FORM 2

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COMPLETE SPECIFICATION
(See Section 10 and Rule 13)

1 **TITLE OF THE INVENTION :**

A FINGERPRINT READER DEVICE AND METHOD OF USE.

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3 **PREAMBLE TO THE DESCRIPTION**

COMPLETE

The following specification particularly describes the invention and the manner in which it is to be performed.

FIELD OF THE INVENTION

The present invention relates to a fingerprint reader device for reading fingerprint of any user and a system where the fingerprint reader device is adapted to be used in conjunction with a companion electronic device such as mobile phone, computer, PDA etc. and also to a method for reading and processing of fingerprint using such system. The fingerprint reader according to the present invention captures the fingerprint of a user, processes it and sends the useful data (with or without encryption) to the companion device via an output jack adapted to be inserted into the microphone port of the companion device. Bi-directional communication with the companion device is also disclosed where the companion device sends signal containing information to the fingerprint reader from its audio output line. The fingerprint reader device is thus having prospects of user friendly application in wide scale for effecting secured transactions/operations for a variety of purposes.

BACKGROUND OF THE INVENTION

Fingerprints are one of the most popular means of biometric identification of a person. The increasing concern of security among the people is now pushing it to use their fingerprints instead of PIN numbers and passwords for identifying themselves, authenticating transactions etc. They can be used in various areas like in security access, control, attendance system, authenticating financial transactions, verifying credentials or a person at airports etc.

A raw fingerprint is captured by a fingerprint sensor and is processed to extract minutiae points which are major features of a fingerprint, using which comparison of one print with another can be made. Minutiae include features such as ridge endings, ridge bifurcations, island, ridge enclosures, independent ridges, spur, bridges, delta and core, which are present in any fingerprint.

Fingerprint scanners capable of capturing fingerprint and finding minutiae points are normally available at counters of places such as officers, check point, banks etc. However, the growing security concerns among the people have created a need of a fingerprint reader device that can be made available at many other locations as well. One such example can be a point-of-sale device through which people may want to

authorize the payment by a more secure feature such as their fingerprint instead of PIN number which can easily be stolen by third party. Not all people can afford to have a dedicated fingerprint scanner installed at their place. It would be convenient if we would have a low cost, portable fingerprint reader device that can be used in conjunction with computer or mobile phones (which are nowadays available everywhere) to read fingerprint of a person anywhere and use it for a transaction or operation.

The present disclosure presents such a fingerprint reader device that captures a fingerprint, process it to find minutiae points and sends it to a companion device such as computer, mobile phone PDA for making use in an transaction / operation.

OBJECTS OF THE INVENTION

The basic object of the present invention is directed to provide a fingerprint reader device for reading fingerprints, to be used in conjunction with companion electronic media such as mobile phones, computers, PDA etc. loaded with application software for performing transactions/operations based on processed fingerprint information.

A still further object of the present invention is directed to provide a fingerprint reader device that reads the fingerprint by sensing the finger laid upon its surface and converting the waveform representative of the fingerprint pattern into digital form and transmits the fingerprint raw image information (either with or without encryption) to a companion electronic media such as mobile phones, computer, PDA etc. for further use.

A still further object of the present invention is directed to provide a fingerprint reader device that reads the fingerprint by sensing the finger laid upon its surface and converting the waveform representative of the fingerprint pattern into digital form, processes it to extract minutiae points and transmits the fingerprint minutiae points information (either with or without encryption) to a companion electronic media such as mobile phones, computer, PDA etc. for further use.

A still further object of the present invention is directed to provide a fingerprint reader device by which digital fingerprint information may be sent in either

encrypted or unencrypted form to a companion devices via an output jack adopted to be inserted into their microphone input line.

Yet another object of the present invention is directed to provide a fingerprint reader device wherein the fingerprint reader device performs bi-directional communication with the companion device such as mobile phones, computer, PDA etc. through their headset port or through their audio and microphone input ports.

