location associated with said universal remote control device.

The cost may comprise average time to resolve each one of said signal influencing commands.

The order may comprise executing signal influencing commands with lower cost first.

The at least one command signal order may comprise first executing command signals with higher popularity in said geo-location.

According to another aspect of the present invention there is provided a database for use with a system comprising an automatically programmable remote control device, said database storing data related to at least one target device type which may be controlled by least one universal remote control device and data required for automatically programming said at least one universal remote control device, comprising: at least one universal remote control device model ID; at least one operating mode corresponding to each one of said at least one universal remote control device model ID; at least one target device code and corresponding at least one target device type; at least one set of command names and related command signals which control said at least one target device; usage statistics of said at least one target device code per geo location; and signal influencing commands comprising parameters required for detecting change in output signal of said at least one target device.

The database may further comprise data related to TV operators; said data related to TV operators describing each of said TV operator's channel lineups, comprising: channel name, channel description, channel logo channel category and popularity statistics of channel per geo location.

The parameters may comprise: signal type, measured property, minimal change, time window size and counter command name.

The database may further comprise data related to streaming and web sites, comprising: site ID, site URL, site description, site logo, site category and popularity statistics of site per geo location.

The database may further comprise data related to customization of said remote control device, comprising: remote ID, customized field and customization data.

BRIEF DESCRIPTION OF THE DRAWINGS

For better understanding of the invention and to show how the same may be carried into effect, reference will now be made, purely by way of example, to the accompanying drawings.

With specific reference now to the drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of the preferred embodiments of the present invention only, and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the invention. In this regard, no attempt is made to show structural details of the invention in more detail than is necessary for a fundamental understanding of the invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the invention may be embodied in practice. In the accompanying drawings:

Fig. 1 is a schematic block diagram of an exemplary system for automatic programming of universal remote control according to embodiments of the present invention;

Fig. 2 is a view of the logical elements of The-Remote required for operating in a single Operating-Mode, according to embodiments of the present invention;

Fig.3 is an exemplary flowchart of the High Level Algorithm performed by the system according to embodiments of the present invention;

Fig. 4 is a flowchart showing one embodiment of a Signals Matching Algorithm for identifying commands required for controlling a single Target-Device operating in all its relevant Operating-Modes of the current Remote-Model-ID, according to embodiments of the present invention;

Fig. 5 is a block diagram of components of the System-Control according to embodiments of the present invention; and

FIG. 6 is a block diagram of components of a Signal-Change-Detector according to embodiments of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention provides an automatic, hands-free, system and method of programming a universal remote control, using detection of changes in Output-Signal (sound or picture or light or temperature or other signal, see definitions) of Target-Devices.

Embodiments of the invention are now discussed in more detail referring to the accompanying drawings.

Various embodiments are disclosed herein; however, it is to be understood that the disclosed embodiments are merely illustrative of the invention, which can be embodied in alternate fashions. In addition, each of the examples given in connection with the various embodiments is intended to be illustrative and not restrictive.

DEFINITIONS

The following terms, used in the present application, are defined as follows:

Target-Device-Type: A group of devices with similar functionalities (e.g. TV, Display, Projector, STB, Streamer, Speakers, Amplifiers, Radios, Air-Conditions, Fans, Lights, Shades, Cameras, Smart Home devices, etc.) which may be controlled by a universal remote control.

Target-Device: A specific device which belongs to a single Target-Device-Type (e.g. Sony-XBR55X850D, LG-LW1016ER).

Control1: An element of a universal remote control with which the user interacts in order to control Target-Devices, by transmitting one or more Command-Signals configured to modify the state of the Target-Devices.

Soft-Button: A Control1 which may be presented to the user by one or more alternative LOOK & FEEL capabilities, as configured by the system.

Button: A soft Control1 or Soft-Button (e.g. as common in touch screen devices) or a physical Control1 or Physical-Button (e.g. buttons of a traditional remote control) or a combined soft-and-physical Control1, or any other Control1. Designated by a Button-ID.

Buttons-Commands-Mapping: Mapping of Buttons to Commands (basic or macro), which their signals will be transmitted once the button is activated.
Designated by a Buttons-Commands-Mapping-ID.

Buttons-L&F-Mapping: Look and Feel properties which may be linked to a Soft-Button, e.g. size, texts, logos, press & release feel parameters, sounds, colors, lights sequence, vibration sequence.
In the context of A/V devices, this may be especially useful for indicating settings of Favorite Channels (e.g. of TV, Internet, Radio).
Designated by a Buttons-L&F-Mapping-ID.

In the detailed description below, any mention of Buttons-L&F-Mapping, or L&F-Characteristics, or L&F-Data, or Button-Characteristics should be read as relating to Soft-Buttons only.

Basic-Command: A message generated by a transmitter and received by the Target-Device, which is intended to modify the state of the Target-Device (e.g. Mute message).

Macro-Command: A Macro-Command is a sequence of at least two Basic-Commands, interleaved with Timeout-Commands (e.g. close-shades-open-TV-channel-78, where a user operation will cause two different Target-Devices to operate, or Single-Button-Press-Tuning, where a user operation will cause the Target-Device to tune to a well-defined, set-in-advance, TV channel 78).

By use of macro commands the system supports automatic programming of buttons to tune to favorite web sites, favorite streaming sites and favorite TV channels, by a single button press.

Favorite-Channel-Button: In the context of A/V/Web Target-Devices, a Button which has been mapped to a Basic or Macro (most cases) Command; once activated, this Button will cause the Target-Device to tune to a desired channel, or web site, or streaming site.

The System may be configured to automatically program Favorite-Channel-Buttons, which will enable tuning by a single button press to the user's most likely to be desired TV channel or web site or streaming site. This will be done by taking advantage of DB knowledge regarding Channel-Popularity (viewing) in different Geo-Locations, per each TV-Operator. Obviously, by use of the Remote-Customizations-Table, the user will be able to modify these system settings.

Command-Name: A Basic-Command or a Macro-Command, with a link to the relevant Command-Signal.

Command-Signal: A sequence of IR or RF or Wi-Fi, or any other form of wireless signals, implementing a Command-Name.

Counter-Command-Name: A Command-Name which has an opposite effect to that of another Command-Name, e.g. Mute and Un-Mute, Pause and Play, Set-Lights-for-Coming-Home and Set-Lights-for-Leaving-Home.

Target-Set-of-Commands-and-Signals: A full set of basic Command-Names and related Command-Signals which control a specific Target-Device.

Target-Device-Code: A code describing a group of Target-Devices which share the same Target-Set-of-Commands-and-Signals, or, where Target-Set-of-Commands-and-Signals of one group member are a subset of the Target-Set-of-Commands-and-Signals of another group member.

Operating-Mode: A remote control mode of operation, where the remote control controls one or more Target-Device-Types, each device controlled by a subset of its Target-Set-of-Commands-and-Signals.

A remote control may have one or more Operating-Modes.

Each Operating-Mode has its own Look & Feel characteristics (Buttons-L&F-Mappings), which are useful for the User to interact with.

Each Operating-Mode has its own Commands and related Buttons (Buttons-Commands-Mapping), which define the function of each Button while using the remote in this Operating-Mode.

Each Operating-Mode may enable control of one or more Target-Device-Types.

Each Operating-Mode has a single Operating-Mode-Required-Commands-Set-ID (defined below), which may control multiple Target-Devices.

Each Operating-Mode may enable control of not more than one Target-Device (e.g. specific TV model) belonging to a Target-Device-Type (e.g. TV type).

A single remote control may control multiple Target-Devices belonging to a specific Target-Device-Type (e.g. a few different TV models), as long as controlling of each such device is done by use of a different Operating-Mode.

This may be achieved by use of the following method:

When connecting an already programmed remote to the system, the system will duplicate all the remote Operating-Modes, assigning each of them with a new name, and program the newly named Operating-Modes while not modifying the old Operating-Modes (e.g. programming the remote to control also the bed room TV model, while previously it controlled only the living room TV model).

Programming will commence almost identically (apart from ignoring original Operating-Modes) to the programming process described in this application for the case of first time programming of the remote.

Examples of Operating-Modes:

In the context of A/V – TV live viewing, VOD viewing, Streaming viewing, Radio listening, Music Listening, Sports Mode, News Mode.

In the context of Climate control – Cooling settings, Warming settings.

In a combined A/V and Climate setting:

Cooling and Summer Music settings, Warming and Winter Music settings.

In a combined setting of a Set Top Box (STB) and a TV:

An Operating-Mode for controlling TV-Power, TV-Volume, STB-Channel-UP, STB-Channel-Down, and six STB-Favorite-Channels.

Operating-Mode-Required-Commands-Set: A set of Command-Names required by a specific Operating-Mode of a specific Remote-Model-ID, where each Command-Name relates to a specific Target-Device-Type (command is a Basic- or Macro-Command) or to multiple Target-Devices-Types (command must be a Macro-Command), where the Command-Names are related to UI (User Interface) characteristics (via the relevant Buttons-L&F-Mapping).

In case Macro-Commands are included, the set of Command-Names also includes all the Basic-Commands used by the relevant Macro-Commands.

Designated by an Operating-Mode-Required-Commands-Set-ID.

Remote-Required-Target-Device-Type-Commands: All Command-Names of Target-Device-Type which are included in any of the Operating-Mode-Required-Commands-Sets of a Remote-Model-ID.

This group includes also Basic-Commands relevant to the Target-Device-Type, used by Macro-Commands of the Remote-Model-ID.

Advanced-Universal-Remote-Control: An enhanced universal remote control which is programmed automatically, without human intervention, with capabilities beyond those of a standard universal remote control, e.g.:

a) It may operate in one or more Operating-Modes.

b) For each remote type (Remote-Model-ID) and Operating-Mode, there is a Buttons-Commands-Mapping-ID, mapping Buttons to Command-Names.

c) For each remote type (Remote-Model-ID) and Operating-Mode, there is a Buttons-L&F-Mapping-ID mapping Buttons to Button-Characteristics.

d) It must have communication capabilities with a controller.

e) It has a Remote-Model-ID (i.e. model identification code), which it may share with a controller.

f) It may inform its interest in being programmed.

g) It may accept all its settings from a controller and use them accordingly.

h) It is likely to change its look and feel (using Buttons-L&F-Mapping) upon entering a different Operating-Mode.

i) It has UI means for selecting its own Operating-Modes, based on the Remote-Model-ID (similar to other universal remote controls that control more than a single target device).

j) It may be customized by each User.

k) It has a unique serial id, The-Remote-ID

Remote-Model-ID: An ID indicating a specific type of an Advanced-Universal-Remote-Control.

The-Remote: An instance of an Advanced-Universal-Remote-Control.

Output-Signal: A signal (e.g. Audio, Sound, Noise, Video, Picture, Lights, Temperature, Humidity, Smell, Magnetic Field, Electrical Field, Infra-Red, RF, Wi-Fi) that is generated by a Target-Device.

Signal-Influencing-Command: Command-Signal generated by The-Remote which causes a change in Output-Signal of a Target-Device.
Each such command is not necessarily included in any group of Remote-Required-Target-Device-Type-Commands relating to the Target-Device.
Each such command is necessarily included in the Target-Set-of-Commands-and-Signals of the related Target-Device.

Detect-Change-Message: A message sent from System-Control to Signal-Change-Detector, requesting that Output-Signal should be monitored for a change which is

relevant to this message parameters; and that once such a change is identified, this should be reported back to System-Control.

Change-Detected-Message: A message sent from Signal-Change-Detector to System-Control, indicating that a signal change has been detected.

Fig. 1

Fig. 1 is a schematic block diagram of an exemplary system **20** for automatic programming of universal remote control according to embodiments of the present invention, comprising:

System-Control unit 22 - A computing unit which, based on DB1, DB2, communication means with the Transmitter and The-Remote, and communication means with the Signal-Change-Detector, is capable of executing the described The-Remote automatic programming process.

Database DB1 24 - A database of Target-Device-Codes with their corresponding Target-Device-Types (e.g. TVs, STBs, Smart Home Appliances), Target-Device-Names (e.g. Sony-XBR55X850D, LG-LW1016ER, GE-AJEM12DCF), Command-Names, Command-Signals, Command-descriptions (all Target-Set-of-Commands-and-Signals) and definitions of related Macro-Commands. This data is commonly used for the sake of programming off-the-shelf universal remote controls.

Database DB2 26 - A database which includes information required in order to fully automatically program an Advanced-Universal-Remote-Control.
DB2 26 is linked to data in DB1 24 by the Target-Device-Type, Target-Device-Codes, and Command-Names fields. DB2 26 comprises:
a) All Advanced-Universal-Remote-Control-Model-IDs supported by the system **20**, each with its respective Operating-Modes.
b) The Operating-Mode-Required-Commands-Set per each Operating-Mode of a Remote-Model-ID

c) The Buttons-L&F-Mappings and the Buttons-Command-Mappings per each Operating-Mode of a Remote-Model-ID.

d) Definitions of all supported Geo-Locations (ID, coordinates, description).

e) Target-Device-Codes, including usage statistics of each Target-Device-Code per Geo-Location.

f) TV Operators (e.g. DirecTV, EchoStar, Sky), each with its respective channel lineups, including information about each of the channels, such as name, description, logo, category, popularity statistics per Geo-Location.

g) Signal-Influencing-Commands, each with its respective values for output Signal-Type, Measured-Property, Minimal-Change, Time-Window-Size, Counter-Command-Name, and, if used, other values of parameters required for detecting change.

h) Web sites which may be accessed by a specific macro-command. This could be done by spelling the web site name using signals of an IR keyboard, or by navigating on a virtual keyboard (e.g. <Right><Right><Down><Enter> for the letter S).

Note that by use of macro commands the system supports automatic programming of buttons to tune to favorite web sites and favorite streaming sites and favorite TV channels, by a single button press.

i) All Remote-Customizations (changing function or appearance of button by user) which have been done by all users of the system.

j) Any other information which may be useful for automatic programming of The-Remote, but is not included in DB1.

It will be appreciated by persons skilled in the art that databases DB1 and DB2 are only defined by their contents, which may alternatively be stored in a single database or in more than two databases.

Data models and content examples of DB1 and DB2 are provided below, in the **Data Models** section.

Signal-Change-Detector 28 - A signal monitoring component which detects changes in the Output-Signal **42** that is generated by a Target-Device 38.

The Signal-Change-Detector's functionality may be divided between a signal detection unit and the System-Control that receives the detected signal and performs the required calculations for detecting signal change.

The-Remote 32 - An instance of an Advanced-Universal-Remote-Control according to the present invention.

Transmitter 36 - for transmitting Command-Signals **34** initiated by System-Control **22** towards the Target-Devices **38** for modifying the state of the Target-Devices.

Target-Devices 38 - Specific devices which may be controlled by a universal remote control. Each Target-Device belongs to a single Target-Device-Type (e.g. both Sony-XBR55X850D, LG-LW1016ER belong to type TV).

According to embodiments of the present invention, one or more of DB1 24, DB2 26, System-Control unit 22, Signal-Change-Detector 28, Transmitter 36 and The-Remote 32 may be embodied as an Application or Applications on a mobile computing device (e.g. smartphone).

According to embodiments of the present invention, one or more of DB1 24, DB2 26, System-Control unit 22, Signal-Change-Detector 28, Transmitter 36 and The-Remote 32 may be embodied as an Application or Applications on a home or office or industrial computing device (e.g. PC, laptop).

According to embodiments of the present invention, one or more of DB1 24, DB2 26, System-Control unit 22, Signal-Change-Detector 28 and Transmitter 36 may be embodied as an integral part of The-Remote 32.

According to embodiments of the present invention, one or more of DB1 24, DB2 26, System-Control unit 22, Signal-Change-Detector 28 and Transmitter 36 may be embodied as an integral part of one or more Target-Devices 38.

According to embodiments of the present invention, one or more of DB1 24, DB2 26, System-Control unit 22, Signal-Change-Detector 28, Transmitter 36 and The-Remote 32 may be embodied as a stand-alone device.

According to embodiments of the present invention, one or more of DB1 24, DB2 26, System-Control unit 22, Signal-Change-Detector 28, Transmitter 36 and The-Remote 32 may be packaged all together in single package, each in a separate package, or in any other packaging combination.

According to embodiments of the present invention, DB1 24 and DB2 26 may each reside in a different unit, or both in the same unit, in local or remote storage unit or units.

The System **20** is capable of automatically programming in parallel multiple instances of The-Remote 32, where each instance may be of a different type (each type identified by Remote-Model-ID), where each instance is capable of controlling multiple Target-Devices 38, where each Target-Devices 38 may operate in multiple Operating-Modes.

In the embodiments of Fig. 1 and of Fig. 5, for the sake of clarity, we assumed that a single System-Control 22 interfaces with one Transmitter 36, one The-Remote 32, and one Signal-Change-Detector 28.

In reality, and as supported by all other parts of this application, a single System-Control 22 may interface with multiple Transmitters 36 based on the type of signals expected by different Target-Devices 38, multiple Signal-Change-Detector 28 based on the different Output-Signals 42 generated by the Target-Devices 38, and multiple The-Remotes 32 based on the number of parallel programming operations done by a single System-Control 22 (e.g. a factory setting may desire to program multiple The-Remotes 32 in parallel).

The above mentioned parallel programming operations done by a single System-Control 22 should not be confused with the parallel programming capability of System 20, while using multiple System-Control 22 units.

Fig. 2

Fig. 2 is a view of logical elements of The-Remote **32**, required for controlling all Target-Devices relevant to a single Operating-Mode, according to embodiments of the present

invention. These logical elements are assigned values from DB1 24 and DB2 26 as an outcome of the automatic programming process.

It is understood that one or more Operating-Modes, each of the modes relating to one or more Target-Devices, may be supported in parallel (without the need for re-programming) by a single The-Remote 32.

An element shared by all Operating-Modes of The-Remote 32 is The-Remote-ID **40**: An ID comprising a Remote-Model-ID and a unique serial number which is assigned to each specific Advanced-Universal-Remote-Control (Remote-Model-ID guarantees that each remote will be programmed automatically with its appropriate commands and buttons, which are retrieved from DB1 and DB2).

The following five logical elements (41, 42, 43, 44, 45) are required by each Operating-Mode of The-Remote 32 in order to control relevant Target-Devices:

Buttons **41**: Each Button is designated by a Button-ID.

Buttons-Commands-Mapping **42**: mapping Buttons to Command-Names.

Commands **43** of Operating-Mode-Required-Commands-Set:
All Operating-Mode-Required-Commands-Sets for a specific Remote-Model-ID, with the relevant Command-Signal of each Command-Name.

Buttons-L&F-Mapping **44**: Mapping of (or linking) Buttons 41 to Look and Feel properties (L&F-Characteristics 45). Each Button-L&F-Mapping is designated by a Buttons-L&F-Mapping-ID.

L&F-Characteristics **45**: Look and Feel properties of a Button, e.g. size, texts, fonts, logos, press & release feel parameters, sounds, colors, lights sequence, vibration sequence.
In the context of A/V devices, text logos and other characteristics may be useful, amongst others, for indicating settings of Favorite Channels (e.g. of TV, Internet, Radio).

During normal operation, pressing a Button **41**, which is identified by its L&F-Characteristics **45**, will send the Command-Signal related to the mapped Command **43** to a Target-Device.

Following successful execution of the Hi-Level Algorithm (described below in conjunction with Fig. 3) and the Signal Matching Algorithm (described below in conjunction with Fig. 4), and based on The-Remote-ID **40** which is provided to the system 20 by The-Remote **32**, all required data elements (and related Commands, Signals, Buttons, L&F- Characteristics and Mappings) are forwarded from DB1 and DB2 to The-Remote **32**, so that a user may comfortably use The-Remote **32**.

Following are definitions of additional terms used in conjunction with the flowcharts of Figs. 3 and 4:

Candidate-Devices: A transient list of Target-Device-Codes (marked with Y in Relevant-Target-Device-Codes data structure of the Calculation-Data-Structures), where one of them will be identified as matching the specific Target-Device desired to be controlled, once the programming process stage is completed successfully.

Calculation-Data-Structures: Runtime data structures which are repeatedly populated from DB1 and DB2 and are used by the algorithms of Fig.3 and Fig. 4. These data structures are helpful in setting the order in which Signal-Influencing-Commands are being used, and the order in which their relevant Command-Signals are being exercised, in order to automatically program The-Remote 32 as quickly as possible.

Usage principles of the Calculation-Data-Structures:

Following are some principles of the method, and description of one embodiment of used data models. Data sources, data usage, and various data driven calculations will be explained.

DB1 and DB2 are databases populated in advance of any automatic programming operation. On the other hand, Calculation-Data-Structures are runtime data structures

which are repeatedly populated during the automatic programming of each The-Remote 32. Population is done per each Target-Device-Type which The-Remote 32 attempts to control. Calculation-Data-Structures are populated with data about all Target-Devices of Target-Device-Type; this is done based on the Remote-Model-ID to be programmed, and on information from DB1 and DB2 (e.g. statistics regarding popularity of Target Devices in the Geo-Location of The-Remote being programmed).

The programming process is based on cycles of tests until test success is achieved, where test success is determined when a command which controls the device is identified. Upon each test failure, the algorithm marks as irrelevant (with N) the related (those using the same failed command signal) target devices (designated by Target-Device-Codes in the Calculation-Data-Structures). Upon each test success, the algorithm marks as relevant (with Y) the related target devices, and marks as irrelevant (with N) the non-related target devices (those using a different command signal).

This process of testing continues until all required commands for all required Target-Device-Types are resolved.

The algorithm attempts to come to conclusions as fast as possible; this is done by executing, on average, the minimal number of tests. This is achieved by ordering the tests so that tests which are more likely to succeed are executed first.

The likelihood of a test to succeed (respond to the Command-Signal used by the test) is determined by the popularity of related Target-Devices in the relevant Geo-Location.

Testing order of the different signals:

The testing order of different signals is determined by going over all potential Target-Devices, all relevant Signal-Influencing-Commands, and all related Command-Signals.

Selecting and ordering Target-Devices is defined by the remote type (Remote-Model-ID) being programmed.

Selecting and ordering Signal-Influencing-Commands is defined by the Target-Device-Type (e.g. TV) which is to be controlled, as described in details below in the paragraph

entitled “Description of the algorithm defining the execution order of Signal-Influencing-Command in DB2”.

Selecting and ordering Command-Signals being tested is defined, as explained above, by the popularity of the still relevant Command-Signals (based on popularity of still relevant Target-Device-Codes) in the relevant Geo-Location. This is also explained in detail while reviewing the Command-Signals data structure below.

Fig. 3

Fig. 3 is an exemplary flowchart **300** of the High Level Algorithm performed by the system **20**. The flowchart describes the automatic programming of The-Remote **32**, by performing an iterative process, of going over all Target-Device-Types of each of the Operating-Modes used by the Remote-Model-ID of The-Remote **32**, which is being programmed for operation at a current Geo-Location (Geo-Location-ID). Based on the current Remote-Model-ID of The-Remote 32, the High Level Algorithm described in conjunction with **Fig.3**, attempts to resolve all Operating-Mode-Required-Commands-Set-IDs of all Operating-Modes, by invoking the process described in **Fig. 4** for all related pairs {Operating-Mode-Required-Commands-Set-ID, Target-Device-Type}. In other words, for each Target-Device-Type, this High Level Algorithm invokes the Signal Matching Algorithm described in conjunction with **Fig. 4**, in order to identify the signals required by The-Remote **32** to control one of the Target-Devices 38.

The automatic programming algorithm starts in step **305** by confirming that all units i.e. Target-Devices **38**, System-Control **22**, Transmitter **36**, Signal-Change-Detector **28** and The-remote 32 are turned on; and requesting that Target-Devices Output-Signals (e.g. Audio, Temperature) be left at regular operating level.

System-Control **22** and The-Remote **32** (which is to be programmed) communicate and identify they are at start-of-programming, and both may indicate it (e.g. to a bystander) by activating an Indicator (e.g. a color light, a sequence of lights, a sound, a display), and in their respective memories. System variables Current-Model-ID and Current-Geo-Location-ID are being set.

In step **310** the first (current) Operating-Mode is set and in step **315** the Operating-Mode-Required-Commands-Set for the current Operating-Mode is set.

In step **320** the current Target-Device-Type for the current Operating-Mode is set (from DB2 26) and in step **325** the Calculation-Data-Structures are initialized for the current Target-Device-Type to include all relevant (e.g. based on Geo-Location statistics, type of device, etc.) Target-Device-Codes from DB1 **24** and DB2 **26**, as will be explained in detail below.

In step **328** the Signal Matching algorithm for the Target-Device-Type is performed by the algorithm of Fig. 4, as will be explained in detail below.

In step **330**, if all Operating-Mode-Required-Commands-Sets for the current Remote-Model-ID have been resolved, the fully automatic programming of The-Remote has been completed (step **335**). System-Control **22** and The-Remote **32** may indicate (e.g. to a bystander) end of programming, by modifying the initially set user indicators (e.g. a color light, a sequence of lights, a sound, a display message). The system confirms that all Operating-Mode-Required-Commands-Sets with related Signals and L&F data were received by The-Remote 32 (step 337).