A further object of the present invention is directed to provide a fingerprint reader that has its own on-board battery to supply power for its functioning.

A further object of the present invention is directed to provide a fingerprint reader that harvests the energy from the audio line of the companion device, and hence does not required any other battery power supply.

A still further object of the present invention is directed to provide a portable and low cost fingerprint reader device to be used in conjunction with a companion device such as mobile phone, computer, PDA etc. having a headset port or having audio output and microphone input ports.

A still further object of the present invention is directed to provide a method of use of a fingerprint reader device that captures a fingerprint and sends the raw fingerprint image to a companion device such as mobile phone, computer, PDA etc. connected to the fingerprint reader device via headset port or via use of audio output and/or microphone input ports.

Yet another object of the present invention is directed to provide a method of use of a fingerprint reader device that captures a fingerprint, process it to find minutiae points and sends the minutiae point information to a companion device such as mobile phone, computer, PDA etc. connected to the fingerprint reader device via headset port or via use of audio output and/or microphone input ports.

A further object of the present invention is directed to provide a fingerprint reader device that does not need its own dedicated human input device such as keypad, display and telephone / radio / internet based data transmission mechanism for reading fingerprint and performing fingerprint related operations, but instead uses the resources already available in pervasive devices such as mobile phones, computers, PDA's etc. for its functioning.

A still further object of the present invention is directed to provide a method of bi-directional communication between the fingerprint reader device according to the invention and a companion computing platform via headset port or via audio and microphone input of mobile phones.

A still further object of the present invention is directed to provide a method of one direction communication of data and information between said fingerprint reader device according to the present invention and a companion electronic media via microphone input line of the later.

A still further object of the present invention is directed to provide a flexible cable connector attached to the fingerprint reader device according to one embodiment of the present invention, said cable terminating into a headset plug or into disjoint microphone and audio plugs, so that fingerprint reader device may be placed at a location convenient to the user given its fingerprint.

A still further object of the present invention is directed to provide a fingerprint reader device whose fingerprint sensor can have various types such as swipe sensor, touch (or area) sensor, optical, capacitive or any other type of sensor used for user friendly capturing fingerprint.

A still further object of the present invention is directed to provide a fingerprint reader device that can be constructed in various shapes and sizes to suit particular application.

SUMMARY OF THE INVENTION

Thus the basic aspect of the present invention is directed to a device for fingerprint capturing and image/information retrieval based thereon comprising:

a fingerprint sensor means wherein finger is touched or swiped, to produce a waveform representative of the fingerprint,

a signal conditioning block and ADC to convert the waveform representative of fingerprint into digital signal,

a control and processing unit to control the functioning and/or processing of the digital signals representative of the captured fingerprint in a form suitable for communication to or with a companion electronic device;

a signal shaping unit adapted to facilitate the transmission of the information to the companion electronic device;
means adapted for establishing operative communication with companion electronic device; and

a power unit adapted to provide power for the functioning of the fingerprint reader.

Another aspect of the present invention is directed to said device wherein said means adapted for establishing operative communication with companion electronic device comprise an output jack adapted to be inserted into a microphone input line of a companion electronic device.

A further aspect of the present invention is directed to said device comprising signal shaping unit to prepare the digital information for transmission. Preferably, the signal shaping unit is adapted to facilitate the transmission of the information to the companion electronic device involves generation of modulated signal or encoding the digital information for direct serial transmission over the communication link

An other aspect of the present invention is directed to said comprising means adapted for establishing operative communication with companion electronic device involves a signal setting unit adapted to facilitate unidirectional or bidirectional

communication link between the reader device and the companion device comprising.

A still further aspect in the present invention, the said signal shaping unit is adapted for modulating and/or demodulating the digital information using any of the modulation scheme including ASK, QPSK, MSK, MPSK, PSK etc. preferably FSK modulation.

According to another aspect in the present invention, the said signal shaping unit is adapted for direct serial communication of the digital information to the companion device, with or without any encoding scheme such as Manchester Encoding.