Otherwise, if there still remain unresolved Operating-Mode-Required-Commands-Sets for the current Remote-Model-ID (**340**), the algorithm continues looping through all remaining Target-Device-Types relevant to the current Operating-Mode, as they appear in DB2 26 (step **345**).

When all Target-Device-Types have been processed for the current Operating-Mode, the algorithm continues looping through all remaining Operating-Modes (steps 350, **355**).

In step **360**, in case all iterations have been completed, i.e. there are no more Operating-Modes (and related Target-Device-Types) to be programmed, and not all Operating-Mode-Required-Commands-Sets have been resolved, it is an indication that at least some parts of the automatic programming have failed (some Commands of some Target-Devices have not been resolved). Failure will be recorded in memory of

The-Remote **32** and System-Control **22**, and communication between the user and customer support may be initiated in order to resolve the issue.

Fig. 4

Fig. 4 is a flowchart **400** showing one embodiment of a Signal Matching Algorithm for all Signal-Influencing-Commands of a single Target-Device-Type, according to the present invention. Use of this algorithm enables System **20** of **Fig. 1** to automatically program The-Remote **32**.

System-Control **22** initializes Signal-Change-Detector **28** to monitor Output-Signal **42** and report upon detection of change, while instructing the Transmitter **36** to transmit Command-Signals **34**, according to an execution-time optimized order.

Once System-Control **22** is notified by Signal-Change-Detector **28** of a change, and the latest transmitted Command-Signal **34** is verified (as described below), the latest transmitted Command-Signal **34** is recorded (in the Resolved-Signal field of the Calculation-Data-Structures) as matching the current Signal-Influencing-Command. Candidate-Devices list of the Calculation-Data-Structures is trimmed down, so as to include only Relevant-Target-Device-Codes that use the last transmitted Command-Signal.

Once Remote-Required-Target-Device-Type-Commands have been resolved, System-Control **22** compiles a message including available (resolved so far) Operating-Mode-Required-Commands-Sets, Buttons-Command-Mappings and Buttons-L&F-Mappings, and forwards it to The-Remote **32**, which follows with its internal programming accordingly.

In step **405** the initial order of Command-Signals for each Signal-Influencing-Command is calculated, and in step **410** the order of Signal-Influencing-Commands is calculated, and the first Signal-Influencing-Command is set to be worked with. Both of the above calculations are done by use of the Calculation-Data-Structures, as will be explained in detail below.

In step **415** the Signal-Change-Detector **28** is initialized by System-Control **22** and in step **420** the algorithm sets a current Command-Signal for the Signal-Influencing-Command from DB1.

In step **425** the current Command-Signal of the Signal-Influencing-Command is transmitted to the Target-Device by the Transmitter **36**.

Signal-Change-Detector **28** monitors Output-Signals **42** from the Target-Device (step 430) and if no change has been detected, the algorithm checks whether additional Command-Signals remain be tested (step 435) and loops back to step 420 if affirmative to test the next Command-Signal. Otherwise, the algorithm checks whether additional Signal-Influencing-Commands remain to be tested (step 440) and if affirmative, loops back to step 415, with the next Signal-Influencing-Command that differentiates, i.e. uses different Command-Signals for the remaining Candidate-Devices.

If the Signal-Influencing-Command does not differentiate (i.e. same Command-Signal is used), the algorithm will progress and try the next-in-order Signal-Influencing-Command.

If in step 430 a change has been detected in the Target-Device's Output-Signal, the algorithm tries to identify and verify the matching Command-Signal (step 450). Identifying the matching Command-Signal is required since a number of different Command-Signals may be transmitted to the Target-Device in a short period of time in order to reduce operation time. The identification is done by comparing the exact time of transmission of each Command-Signal with the exact time of Output-Signal change identification. Verifying the matching Command-Signal is required in order to confirm that the Command-Signal identified as matching is truly the Command-Signal that caused the change in the Target-Device's Output-Signal. This is done by exercising the identified Command-Signal and the signal of the Counter-Command-Name in a slow and careful way, and verifying that we truly found the influencing Command-Signal. For example, assume that the TV movie has a period of silence; the system may wrongly assume that the Command-Signal used during this silence period caused the TV to MUTE. The verification process may identify that actually the Command-Signal does not have any influence on the TV.

If the process of verifying and identifying the matching Command-Signal is successful, the resolved Command-Signal is recorded as matching the current Signal-Influencing-Command (step 455). In step 460 the Candidate-Device field is set to N for all Relevant-Target-Device-Codes NOT using the verified Command-Signal (in the Calculation-Data-Structures:Relevant-Target-Device-Codes data structure). Following, if Remote-Required-Target-Device-Type-Commands for the Current Target-Device have been identified (step 465) – the Target-Device-Type is recorded as "Success" (step 470), the Operating-Mode-Required-Commands-Sets with related Signals and L&F data are sent to The-Remote 32 (step 475) for programming and the execution flow returns to the High Level Algorithm of Fig. 3 in order to continue resolving signals for other Target-Device-Types and other Operating-Mode-Required-Commands-Sets (i.e. other Operating-Modes).

Otherwise, if in step 465 not all of the Remote-Required-Target-Device-Type-Commands for the Current Target-Device have been identified, the algorithm loops back to step 440, and continues to search for a Command-Signal used by the Target-Device for the next Signal-Influencing-Command.

Alternatively, if in step 450 the Output-Signal has not been verified, the algorithm loops back to step 435.

If in step 440 it has been determined that all the Signal-Influencing-Commands have been tested, failure is recorded for this Target-Device-Type, and the execution flow returns to the Hi Level Algorithm of Fig. 3 in order to continue resolving signals for other Target-Device-Types and other Operating-Mode-Required-Commands-Sets (i.e. other Operating-Modes).

Fig. 5

Fig. 5 is a block diagram of one embodiment of components of the System-Control 22. In the accompanied description "i/f" stands for Interface, "Tx" stands for Transmit, "RC" stands for remote-control.

System-Control **22** comprises Command-Tx i/f **510**, Signal Change Detector i/f **520**, RC

Programming i/f **530**, Indicator i/f **540**, Databases i/f **550**, Processor **560** and Memory **570**. Part of the Memory is used for the Calculation-Data-Structures **580**. System-Control 22 additionally comprises Global-Positioning module 590, such as GPS (Global Positioning System) or IP Address-to-Geo-Location, e.g. IP Find (www.ipfind.co), accessed via Internet-Connection module 595.

Upon start of operation (power on), the Processor **560** checks via the RC Programming i/f **530** whether The-Remote **32** is available and interested in being programmed. Upon confirmation, the Processor **560** may use the Indicator i/f **540** to turn on the Indicator; this indicates to a bystander that programming is in progress.

Using the Databases i/f **550**, the Processor **560** retrieves information from DB1 **24** and DB2 **26** as required by the algorithms of FIGs.3 and 4, and stores all or some of this information in memory (e.g. for populating the Calculation-Data-Structures).

Processor **560**, using the Command-Tx i/f **510**, instructs Transmitter **36** to start transmitting Command-Signals.

The Processor **560**, using Signal Change Detector i/f **520**, requests Signal-Change-Detector **28** to start looking for changes in the Output-Signal **42** (e.g. sound, light, temperature), based on parameters (stored in DB2) such as Signal-Type, Measured-Property, Minimal-Change, Time-Window-Size, and others. Following, using Command-Tx i/f **510**, the Processor **560** requests the Transmitter **36** to transmit Command-Signals, as described in conjunction with Fig. **4**. When required by the algorithm of Fig. 4 (e.g. when Change-Detected-Message arrived via the Signal Change Detector i/f **520**), the Processor **560**, using the Command-Tx i/f **510**, instructs Transmitter **36** to stop transmitting the Command-Signals.

Once a Change-Detected-Message arrives, Processor **560** instructs Transmitter **36** and Signal-Change-Detector **28**, via the corresponding interfaces, to verify (step 450) the detection (e.g. by repeating a few times transmission of the Command-Signal just used, and their Counter-Command-Name signals, and verifying identification of change).

Once verification succeeds, Processor **560** records in Memory **570** the verified Command-Signal **34** as implementing the current Signal-Influencing-Command.

Processor **560** manages and updates the Calculation-Data-Structures **580** and the Candidate-Devices list, as described in conjunction with Fig. **4**.

Once Remote-Required-Target-Device-Type-Commands for current Target-Device-Type have been identified (e.g. a single Target-Device-Code in the Candidate-Devices list), Processor **560** sends from Memory the Remote-Required-Target-Device-Type-Commands with related Signals and L&F data, via the RC Programming i/f **530**, to The-Remote **32**.

Once automatic programming has been completed successfully (Fig. 3), Processor **560**, using the Indicator i/f **540**, may order to indicate "completed successfully" (e.g. to a bystander).

In the embodiments of Fig. 1 and of Fig. 5, for the sake of clarity, we assumed that a single System-Control 22 interfaces with one Transmitter 36, one The-Remote 32, and one Signal-Change-Detector 28.

According to embodiments of the invention a single System-Control 22 may be used for programming a plurality of The-Remote 32, optionally of different Remote-Model-IDs, using a plurality of Transmitters 36 and a plurality of Signal-Change-Detectors 28, whereby the System-Control 22 may comprise a respective plurality of command-Tx interfaces 510, a plurality of signal change detector interfaces 520, a plurality of programming interfaces 530 and a plurality of indicator interfaces 540.

Fig. 6

Fig. 6 is a block diagram of one embodiment of components of a Signal-Change-Detector **28**. Other different implementations may be integrated with The-System 20.

Following are definitions of parameters of the Detect-Change-Message sent from the System-Control **22** to the Signal-Change-Detector **28** upon request to identify change in the Output-Signal **42**.

Parameter name	Description, Exemplary values
Signal-Type	Sound, Noise – for example Signals generated by a TV or Audio

	system, Air Condition system noises, Shades moving noises, other home systems, other industrial systems. Picture – for example Signals generated by a Video Display system (e.g. TV, PC, Home-Theatre, Projector). Temperature - For example, Signals generated by an Air Conditioning (AC), Heating, Climate-Control system. Light – for example Signals generated by a Light system for entertainment, control; light changes generated by Shades opening or closing; etc.
Measured-Property	Measured values of a specific property of the signal. Properties of Sound – for example level, gain, noise, audio frequency (AF) etc. Properties of Picture - for example play-speed (e.g. freeze, *0.5 speed – slow motion, *1 speed – normal play speed, *4 speed – fast forward), black screen, color .vs. black & white, resolution, etc. Properties of Temperature – for example degrees measured, rate of change of degrees. Properties of Light - for example intensity, rate of change of light intensity, wavelength (color).
Minimal-Change	The minimum amount of change in Measured-Property between two consecutive periods of Time-Window-Size, which will cause reporting of such an event.
Time-Window-Size	Size of a timeslot, measured in time units, in which the average Measured-Property is calculated (for the sake of comparison with the average Measured-Property of the previous time period).

Examples of sets-of-values (each row represents a set) of parameters:

Signal-Type	**Measured-property**	**Minimal-Change**	**Time-Window-Size**
Audio	Level (amplitude)	10.0 dB	0.5 second

Video	Freezing Picture	Freeze or Moving picture (0/1)	2 second
Temperature	Degree change	0.5 degrees Celsius	5 minutes
Light	Intensity	10 Watts	30 seconds

In one embodiment, Once System-Control **22** requests to be informed of a change in the Output-Signal **42**, Signal-Change-Detector **28** will monitor for the change and once identified, will report the change event back to System-Control **22**.

According to embodiments of the invention, as represented in Fig. **6**, Signal-Change-Detector **28** comprises Signal Receiver **610**, Signal Recorder **620**, Signal Analyzer **630**, Detector Control Unit **640**, System-Control i/f **650**, and Memory **660**.

Upon reception of Detect-Change-Message from System-Control **22** via the System-Control i/f **650**, the Detector Control Unit **640** stores in Memory **660** the parameters of the request, i.e. Signal-Type, Measured-Property, Minimal-Change, Time-Window-Size, and others. See parameters described above.

Detector Control Unit **640** instructs Signal Recorder **620** to start recording signals that are expected from Signal Receiver **610**.

Detector Control Unit **640** instructs Signal Analyzer **630** to expect a Recording-Available-Message from Signal Recorder **620**, and to analyze the recorded signals according to the parameters Measured-Property, Minimal-Change and Time-Window-Size.