According to yet another aspect in the said device, the analog signal used for modulation is generated locally by using an oscillator comprising of simple analog components such as capacitor and inductor, or a frequency generator such as VCO or a digital microcontroller followed by a low pass filter.

According to another aspect in the present invention, the signal shaping unit additionally contain an amplifier and/or a band pass filter for setting the amplitude and bandwidth of the modulated or encoded signal.

In accordance with another aspect in the present invention, the power unit preferably contains a battery or a socket to take power from an external source or means for extracting the energy for device functioning from the audio port of the companion device.

In accordance with yet another aspect in the present invention, the means for extracting the energy from the companion device involves audio frequencies which are sent via the audio output line of the companion device to energy harvester circuit comprising of a step-up transformer, a rectifier and filters to provide power to the magnetic card reader device.

According yet another aspect in the said device, the control and processing Unit is adapted to provide a temporary buffer for temporary storage of the data.

According to another aspect in the said device, the control and processing Unit may contain an encryption chip for encrypting and decrypting the data for secure communication through the communication link.

A still further aspect of the present invention is directed to said device comprises of a fingerprint sensor upon which finger is touched or swiped, to produce a waveform representative of the fingerprint, a signal conditioning block and ADC to convert the waveform representative of fingerprint into digital signal, a power unit to provide power for device functions, a power management unit to regulate the power and voltage in the device, a control and processing unit to control the functioning, process the digital signals representative of the captured fingerprint to generate a data structure (like an image) representative of the fingerprint and adapt the same to send it to the compression electronic device (either with or without encryption), a signal shaping unit to prepare the digital information for transmission and an output jack adapted to be inserted into the microphone input line of companion electronic media including mobile phones, computer etc. to provide a channel for transfer of data and information from device to any companion electronic device.

A still further aspect of the present invention is directed to said device comprising of a fingerprint sensor upon which finger is touched or swiped, to produce a waveform representative of the fingerprint, a signal conditioning block and ADC to convert the waveform representative of fingerprint into digital signal, a power unit to provide power for device functions, a power management unit to regulate the power and voltage in the device, a control and processing unit to control the functioning of the device, process the digital signals representative of the captured fingerprint to generate a data structure (like an image) representative of the fingerprint and send it to the compression electronic device (either with or without encryption), a signal shaping unit to prepare the digital information for transmission and an output jack that acts a communication channel for bi-directional transfer of data between fingerprint reader device and any said companion electronic device.

A still further aspect of the present invention is directed to said device comprising of a fingerprint sensor upon which finger is touched or swiped, to produce a waveform representative of the fingerprint, a signal conditioning block and ADC to convert the waveform representative of fingerprint into digital signal, a power unit to provide

power for device functions, a power management unit to regulate the power and voltage in the device, a control and processing unit to control the functioning of the device, process the digital signals representative of the captured fingerprint to extract minutiae point information of the fingerprint and send them to compression device in encrypted or unencrypted form, a signal shaping unit to prepare the digital information for transmission, an output jack adapted to be inserted into the microphone input line of companion electronic media including mobile phones, computer etc. to provide a communication channel for transfer of data from the device to the companion electronic device.

A still further aspect of the present invention directed to said device comprising of a fingerprint sensor upon which finger is touched or swiped, to produce a waveform representative of the fingerprint, a signal conditioning block and ADC to convert the waveform representative of fingerprint into digital signal, a power unit to provide power for device functions, a power management unit to regulate the power and voltage in the device, a control and processing unit to control the functioning of fingerprint reader device, process the digital signals representative of the captured fingerprint to extract minutiae point information of the fingerprint and send them to compression device in encrypted or unencrypted form, a signal shaping unit to prepare the digital information for transmission, output jack that acts a communication channel for bi-directional transfer of data between the device and any said companion electronic device.

According to a further aspect of the present invention is directed to said device wherein said control and processing unit and said signal shaping unit comprise a single or separate microcontroller.