Detector Control Unit **640** instructs Signal Receiver **610** to start detecting signals of type Signal-Type (parameter) and forward them to Signal Recorder.

According to embodiments of the present invention, signal analysis comprises measuring the Measured-Property, calculating the average within Time-Window-Size, comparing to the value of the previous period, and reporting in case of a change larger than Minimal-Change.

Signal-Change-Detector **28** continues working (receiving, recording, analyzing signals) until Signal Analyzer detects a change. At that point Detector Control Unit **640** is informed of the change, Detector Control Unit **640** forwards a Change-Detected-Message to System-Control **22** via System Control i/f **650** and stops operation of Signal Receiver **610**, Signal Recorder **620** and Signal Analyzer **630**.

DATA MODELS

DB1 data model

DB1 is similar to other IR or RF universal remote control databases. It is commonly used for programming standard universal remote controls.

DB1 Tables and Fields:

Target-Devices-Table

Target-Device-Name (key)

Target-Device-Type (e.g. TVs, STBs, Air-Conditions, other Smart Home Appliances)

Target-Device-Code

Target-Device-Codes-Table (implementing Target-Set-of-Commands-and-Signals)

Target-Device-Code (compound key1), (compound key2)

Command-Name (compound key1)

Command-description (compound key2)

Command-Signal

Macro-Commands-Table

Macro-Command-Name (compound key1)

Basic-Command-Order (compound key1) (e.g. 1, 2, 3)

Target-Device-Type

Basic-Command-Name (copy of one of the Command-Names, or a timeout)

Note: Delay-Device is the name of a fake Target-Device-Type used to assist in designating timeout commands which are used by Macro-Command-Names. The Basic-Command-Names in the format of Tabc (e.g. T200, T500) designate timeout commands (e.g. of 200ms, 500ms respectively).

DB1 Example

Following is a small example of populated tables of DB1, which may help understand this invention.

Target-Devices-Table:

Target-Device-Name	Target-Device-Type	Target-Device-Code
LG-LW1016ER	TV	NEC1-4-CG1
NEC-E326	TV	NEC1-4-CG1
Haier-LE39D2380	TV	NEC1-96-CG2
Vizio-M401i	TV	NEC1-96-CG2
GE-AJEM12DCF	AC	DC101

Target-Device-Codes-Table:

Target-Device-Code	Command-name	Command-description	Command-Signal (truncated)
NEC1-4-CG1	MUTE TOGGLE	Mute/Un-Mute toggle signal	0000 006D 0022 0002 0154 00A9 001
NEC1-4-CG1	POWER OFF	POWER OFF	0000 006d 0022 0002 0157 00ac 001
NEC1-4-CG1	POWER ON	POWER ON	0000 006d 0022 0002 0157 00ac 001
NEC1-4-CG1	POWER TOGGLE	POWER On/Off TOGGLE	0000 006D 0022 0002 0154 00A9 001
NEC1-4-CG1	VOLUME DOWN	VOLUME DOWN	0000 006D 0022 0002 0154 00A9 001
NEC1-4-CG1	VOLUME UP	VOLUME UP	0000 006D 0022 0002 0154 00A9 001
NEC1-4-CG1	MY APPS	Go to MY APPS screen (Smart TV)	0000 006D 0022 0002 0155 00AA 001
NEC1-4-CG1	CURSOR DOWN	CURSOR DOWN (web and Smart	0000 006D 0022 0002 0154 00A9 001

		TV)	
NEC1-4-CG1	CURSOR ENTER	CURSOR ENTER (web and Smart TV)	0000 006D 0022 0002 0154 00A9 001
NEC1-4-CG1	CURSOR LEFT	CURSOR LEFT (web and Smart TV)	0000 006D 0022 0002 0154 00A9 001
NEC1-4-CG1	CURSOR RIGHT	CURSOR RIGHT (web and Smart TV)	0000 006D 0022 0002 0154 00A9 001
NEC1-4-CG1	CURSOR UP	CURSOR UP (web and Smart TV)	0000 006D 0022 0002 0154 00A9 001
NEC1-4-CG1	ENTER	ENTER (web and Smart TV)	0000 006D 0022 0002 0154 00AB 001
NEC1-4-CG1	EXIT	EXIT out of all menus	0000 006D 0022 0002 0154 00A9 001
NEC1-4-CG1	BACK	BACK - go one step back in menu or web	0000 006D 0022 0002 0155 00AA 001
NEC1-4-CG1	INPUT	Set TV INPUT to next input	0000 006D 0022 0002 0155 00AB 001
NEC1-4-CG1	INPUT HDMI 1	Set TV INPUT to HDMI 1	0000 006D 0022 0002 0157 00AC 001
NEC1-4-CG1	INPUT HDMI 2	Set TV INPUT to HDMI 2	0000 006D 0022 0002 0157 00AC 001
NEC1-4-CG1	INPUT HDMI 3	Set TV INPUT to HDMI 3	0000 006D 0022 0002 0157 00AC 001
NEC1-96-CG2	MUTE TOGGLE	Mute/Un-Mute toggle signal	0000 006C 0022 0002 0156 00AC 001
NEC1-96-CG2	POWER TOGGLE	POWER On/Off TOGGLE	0000 006C 0022 0002 0156 00AC 001
NEC1-96-CG2	VOLUME DOWN	VOLUME DOWN	0000 006C 0022 0002 0156 00AC 001
NEC1-96-CG2	VOLUME UP	VOLUME UP	0000 006C 0022 0002 0156 00AC 001
NEC1-96-CG2	CURSOR DOWN	CURSOR DOWN (web and Smart TV)	0000 006C 0022 0002 0156 00AC 001
NEC1-96-CG2	CURSOR ENTER	CURSOR ENTER (web and Smart TV)	0000 006C 0022 0002 0156 00AC 001
NEC1-96-CG2	CURSOR LEFT	CURSOR LEFT (web and Smart TV)	0000 006C 0022 0002 0156 00AC 001
NEC1-96-CG2	CURSOR RIGHT	CURSOR RIGHT (web and Smart TV)	0000 006C 0022 0002 0156 00AC 001
NEC1-96-CG2	CURSOR UP	CURSOR UP (web and Smart TV)	0000 006C 0022 0002 0156 00AC 001
NEC1-96-CG2	ENTER	ENTER (web and Smart TV)	0000 006C 0022 0002 0156 00AC 001
NEC1-96-CG2	EXIT	EXIT out of all menus	0000 006C 0022 0002 0156 00AC 001
NEC1-96-CG2	BACK	BACK - go one step back in menu or web	0000 006C 0022 0002 0156 00AC 001
NEC1-96-CG2	INPUT	Set TV INPUT to next input	0000 006C 0022 0002 0156 00AC 001
NEC1-96-CG2	INPUT HDMI 1	Set TV INPUT to HDMI 1	0000 006D 0022 0002 0154 00AA 001
DC101	Power-On	Power On	0x20
DC101	Power-Off	Power Off	0x00
DC101	Mode-Heat	Heat mode - winter time	0x08
DC101	Mode-Dry	Dry mode	0x10
DC101	Mode-Cold	Cold mode - summer time	0x18
DC101	Mode-Auto	Auto mode - based on outside temp	0x20
DC101	Temp-Min	Represents 16 Celsius	0x00
DC101	Temp-Max	Represents 31 Celsius	0x0F

Macro-Commands-Table:

Macro-Command-Name	Basic-Command-Order	Target-Device-Type	Command-Name
TV-PWR-HD3-MUTE	1	TV	POWER ON

TV-PWR-HD3-MUTE	2	Delay-Device	T200
TV-PWR-HD3-MUTE	3	TV	INPUT HDMI 3
TV-PWR-HD3-MUTE	4	TV	MUTE TOGGLE
TV-PWR-HD2-AC-Auto	1	TV	POWER ON
TV-PWR-HD2-AC-Auto	2	Delay-Device	T200
TV-PWR-HD2-AC-Auto	3	TV	INPUT HDMI 2
TV-PWR-HD2-AC-Auto	4	AC	Power-On
TV-PWR-HD2-AC-Auto	5	Delay-Device	T100
TV-PWR-HD2-AC-Auto	6	AC	Mode-Auto

DB2 data model

DB2 is a database which includes information required in order to fully automatically program an Advanced-Universal-Remote-Control.
It is linked to data in DB1 by the Target-Device-Type, Target-Device-Codes, and Command-Names fields.

All fields in DB2 are populated based on information which is publicly available (e.g. PayTV operators sites, Nielson publications), or defined by the System Operator, or forwarded by the User of The-Remote (see Remote-Customizations below).

The method for populating most fields in DB2 is self-explanatory, by name of the field. Other fields have explanation comments next to them.

DB2 Tables and Fields:

Advanced-Universal-Remote-Controls-Table

Remote-Model-ID (compound key1)

Operating-Mode (compound key1) (multiple Operating-Modes may be supported by each remote model)

Operating-Mode-Required-Commands-Set-ID (operator defined IDs)

Buttons-L&F-Mapping-ID

Buttons-Commands-Mapping-ID

Operating-Mode-Required-Commands-Sets-Table

Operating-Mode-Required-Commands-Set-ID (compound key1) (per each Operating-Mode of a remote model)

Target-Device-Type (compound key1)

Command-Name (compound key1)

Buttons-L&F-Mappings-Table

Buttons-L&F-Mapping-ID (compound key1)

Button-ID (compound key1)

Button-Characteristics (positions, sizes, colors, texts, etc.)

Button-Description (description text, help text)

Buttons-Commands-Mappings-Table

Buttons-Commands-Mapping-ID (compound key1)

Button-ID (compound key1)

Target-Device-Type

Command-Name

Target-Device-Codes-Stats-Table

Target-Device-Code (compound key1)

Geo-Location-ID (compound key1)

Popularity (%)

Signal-Influencing-Commands-Table

Target-Device-Type (compound key1)

Signal-Influencing-Command (compound key1)

Signal-Trial-Duration

Signal-Type

Measured-Property

Minimal-Change

Time-Window-Size

Counter-Command-Name

TV-Operators-Lineup-and-popularity-by-Geo-Location-Table

Operator-ID (compound key1)

Geo-Location-ID (compound key1)

Operator-Name

Operator-Description

Operator-popularity-in-Geo-Location

Channel-lineup-in-Geo-Location (ordered list of {Channel-ID, Channel-Number})

Channels-Table

Channel-ID (key)

Channel-name

Channel-description

Channel-logo

Channel-category

Channel-Popularity-Per-Operator-and-Location-Table

Operator-ID (compound key1)

Geo-Location-ID (compound key1)

Channel-ID (compound key1)

Channel-Popularity

Geo-Locations-Table (All world regions which are supported by the System)

Geo-Location-ID (key)

Coordinates-Defining-Geo-Location

Geo-Location-description

Streaming and Web Sites-Table

Site-ID (key)

URL (key)

Goto-Site-Command-Name

Description

Logo

Category

Popularity-list (sorted list of pairs {Geo-Location-ID, Percentage})

Remote-Customizations-Table

Remote-ID (key)

Overwritten-Field-ID (assume all DB2 fields, e.g. Button-Characteristics, have IDs)

Customization-Data (by User)

DB2 Example

Following are some partially populated tables of DB2; they will help the reader better realize the structure and nature of these tables.