Yet another aspect of the present invention is to provide data security during transmission of data through the audio interface, wherein the encryption and/or decryption operation may be performed by the control and Processing Unit or by a separate on-board encryption chip.

Yet another aspect of the present invention is directed to a system for transaction and operation based on processed fingerprint comprising :

(I) A device for fingerprint capturing and image/information retrieval based thereon comprising:

a fingerprint sensor means wherein finger is touched or swiped, to produce a waveform representative of the fingerprint,

a signal conditioning block and ADC to convert the waveform representative of fingerprint into digital signal,

a control and processing unit to control the functioning and/or processing of the digital signals representative of the captured fingerprint in a form suitable for communication to or with a companion electronic device;

signal shaping unit to modulate or encode the digital information for transmission as modulated wave or as direct digital serial communication;

means adapted for connecting with companion electronic device; and

a power unit adapted to provide power for the functioning of the fingerprint reader; and

(II) companion electronic media adapted for receiving the representative inputs of the said captured and processed fingerprint inputs from said device for desired transaction and operation based on processed fingerprint.

A further aspect of the present invention is directed to said system comprising a channel for transfer of data and /or information from said device to said companion electronic device.

A still further aspect of the present invention is directed to said system comprising a communication channel for bi-directional transfer of data between said device and said companion electronic device.

A still further aspect of the present invention is directed to said system wherein said means adapted for establishing operative communication with companion electronic device comprise an output jack adapted to be inserted into a microphone input line (and audio line for bi-directional communication) of said companion electronic device.

A still further aspect of the present invention is directed to said system wherein said companion electronic device comprises (a) provision for input jack or other cooperative connection with said device (b) signal shaping unit and (c) microcontroller means.

According to a further aspect of the present invention is directed to a method of transaction and operation based on processed fingerprint involving the system described above comprising

providing a fingerprint reader device comprising of a fingerprint sensor, a signal conditioning block and ADC, a power unit, a power management unit, a control and processing unit, a signal shaping block and an output jack;

Touching or swiping of the finger over the fingerprint sensor;

Processing the captured fingerprint and extracting the information to be communicated to the companion electronic device;

Modulating the information to be transmitted over an analog carrier and sending it into the companion device through its microphone input line;

Demodulation of received signal inside the companion device, and using it for carrying a transaction;

A further aspect of the present invention is directed to a method of transaction and operation based on processed fingerprint involving the system as described above comprising

providing a fingerprint reader device comprising of a fingerprint sensor, a signal conditioning block and ADC, a power unit, a power management unit, a control and processing unit, a signal shaping block and an output jack;

Touching or swiping of the finger over the fingerprint sensor;

The companion electronic device requests information from the fingerprint reader by sending instructions as a modulated signal from its audio line;

Processing the captured fingerprint and extraction of the requested information by control and processing unit of fingerprint reader;

Modulating the information to be transmitted on an analog carrier and sending the modulated signal into the companion device through its microphone input line;

Demodulation of received signal inside the companion device, and using it for carrying a transaction.

A further aspect of the present invention is directed to a method of transaction and operation based on processed fingerprint involving the system as previously described, comprising

providing a fingerprint reader device comprising of a fingerprint sensor, a signal conditioning block and ADC, a power unit , a power management unit, a control and processing unit, a signal shaping block and output jack;

Touching or swiping of the finger over the fingerprint sensor;

Processing the captured fingerprint and extracting the information to be communicated to the companion electronic device;

serial direct transmission of digital information without any modulation (the digital information may be encoded using an encoding scheme such as Manchester encoding before transmission) into the microphone input line of the companion device;

Decoding or reconstructing the received signal inside the companion device, and using it for carrying a transaction.