Advanced-Universal-Remote-Controls-Table:

Remote-Model-ID	Operating-Mode	Operating-Mode-Required-	Buttons-L&F-Mapping-ID	Buttons-Commands-Mapping-ID

		Commands-Set-ID		
101	TV-STB	CMD-SET-001	BLFM-001	BCM-001
101	TV-STB-DVR	CMD-SET-002	BLFM-002	BCM-002
102	TV-STB-DVR	CMD-SET-002	BLFM-002	BCM-002
103	TV-STB-AC	CMD-SET-003	BLFM-003	BCM-003

Operating-Mode-Required-Commands-Sets-Table:

Operating-Mode-Required-Commands-Set-ID	Target-Device-Type	Command-Name
CMD-SET-001	TV	MUTE-Toggle
CMD-SET-001	TV	Power-Toggle
CMD-SET-001	TV	Vol-UP
CMD-SET-001	TV	Vol-DN
CMD-SET-001	TV	Source
CMD-SET-001	STB	MUTE-Toggle
CMD-SET-001	STB	Power-Toggle
CMD-SET-001	STB	Digit-0
CMD-SET-001	STB	Digit-1
CMD-SET-001	STB	Digit-9
CMD-SET-002	TV	MUTE
CMD-SET-002	TV	Power-Toggle
CMD-SET-002	TV	Vol-UP
CMD-SET-002	TV	Vol-DN
CMD-SET-002	TV	Source
CMD-SET-002	STB	MUTE-Toggle
CMD-SET-002	STB	Power-Toggle
CMD-SET-002	STB	Digit-0
CMD-SET-002	STB	Digit-1
CMD-SET-002	STB	Digit-9
CMD-SET-002	STB	PLAY
CMD-SET-002	STB	FORWARD
CMD-SET-002	STB	REVERSE
CMD-SET-002	STB	PAUSE
CMD-SET-002	STB	STOP
CMD-SET-002	STB	RECORD
CMD-SET-003	AC	Power-ON
CMD-SET-003	AC	Power-OFF
CMD-SET-003	AC	Temp-UP
CMD-SET-003	AC	Temp-DN
CMD-SET-003	TV	MUTE-Toggle

CMD-SET-003	TV	Power-Toggle
CMD-SET-003	TV	Vol-UP
CMD-SET-003	TV	Vol-DN
CMD-SET-003	TV	Source
CMD-SET-003	STB	MUTE-Toggle
CMD-SET-003	STB	Power-Toggle
CMD-SET-003	STB	Digit-0
CMD-SET-003	STB	Digit-1
CMD-SET-003	STB	Digit-9

Target-Device-Codes-Stats-Table:

Target-Device-Code	Geo-Location-ID	Popularity
NEC1-4-CG1	NYC	34%
NEC1-4-CG1	Boston	20%
NEC1-96-CG2	NYC	12%
NEC1-96-CG2	Boston	15%
NEC2 7.7	NYC	54%
NEC2 7.7	Boston	65%
DC101 (AC)	NYC	22%
DC101 (AC)	Boston	18%

Signal-Influencing-Commands-Table:

Target-Device-Type	Signal-Influencing-Command	Signal-Type	Measured-Property	Minimal-Change	Time-Window-Size	Counter-Command-Name
TV	MUTE-Toggle	Audio	DB	7.5	100	MUTE-Toggle
TV	Vol-UP	Audio	DB	3	200	Vol-DN
TV	Power-Toggle	Audio	DB	7.5	100	Power-Toggle
STB	MUTE-Toggle	Audio	DB	7.5	80	MUTE-Toggle
STB	Vol-UP	Audio	DB	3	160	Vol-DN
STB	Power-Toggle	Audio	DB	7.5	80	Power-Toggle
AC	Power-ON	Audio	DB	2	50	Power-OFF

Runtime Calculation-Data-Structures

Following is a description of one embodiment of Calculation-Data-Structures (runtime data structures), which are helpful in resolving the Operating-Mode-Required-Commands-Sets of The-Remote, for controlling a single Target-Device of Target-Device-Type.

The use of the Calculation-Data-Structures is initialized when moving to the next required Target-Device-Type (See Fig. 4 of drawings).

Once the process is completed for all Target-Device-Types, all Required-Commands-and-Signals have been forwarded to The-Remote, and a fully automatic setup has been achieved.

Calculation and population of all required fields is explained below.

The following variables are set (here using examples), prior to each population and use of the Calculation-Data-Structures:

Current-Model-ID = 02 (provided by The-Remote to be programmed).

Current Geo-Location-ID = GL02 (provided by the Global Positioning module 590 of the System-Control, based on location of The-Remote to be programmed;

Current-Target-Device-Type = TV (retrieved from DB2 one after the other)

Calculation-Data-Structures:

Relevant-Target-Device-Codes data structure:

Relevant-Target-Device-Code (key) (e.g. all TV models which initially are in the Candidate-Devices list)

Geo-availability (% popularity of this Target-Device-Code, e.g. the number of TV models in the Geo-Location of the currently programmed remote).

Candidate-Device (Initially all set to Y; updated after each Signal-Influencing-Command is tested).

Signal-Influencing-Commands data structure:

Signal-Influencing-Command-Name (key) (Name of the Command, e.g. MUTE)

Command-Test-Order (key) (The ordinal place of this Signal-Influencing-Command in the testing order, e.g. 1, 2, etc. Population explained below)

Resolved-Signal (The successful end result for this Command-Name)

Command-Signals data structure:

Command-Signal (key) (for the current Signal-Influencing-Command)

Signal-Usage (percent of times this Command-Signal is used by the current Signal-Influencing-Command across all Relevant-Target-Device-Codes. Important note: More than a single Target-Device-Code may use the same Command-Signal).

Signal-Test-order (key) (The ordinal place of this Command-Signal in the testing order; highest Signals-Usage gets first place, lowest Signals-usage gets last place).

Tested (Y/N, has this Command-Signal been tested so far; indicating progress of testing).

Example of populated Calculation-Data-Structures

Following is an example of populated Calculation-Data-Structures, in order to further clarify their usage.

All are populated only after Target-Device-Type, Geo-Location, Model-ID are set, e.g.:

Current-Target-Device-Type = TV

Current Geo-Location-ID = GL02

Current-Model-ID = MOD007

Relevant-Target-Device-Codes data structure example:

Geo-availability - Percentage (%) of TVs using this same set of Signals (for all commands) in Geo-Location-ID GL02.

Some Candidate-Device fields are set to N after first Command (e.g. MUTE) has been resolved (initially all were set to Y).

Relevant-Target-Device-Code	Geo-availability	Candidate-Device	Comment: Used by models (IR protocol)
DC01	40%	N	Telefunken, Bush, AEG (RC5 1 CG3)
DC02	30%	Y	Nikai, Digihome, SEG (RC5 1 CG1)
DC13	10%	N	Loewe, Grundig, Vestel (RC5 0 CG1)
DC14	5%	Y	Magnavox, Hisense, Viewsonic (RC5 0 CG2)
DC25	5%	N	Hitachi, Insignia (RC5 0 CG3)
DC26	5%	N	Pioneer, Runco, Sharp (Pioneer 170)
DC37	3%	N	Proscan, Sansui, W-house (NECx2 7.7 CG4)
DC48	2%	N	BenQ, Polaroid,

			Gateway (NEC1 96 CG1)

Signal-Influencing-Commands data structure example:

e.g. For Device -Type = TV, after first command, MUTE, has been resolved

Signal-Influencing-Command	Command-Test-order	Resolved-Signal
POWER-OFF	4	-
VOL-UP	3	-
VOL-DOWN	2	-
MUTE	1	MU01

Command-Signals data structure example:

Example for Signal-Influencing-Command = MUTE. The data structure **view after testing of the second signal (MU01) was a success**. Note that signals ordered 3 and 4 below will never get to be tested, and their respective Relevant-Target-Device-Codes have been removed (marked with N) from the Candidate-Device list in Relevant-Target-Device-Codes data structure above.

Command-Signals data structure

Command-Signal	Signals-usage	Signal-Test-order	Tested	Used-By-Device-Code
MU01	35%	2	Y	DC02, DC14

MU02	45%	1	Y	DC01, DC25
MU03	7%	4	N	DC26, DC48
MU04	13%	3	N	DC13, DC37

Note that prior to a successful test (**not the case presented in these exemplary tables**), Tested=N (the initial state for all Command-Signals) indicates that this Command-Signal has not yet been tested; this Command-Signal represents devices (Relevant-Target-Device-Code) which are still in the Candidate-Devices list.

Detailed explanation on how some fields of the Calculation-Data-Structures are populated

Relevant-Target-Device-Codes data structure:

Initialization:

When starting the programming process, all populated Relevant-Target-Device-Code make up the initial Candidate-Devices list (marked with Y).

Population process

Relevant-Target-Device-Code: Based on the Remote-Model-ID (provided by The-Remote to be programmed), and all its Operating-Mode-Required-Commands-Set-IDs (from DB2:Advanced-Universal-Remote-Controls), all Target-Device-Types are retrieved from DB2:Operating-Mode-Required-Commands-Sets. For each Target-Device-Type, all matching Target-Device-Codes are retrieved from DB1:Target-Device-Codes (expecting less Target-Device-Codes than Target-Devices) and populate the Relevant-Target-Device-Code fields.

Geo-availability:

Based on the Geo-Location which is provided by The-Remote being programmed, the popularity (%) of each Relevant-Target-Device-Code is populated from DB2:Target-Device-Codes-Stats.

Candidate-Device:

Initially, when updating Current-Target-Device-Type, all set to Y.
Each time a Command-Signal fails a test, all associated Relevant-Target-Device-Codes are set to N (removed from the Candidate-Devices list).
Each time a Command-Signal is resolved, all non-associated Relevant-Target-Device-Codes are set to N (removed from the Candidate-Devices list).

Signal-Influencing-Commands data structure:

Based on Target-Device-Type (explained above under Relevant-Target-Device-Code), all Signal-Influencing-Commands are retrieved from DB2:Signal-Influencing-Commands:Signal-Influencing-Command, e.g. MUTE, VOL-UP

Command-Test-order:

The ordinal place of this Signal-Influencing-Command in the testing order, e.g. 1st, 2nd.

The Command-Test-order values are calculated (Fig. 4 step 410) following each population of the Calculation-Data-Structures (Fig. 3 step 325). The calculation is based on the Current-Target-Device-Type, the popularity of relevant target-devices (i.e. relevant Command-Signals for each relevant Command) in the current Geo-Location-ID, according to the formula explained below (see below "Description of the algorithm defining the Command-Test-order values of Signal-Influencing-Commands data structure").

Resolved-Signal:

Runtime storage for the signal found and verified by the described method (Fig. 4) as controlling the Current-Target-Device-Type for the current Signal-Influencing-Command.

Command-Signals data structure:

Command-Signal:

A signal implementing the Signal-Influencing-Command for this Target-Device-Code. Based on Signal-Influencing-Command name, Command-Signals of all Target-Device-Codes are retrieved from DB1:Target-Device-Codes:Command-Signal

Signals-usage:

The popularity (%) of each of the Command-Signals in the Geo-Location. For each Command-Signal, go over Relevant-Target-Device-Codes table and set the accumulated percent (%) of Geo-availabilities which use this Command-Signal.

Signal-Test-order:

The ordinal place of this Command-Signal in the testing order. Going over all Signals-usage values, sort all Command-Signals so that first place (1) is set to a Command-Signal with the highest likelihood to influence the Target-Device, last place (4 in above example) is set to a Command-Signal with the lowest likelihood to influence, and all others are set accordingly.

The likelihood of a specific Command-Signal to influence the Target-Device is determined by:

A) Statistical information regarding popularity of each Target-Device-Code (which uses this specific Command-Signal) in the Current-Geo-Location (i.e. popular TV models in this area).
B) Total percentage of each Command-Signal used by all Candidate-Devices (since different Target-Device-Codes may use an identical Command-Signal for some Command-Names).

Note that the testing order of signals is repeatedly calculated, during programming, for each Signal-Influencing-Command. The testing order depends on:

A) The Geo-location in which programming is taking place

B) The percentage breakdown of the Candidate-Devices list prior to testing of each Signal-Influencing-Command, which in turn is dependent on the results of previously tested Signal-Influencing-Commands.

Tested:

Y/N, has this Command-Signal been tested so far. Set by the system during execution, indicating progress of testing.
Prior to running a successful test, Tested=N (initial state for all commands) indicates that this Command-Signal is representing a device (Relevant-Target-Device-Code) which is still in the Candidate-Devices list.

Comment regarding next steps, following use of the Calculation-Data-Structures for the Current-Target-Device-Type:

Once all Resolved-Signals for the Current-Target-Device-Type are identified, they are forwarded to The-Remote being programmed.

System will continue working on the next required Target-Device-Type (based on DB2:Advanced-Universal-Remote-Controls:Operating-Mode-Required-Commands-Set-ID, taken from DB2:Operating-Mode-Required-Commands-Sets:Target-Device-Type).

Description of the algorithm defining the Command-Test-order values of Signal-Influencing-Commands data structure:

This algorithm is executed (Fig. 4 step 410) following each population of the Calculation-Data-Structures (Fig. 3 step 325).
The algorithm defines the execution order, for all Signal-Influencing-Commands relevant to the current Target-Device-Type, as follows:
For each such command, the COST for executing this command is defined as the average time it takes to resolve this command (the time is takes to identify the Signal implementing this command).

The command with the minimal COST will be executed first, the command with the maximum COST will be executed last; all other commands will be ordered according to their COST, lower COST first, higher COST later.

Rationale:

Each resolved command reduces significantly the number of Candidate-Devices.
The sooner we get to a single Candidate-Device, the sooner we'll complete our search for the Target-Device.
Hence we want to minimize the number of Candidate-Devices by investing the minimal COST (time) possible.