A still further aspect of the present invention is directed to a method of method transaction and operation based on processed fingerprint involving the system as previously described, fingerprint reader device comprising of a fingerprint sensor, a signal conditioning block and ADC, a power source, a power management unit, a control and processing unit, a signal shaping block and an output jack;

Touching or swiping of the finger over the fingerprint sensor;

The companion electronic device requests information from the fingerprint reader by sending instructions in digital form (optionally encoded) serially from its audio line;

Processing the captured fingerprint and extraction of the requested information by control and processing unit of fingerprint reader;

The requested information is sent serially (optionally encoded with an encoding scheme such as Manchester encoding) without any modulation, into the companion device through is microphone input line;

Decoding or reconstruction of received signal inside the companion device, and using it for carrying a transaction.

According to an other aspect in the said system, the companion device such as mobile phone having suitable application software loaded in it adapted to use the fingerprint details for doing an operation.

The various objects and advantages of the present invention are described in greater details with reference to the following accompanying non limiting illustrative drawings.

BRIEF DESCRIPTION OF THE ACCOMPANYING FIGURES

Figure 1: is the schematic views of one of the illustrative embodiments of the finger print reader device according to the present invention, showing (a) The perspective view of fingerprint sensor with 'area' or 'touch' type fingerprint sensor (b) Position of finger while giving the fingerprint (c) Back side of the fingerprint reader device showing one of the possible placement for power source (d) perspective view of fingerprint sensor with 'swipe' type fingerprint sensor.

Figure 2: is the schematic diagram of one form of the architecture of the presently disclosed fingerprint reader device.

Figure 3: is the schematic diagram of another form of disclosed fingerprint reader device for bi-directional communication.

Figure 4: shows schematic diagram of using a microcontroller as a Modem or as an Encoder-Decoder.

Figure 5: is the schematic view of another embodiment of the present invention showing (a) Perspective view of a disclosed fingerprint reader device with a headset

plug at the end of a flexible cable, and (b) perspective view of the disclosed fingerprint reader device with audio and microphone plugs at the end of a bifurcating cable.

Figure 6: is a flowchart of a method of operation and use of fingerprint reader device supporting one-direction communication constructed according to the present invention.

Figure 7: is a flowchart showing the steps of a method of operation and use of fingerprint reader device supporting bi-direction communication constructed according to the present invention.

Figure 8: is a flowchart of another method of operation and use of fingerprint reader device supporting one-direction communication constructed according to the present invention.

Figure 9: is a flowchart of yet another method of operation and use of fingerprint reader device supporting bi-direction communication constructed according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION WITH REFERENCE TO THE ACCOMPANYING FIGURES

Reference is first invited to accompanying **Figure 1(a)** that shows one of the illustrative embodiments of the fingerprint reader device according to the present invention. The fingerprint reader device **10** comprises of a housing **11**, a fingerprint sensor **12** and a jack **13** extending out from the housing **12**. The jack **13** is adapted to be inserted into a socket such as headset port or microphone port of the companion input computing device (not shown in the figure) which may be a mobile phone, computer, PDA etc. The output jack **13** may be a TRS (Tip, Ring, Sleeve) connector also known as audio jack, headset plug, phone plug, jack plug, stereo plug, mini-jack or mini-stereo audio connector. The jack **13** may be formed of different stages such as miniaturized versions that are 3.5 mm and 2.5 mm. It is

also possible and contemplated that jack **13** may be retractable within the housing **11**.

Accompanying **Figure 2** shows the detailed block diagram of one form of the present invention. The fingerprint reader device **110** comprises of a fingerprint sensor **111** upon which the user touches or swipes his/her finger. The fingerprint sensor **111** produces an analog waveform representative of the fingerprint of the impressed (or swiped) finger. The analog waveform generated by the fingerprint sensor **111** is sent to a signal conditioning block **112** for setting its gain and offset before it is converted into digital signal stream by the ADC **113**.

The output of ADC **113** is a digital signal representative of the captured fingerprint. The control and processing unit **114** contains property instructions and register for controlling the functions of fingerprint reader device **110** and quality of the captured fingerprint. Besides controlling the fingerprint reader device **110**, the control and processing unit **114** also process the digital signal output of the ADC **113** to generate a data structure (like an image) representative of the captured fingerprint. The control and processing unit **114** may perform additional tasks like encrypting the digital data before transmission. It may also provide for a temporary buffer for temporary storage of the data. The control and processing unit **114** typically comprises of a microcontroller. It may also include hardware accelerators like Encryption engine for better performance.