Calculating the COST of each command:
Cost of a specific command (i.e. time for resolving this command) = {**A**verage number of trials (signals) for this command} multiplied by {signal-trial-**D**uration for each signal} = **A*D**
Obviously, the signals of each command will be tried according to the order of their popularity, most popular first, since we want to complete our search as soon as possible.

Calculating **A** – the **A**verage number of trials (signals) for this command
n – The number of signals implementing this command in the relevant geo location
p(i) - The probability of signal i appearing in the relevant geo location

$$\mathbf{A} = 1*p(1) + 2*p(2) + \ldots + n*p(n)$$

Explanation: Each signal contributes to the "average number of trials" the number of trails "used" until this signal is discovered (i.e. 1, 2,…n), multiplied by the probability of this signal appearing (i.e. p(1), p(2)…p(n)).

D = Trial-duration for each command signal = value set by operator in DB2 (based on prior experience)

Examples of Trial-duration **D:**
- checking one signal of MUTE (of TV) takes **50** ms

- checking one signal of VOL-UP (of TV) takes 150 ms
- checking one signal of "beep" (of AC) takes 100 ms

Example for calculating Average number of trials **(A)** for the MUTE command**:**

A = 1*p(1) + 2*p(2) + …. + n*p(n)

Based on the first 3 columns of the MUTE Command-Signals data structure provided below, Signal Contribution to Average of each Command-Signal is the result of multiplying column 2 (p(i) in above formula) by column 3 (i in above formula).

First 3 columns of the MUTE Command-Signals data structure Average:

Command-Signal	Signals-usage	Signal-Test-order	Signal Contribution to Average
MU01	25%	2	0.5
MU02	50%	1	0.5
MU03	5%	4	0.2
MU04	20%	3	0.6
	Average number of trials:		**1.8**

Average number of trials is the sum of the values of column 4 (Signal Contribution to Average).

Finally, the COST of MUTE will be: COST=A*D=**1.8*50**=90ms

It will be appreciated that the scope of the claimed invention is defined only by the appended claims; the invention cannot be limited by the described in other sections of this application.

CLAIMS

1. A system for automatically programming at least one universal remote control, comprising:

at least one universal remote control device;

at least one database storing data related to at least one target device type which may be controlled by said at least one universal remote control device and data required for automatically programming said at least one universal remote control device;

at least one transmitter configured to transmit at least one command signal towards at least one target device;

at least one signal change detector configured to automatically detect changes in output signals of said at least one target device; and

a system control unit communicating with said at least one universal remote control device, said at least one transmitter and said at least one signal change detector, said system control unit connected with said at least one database, said system control unit configured to execute automatic programming of said at least one universal remote control device.

2. The system of claim 1, wherein each one of said at least one universal remote control device is configured to operate in at least one operating mode.
3. The system of claim 2, wherein each one of said at least one universal remote control device comprises, for each one of said at least one operating mode, mapping of buttons to command names.
4. The system of claim 2, wherein each one of said at least one universal remote control device comprises, for each one of said at least one operating mode, mapping of soft buttons to buttons characteristics.
5. The system of claim 1, wherein the data stored in said at least one database comprises target device codes and corresponding target device types, target device names, command names, command signals and command descriptions.
6. The system of claim 1, wherein the data stored in said at least one database comprises:

at least one universal remote control device model ID;

at least one operating mode corresponding to each one of said at least one universal remote control device model ID;

at least one target device code;

usage statistics of each target device code per geo location; and

signal influencing commands comprising parameters required for detecting signal change.

7. The system of claim 6, wherein said at least one database further comprises data related to TV operators;

said data related to TV operators describing each of said TV operator's channel lineups, comprising: channel name, channel description, channel logo channel category and popularity statistics of channel per geo location.

8. The system of claim 7, further configured to automatically program favorite channel buttons using said popularity statistics of channel per geo location and per TV operator.

9. The system of claim 6, wherein said parameters comprise: signal type, measured property, minimal change, time window size and counter command name.

10. The system of claim 1, wherein at least one of said at least one database, system control unit, signal change detector, transmitter and at least one universal remote control device are embodied as at least one application on a mobile computing device.

11. The system of claim 1, wherein at least one of said at least one database, system control unit, signal change detector, transmitter and at least one universal remote control device are embodied as at least one application on one of a home computing device, an office computing device and an industrial computing device.

12. The system of claim 1, wherein at least one of said at least one database, system control unit, signal change detector and transmitter are embodied as an integral part of said at least one universal remote control device.

13. The system of claim 1, wherein at least one of said at least one database, system control unit, signal change detector and transmitter are embodied as an integral part of one or more target devices.

14. The system of claim 1, wherein at least one of said at least one database, system control unit, signal change detector, transmitter and at least one universal remote control device are embodied as a stand-alone device.
15. The system of claim 1, wherein said at least one database, system control unit, signal change detector, transmitter and at least one universal remote control device are packaged in any packaging combination.
16. The system of claim 1, wherein said at least one database reside in one of a local storage unit and a remote storage unit.
17. The system of claim 1, wherein said at least one universal remote control device comprises a plurality of universal remote control devices and wherein said system is configured to automatically program in parallel said plurality of universal remote control devices.
18. The system of claim 1, wherein each one of said at least one universal remote control device comprises a universal remote control model ID, a unique serial number and at least one set of logical elements, each set of logical elements configured to implement a given operating mode and to control one or more target device types , said at least one set of logical elements comprising at least one of:

a plurality of commands comprising all the commands for implementing said given operating mode in said universal remote control model ID, each command associated with a command name and with a command signal;

a plurality of buttons, each designated by a button ID;

buttons command mapping configured to map said plurality of buttons to a plurality of command names and command signals, said buttons comprising soft buttons;

a plurality of look and feel characteristics of said soft buttons; and

buttons look and feel mapping configured to map each one of said soft buttons to said look and feel characteristics,

wherein said universal remote control device is configured to receive said at least one set of logical element from said at least one database.

19. The system of claim 18, wherein said commands comprise basic commands and macro commands, said macro commands comprising a sequence of at least two basic commands.

20. The system of claim 1, wherein said system control unit comprises:

a processor;

control memory comprising run-time calculation data structures configured to be populated with data from said at least one database, said data relating to target devices;

at least one command transmit interface configured to communicate between said processor and said at least one transmitter;

at least one signal change detector interface configured to communicate between said processor and said at least one signal change detector;

a database interface configured to retrieve data from said at least one database;

at least one programming interface configured to send commands, command signals and look and feel data from said control memory to said at least one universal remote control device;

at least one indicator interface configured to indicate the status of ongoing programming of said at least one universal remote control device;

and

a geo location module.

21. The system of claim 20, wherein said system control unit further comprises internet connection means.

22. The system of claim 1, wherein each one of said at least one signal change detector comprises:

change detector memory;

a signal receiver configured to receive said output signals from said at least one target device;

a signal recorder configured to receive said output signals from said signal receiver and record them in said change detector memory;

a signal analyzer configured to analyze said received output signals according to predefined parameters;

a detector control unit configured to control operation of said signal receiver, said signal recorder and said signal analyzer; and

a system control interface configured to communicate between the signal change detector and said system control unit.

23. The system of claim 22, wherein said predefined parameters comprise measured property, minimal change and time window size.

24. The system of claim 1, wherein said data required for automatically programming said at least one universal remote control device comprises data related to one or more operating modes and one or more target device types.

25. The system of claim 1, wherein said at least one target device type comprises at least one of the group consisting of: TV, Display, Projector, Set-Top-Box (STB), Streamer, Speakers, Amplifiers, Radios, Air-Conditions, Fans, Lights, Shades, Cameras and Smart Home devices.

26. The system of claim 1, wherein the data stored in said at least one database comprises a streaming and web sites table.

27. The system of claim 1, wherein the data stored in said at least one database comprises a remote customization table.

28. The system of claim 1, wherein said automatic programming is configured to be done without human intervention.

29. The system of claim 1, wherein said at least one universal remote control device comprises a plurality of universal remote control devices and wherein at least one of said plurality of universal remote control devices has a model ID different than the model ID of the other universal remote control devices in said plurality.

30. A method of automatically programming a universal remote control device, comprising:

transmitting at least one basic command signal toward at least one target device to be controlled by said universal remote control device, said at least one basic command signal configured to modify the state of said target device;

detecting at least one change in said at least one target device's at least one output signal in response to said sent at least one basic command signal; and

programming said at least one command in said universal remote control device for controlling said at least one target device.

31. The method of claim 30, further comprising obtaining at least one operating mode of said universal remote control, wherein said at least one target device comprises a target device type; said at least one basic command signal belongs to one signal influencing command for said target device type; and said programming comprises programming said at least one command for said universal remote control device for controlling said at least one target device.
32. The method of claim 30, wherein said transmitting at least one basic command signal comprises transmitting in a calculated order configured to minimize said programming time.
33. The method of claim 30, wherein said detecting changes comprises identifying the basic command signal that caused said changes.
34. The method of claim 30, further comprising obtaining look & feel buttons data for said programmed at least one command.
35. The method of claim 30, wherein said at least one target device and said at least one basic command signal are selected from a database.
36. The method of claim 30, wherein said automatic programming is done without human intervention.
37. The method of claim 31, wherein said at least one signal influencing command is selected from a database, based on a calculated order configured to minimize said programming time.
38. The method of claim 31, further comprising calculating an order of said signal influencing commands using cost related with executing each one of said signal influencing commands
39. The method of claim 32, wherein said at least one basic command signal order is calculated during said programming.

40. The method of claim 37, wherein said at least one signal influencing command order is calculated during said programming.
41. The method of claim 39, wherein said calculating comprises using data related to the popularity of devices of said target device type in a geo-location associated with said universal remote control device.
42. The method of claim 38, wherein said cost comprises average time to resolve each one of said signal influencing commands.
43. The method of claim 42, wherein said order comprises executing signal influencing commands with lower cost first.
44. The method of claim 41, said at least one command signal order comprises first executing command signals with higher popularity in said geo-location.
45. A database for use with a system comprising an automatically programmable remote control device, said database storing data related to at least one target device type which may be controlled by at least one universal remote control device and data required for automatically programming said at least one universal remote control device, comprising:

at least one universal remote control device model ID;

at least one operating mode corresponding to each one of said at least one universal remote control device model ID;

at least one target device code and corresponding at least one target device type;

at least one set of command names and related command signals which control said at least one target device;

usage statistics of said at least one target device code per geo location; and

signal influencing commands comprising parameters required for detecting change in output signal of said at least one target device.

46. The system of claim 45, wherein said database further comprises data related to TV operators;

said data related to TV operators describing each of said TV operator's channel lineups, comprising: channel name, channel description, channel logo channel category and popularity statistics of channel per geo location.

47. The system of claim 45, wherein said parameters comprise: signal type, measured property, minimal change, time window size and counter command name.

48. The system of claim 45, wherein said database further comprises data related to streaming and web sites, comprising: site ID, site URL, site description, site logo, site category and popularity statistics of site per geo location.

49. The system of claim 45, wherein said database further comprises data related to customization of said remote control device, comprising: remote ID, customized field and customization data.

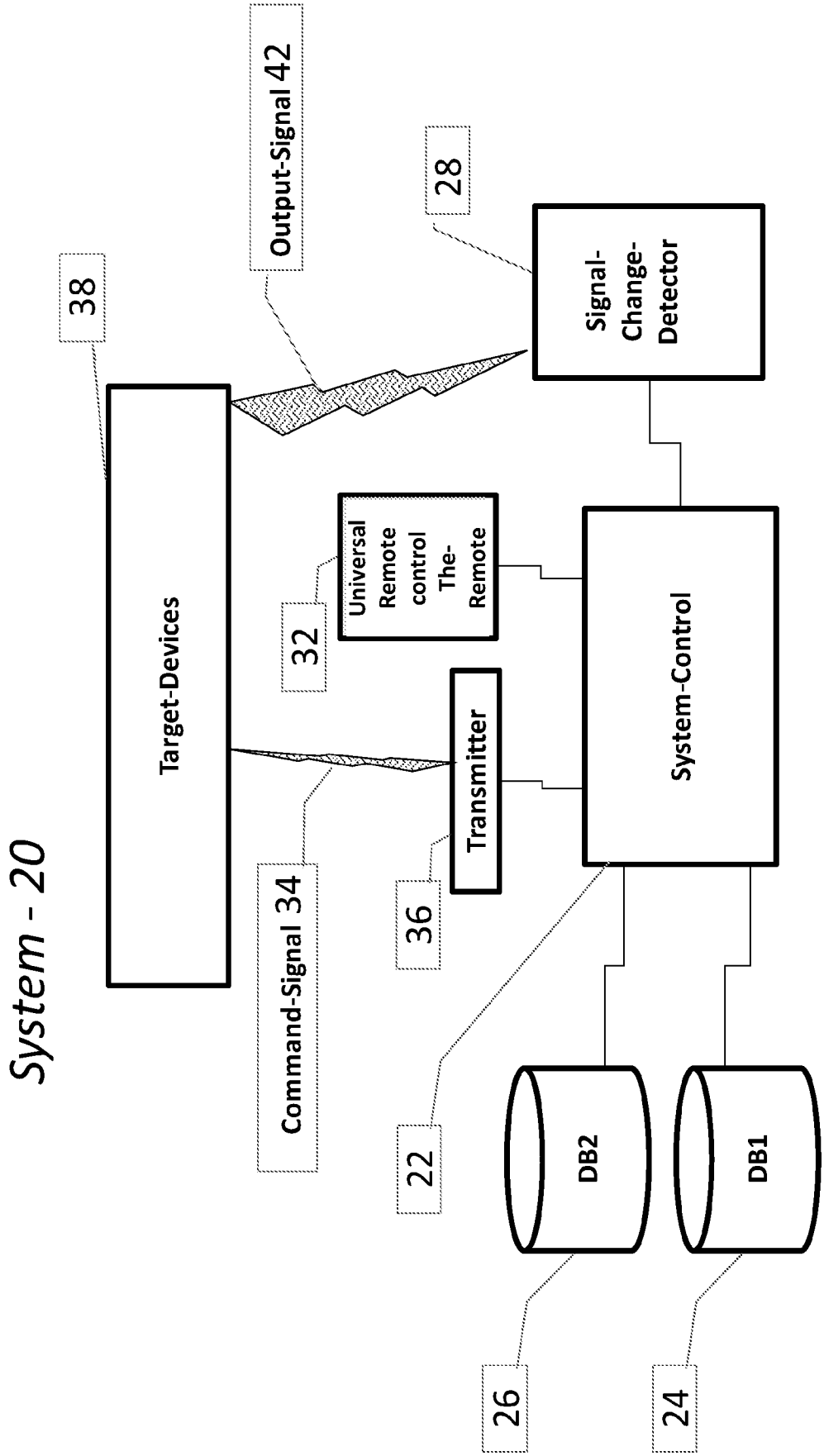
System - 20
Target-Devices
38
Output-Signal 42
28
Signal-Change-Detector
Universal Remote control The-Remote
32
System-Control
Transmitter
Command-Signal 34
36
22
DB2
DB1
26
24

Fig. 1

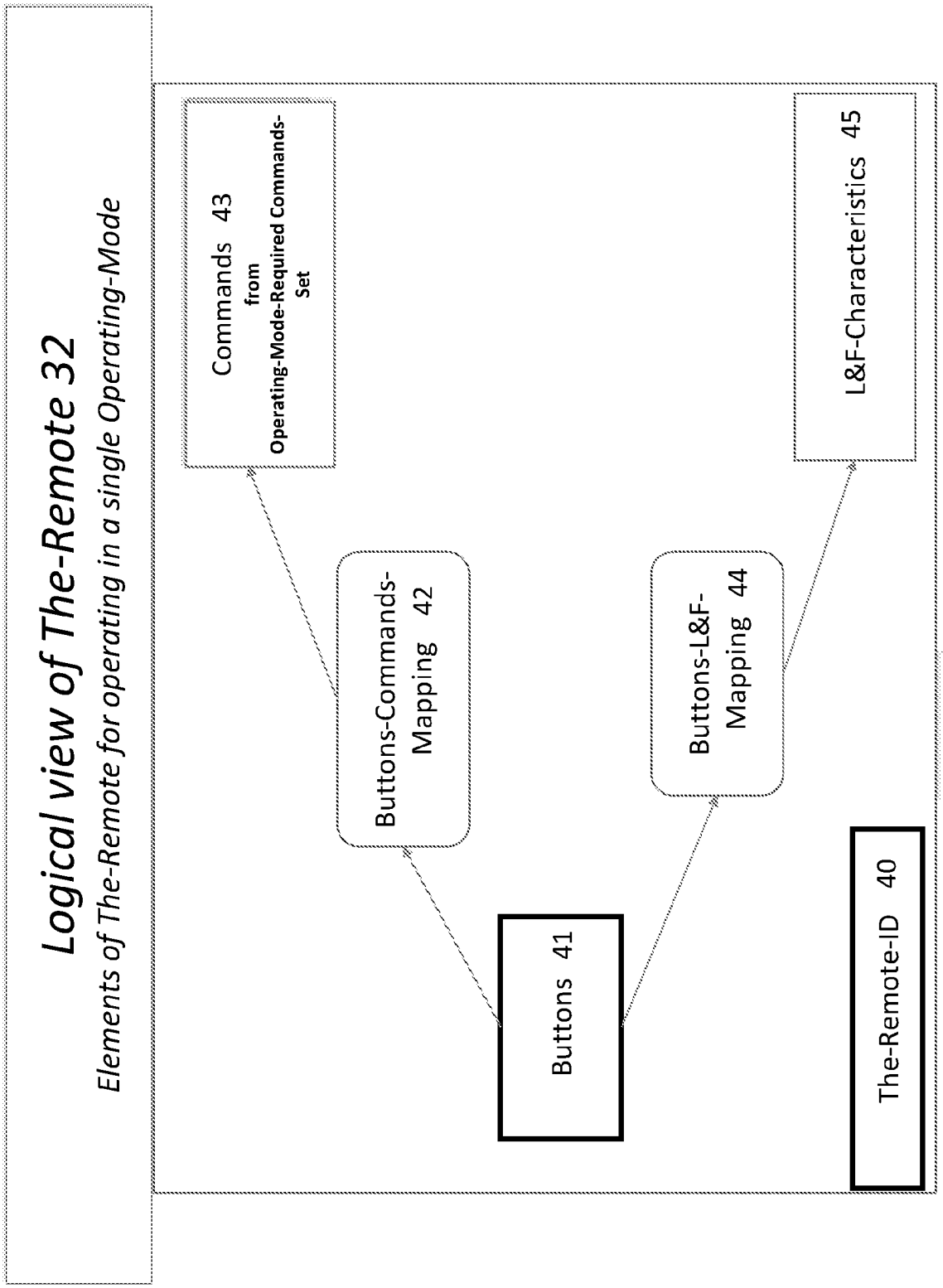
Logical view of The-Remote 32
Elements of The-Remote for operating in a single Operating-Mode
Commands 43 from Operating-Mode-Required Commands-Set
L&F-Characteristics 45
Buttons-Commands-Mapping 42
Buttons-L&F-Mapping 44
Buttons 41
The-Remote-ID 40

Fig. 2

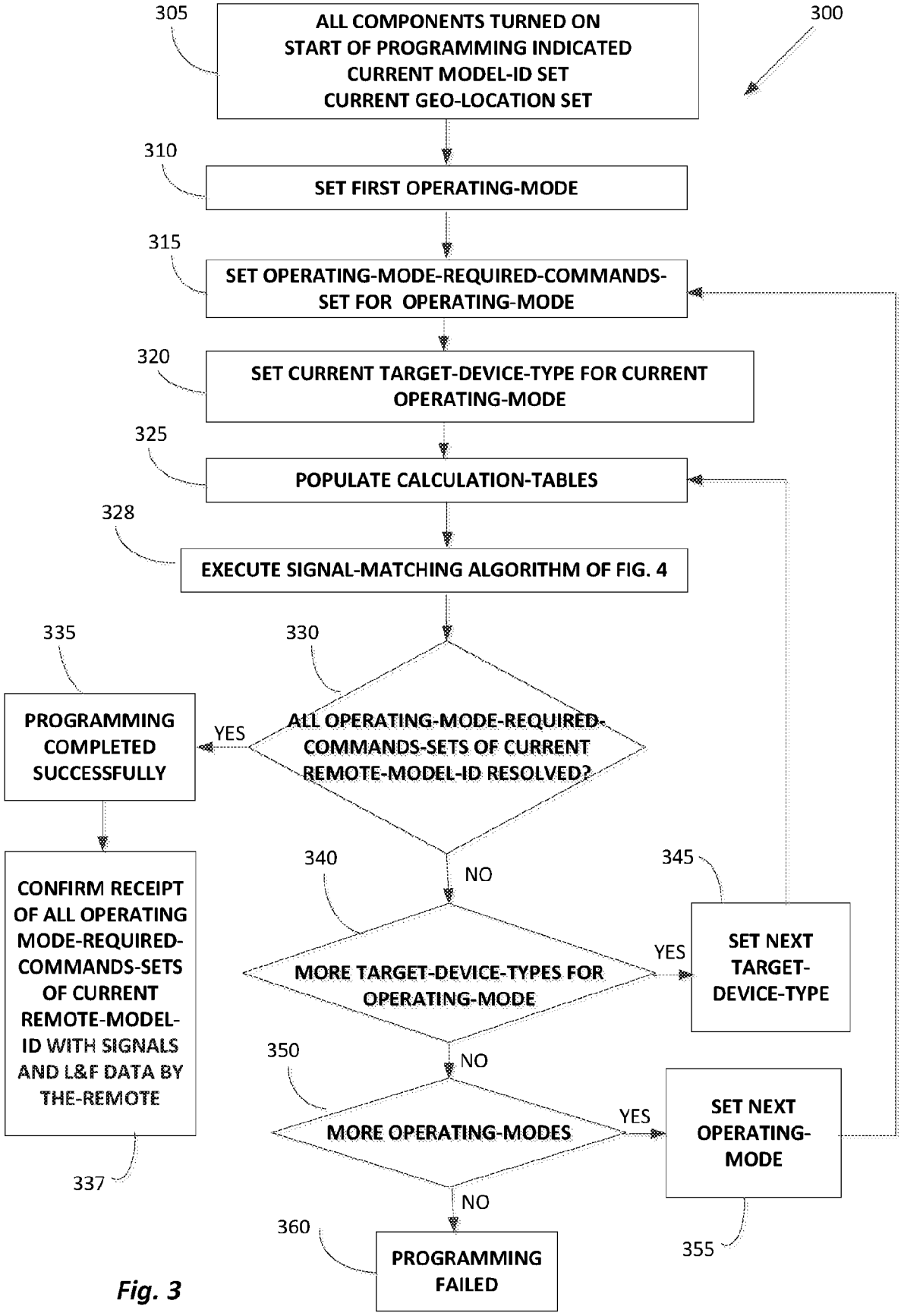
305
ALL COMPONENTS TURNED ON
START OF PROGRAMMING INDICATED
CURRENT MODEL-ID SET
CURRENT GEO-LOCATION SET
300
310
SET FIRST OPERATING-MODE
315
SET OPERATING-MODE-REQUIRED-COMMANDS-SET FOR OPERATING-MODE
320
SET CURRENT TARGET-DEVICE-TYPE FOR CURRENT OPERATING-MODE
325
POPULATE CALCULATION-TABLES
328
EXECUTE SIGNAL-MATCHING ALGORITHM OF FIG. 4
335
330
PROGRAMMING COMPLETED SUCCESSFULLY
YES
ALL OPERATING-MODE-REQUIRED-COMMANDS-SETS OF CURRENT REMOTE-MODEL-ID RESOLVED?
NO
340
345
MORE TARGET-DEVICE-TYPES FOR OPERATING-MODE
YES
SET NEXT TARGET-DEVICE-TYPE
CONFIRM RECEIPT OF ALL OPERATING MODE-REQUIRED-COMMANDS-SETS OF CURRENT REMOTE-MODEL-ID WITH SIGNALS AND L&F DATA BY THE-REMOTE
350
NO
MORE OPERATING-MODES
YES
SET NEXT OPERATING-MODE
337
NO
360
355
PROGRAMMING FAILED

Fig. 3

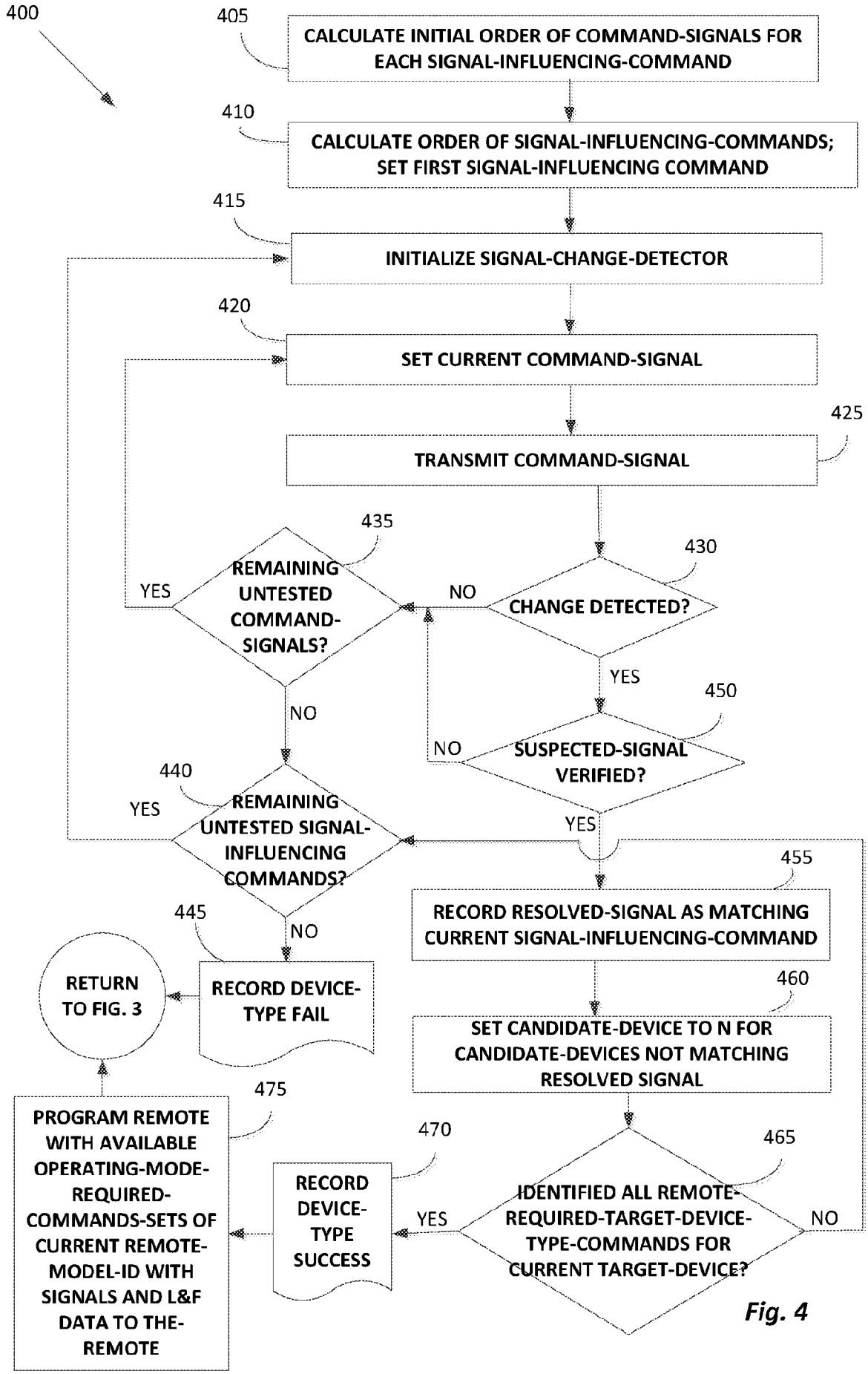
400
405
CALCULATE INITIAL ORDER OF COMMAND-SIGNALS FOR EACH SIGNAL-INFLUENCING-COMMAND
410
CALCULATE ORDER OF SIGNAL-INFLUENCING-COMMANDS; SET FIRST SIGNAL-INFLUENCING COMMAND
415
INITIALIZE SIGNAL-CHANGE-DETECTOR
420
SET CURRENT COMMAND-SIGNAL
425
TRANSMIT COMMAND-SIGNAL
430
CHANGE DETECTED?
NO
YES
435
REMAINING UNTESTED COMMAND-SIGNALS?
YES
NO
450
SUSPECTED-SIGNAL VERIFIED?
NO
YES
440
REMAINING UNTESTED SIGNAL-INFLUENCING COMMANDS?
YES
NO
455
RECORD RESOLVED-SIGNAL AS MATCHING CURRENT SIGNAL-INFLUENCING-COMMAND
460
SET CANDIDATE-DEVICE TO N FOR CANDIDATE-DEVICES NOT MATCHING RESOLVED SIGNAL
465
IDENTIFIED ALL REMOTE-REQUIRED-TARGET-DEVICE-TYPE-COMMANDS FOR CURRENT TARGET-DEVICE?
YES
NO
470
RECORD DEVICE-TYPE SUCCESS
475
PROGRAM REMOTE WITH AVAILABLE OPERATING-MODE-REQUIRED-COMMANDS-SETS OF CURRENT REMOTE-MODEL-ID WITH SIGNALS AND L&F DATA TO THE-REMOTE
445
RECORD DEVICE-TYPE FAIL
RETURN TO FIG. 3

Fig. 4

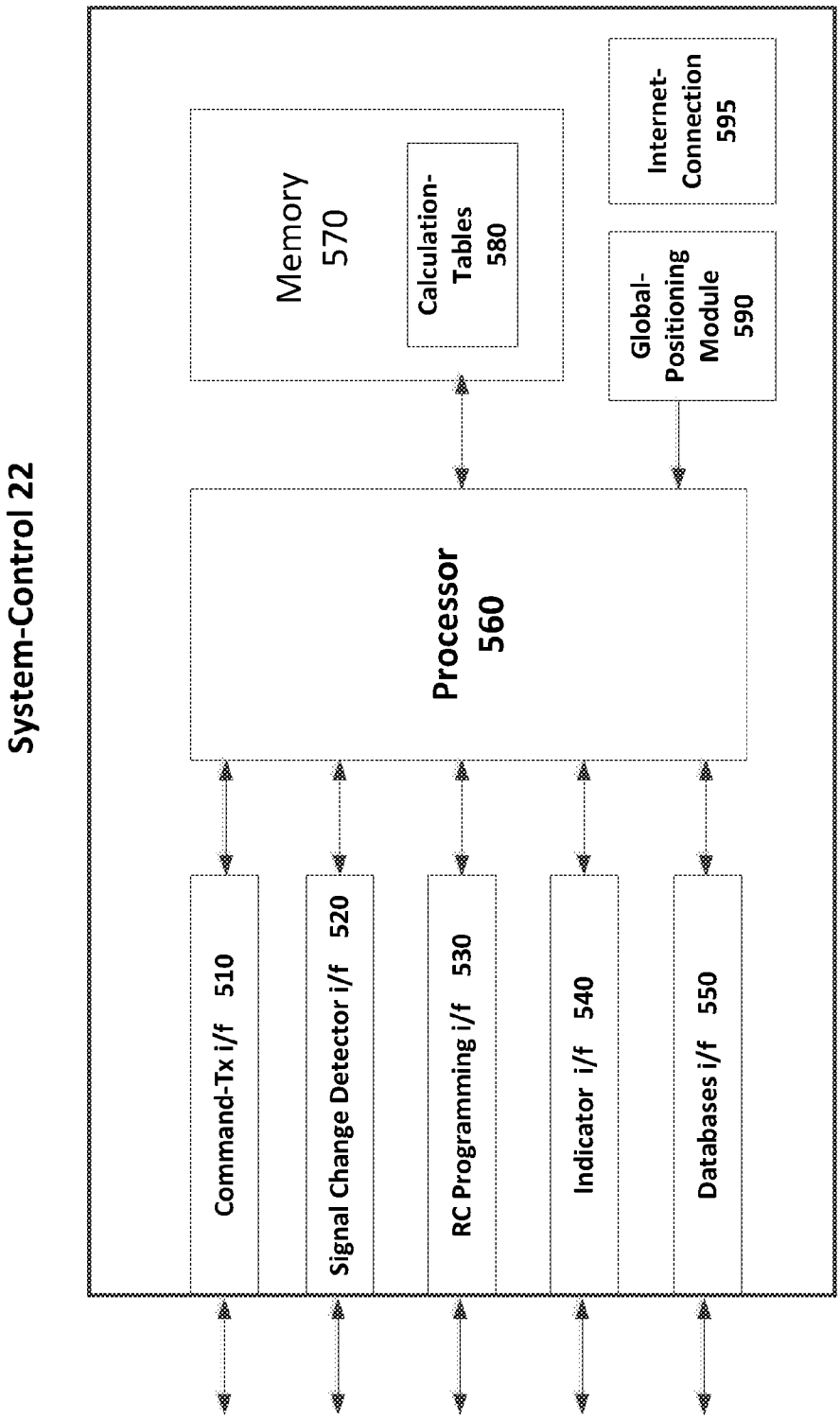
System-Control 22
Memory 570
Calculation-Tables 580
Internet-Connection 595
Global-Positioning Module 590
Processor 560
Command-Tx i/f 510
Signal Change Detector i/f 520
RC Programming i/f 530
Indicator i/f 540
Databases i/f 550

Fig. 5

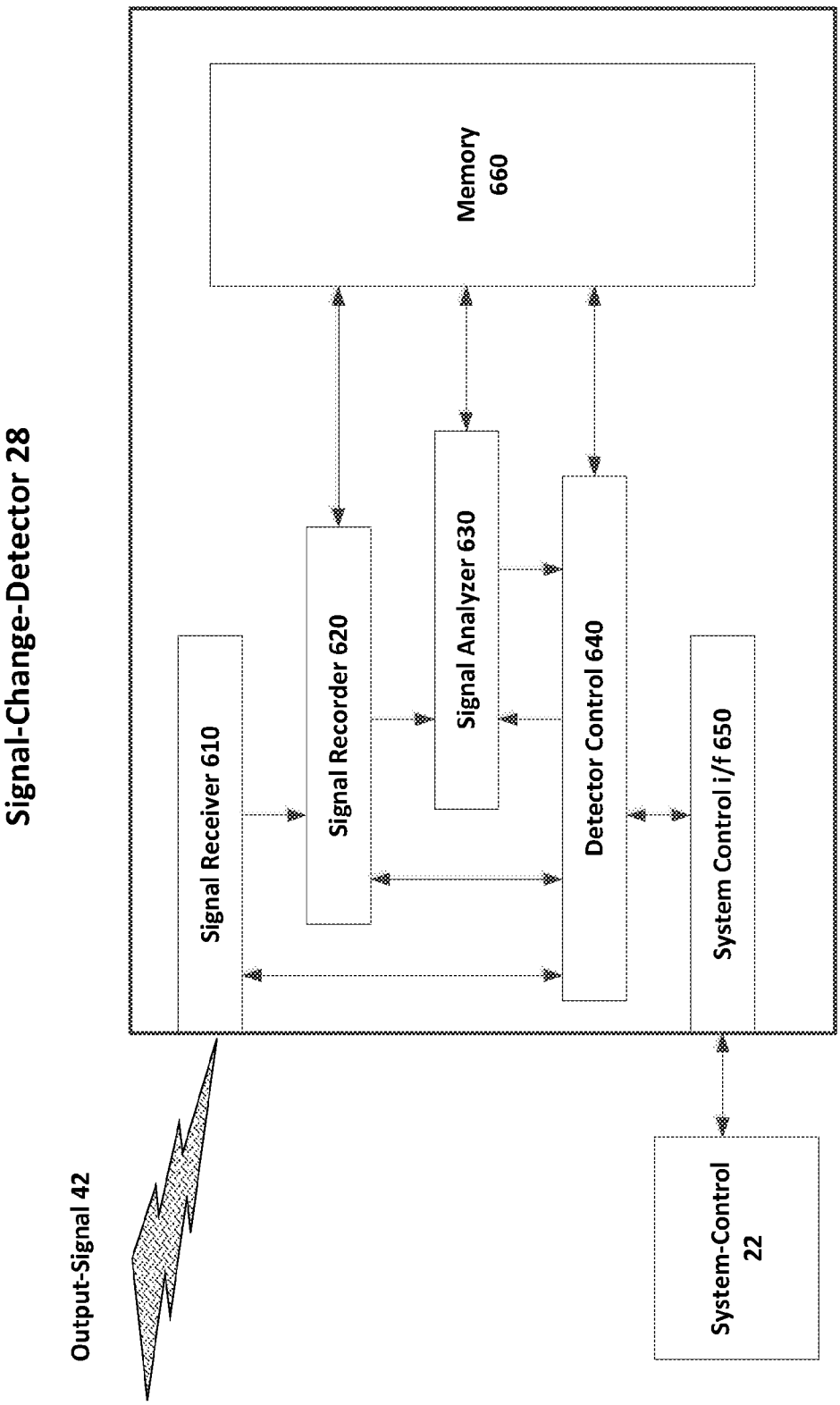
Signal-Change-Detector 28
Memory 660
Signal Receiver 610
Signal Recorder 620
Signal Analyzer 630
Detector Control 640
System Control i/f 650
Output-Signal 42
System-Control 22

Fig. 6