The control and processing unit **114** transmits the digital information to the companion device **119**. However, the input jack **120** of the companion device **119** typically expects analog signals. Because of this reason, the digital information to be transmitted is first passed through a signal shaping unit **115** before it is transmitted over the output jack **116**.

The signal shaping unit **115** may be a modulator resulting into a Modulated digital communication. A modulator modulates a locally generated analog signal carrier to encode the digital information for transmission. FSK modulation is one of the preferred modulation schemes. However, any other modulation scheme such as ASK, QPSK, MSK, MPSK, PSK etc may also be used. The analog signal which is used for modulation is generated locally by an analog circuitry like an oscillator comprising of

simple analog components such as capacitor and inductor, or a frequency generator such as VCO or a digital microcontroller followed by a low pass filter. Alternatively, the data may be transmitted serially over the output jack without first modulating it. In that case, the signal shaping unit **115** is an encoder that employs an encoding scheme such as Manchester encoding scheme for encoding the data prior to transmission. Any other encoding scheme may also be used. It must be noted that encoding is not compulsory for serial transmission of data, but is recommended to prevent channel saturation. The signal shaping unit may additionally contain an amplifier and/or a band pass filter for setting the amplitude and bandwidth of the modulated or encoded signal.

The output jack **116** is adapted to be inserted into the microphone input plug **120** of the companion device **119**. The companion device **119** may be a mobile phone, a computer, PDA or any other device having a microphone input line, provided either separately as microphone input port or as a headset port. The signal transmitted over the output jack **116** is send to the microphone input line of the companion device. A scheme, corresponding to the one implemented in the fingerprint reader device **110** is implemented in the signal shaping unit **121** of the companion device. This signal shaping unit **121** may also set amplitude and bandwidth of the received signals. The signal shaping unit **121** may be realised using hardware or software or both. The signal representative of the data stored on magnetic stripe card is finally received by the microcontroller **122** which might contain application software loaded into it for performing transactions and/or operations based upon the card details.

The fingerprint reader device **110** requires a power source **117** for its functioning. The power source **117** can be a battery (e.g. a button cell or coin cell of suitable ratings) to provide power for the device functioning. **Fig 1(c)** shows the back view of fingerprint reader **10**. It shows a battery **15** housed at the back of the housing **11**. Any other suitable form and positioning of the battery can be employed. The power source **15** may be rechargeable or a non-rechargeable battery. It might also be possible that the energy for device functioning is extracted from the audio port of the companion device **119.** . In this method of extracting energy from the companion device, the companion device produces audio frequencies which are sent via the audio output line to the companion device. This audio signal is sent to energy harvester circuit comprising of a step-up transformer, a rectifier and filters. In this

way, power is transferred to the fingerprint reader device from the companion device. Any of the left or right audio line may be used for sending audio signal to the energy harvester circuit. The power and voltage in fingerprint reader device **110** is regulated and monitored by a power management unit **118** also housed in the fingerprint reader device **110** housing.

The companion device **119** may also include components such as memory, including flash, ROM, SRAM, LCD driver, display, camera, battery, an antenna, a speaker, a keypad etc. for interacting with the user. For the sake of clarity, most of these components of the companion device **119** have not been shown.

The fingerprint reader device **110** may contain some driver ICs and additional circuitry for noise removal, buffering, voltage equalization etc. for proper functioning and integrator of various units described here.

The fingerprint capturing method of the fingerprint sensor **111** may either be capacitive, optical or any other type used in the act. A capacitive fingerprint sensor output signal response is electrical interactions between the embedded capacitor and the finger skin, which vary according to the print contour. The optical fingerprint sensor includes light emitting source that emits light and microphone sensors which capture the light emitted off the light emitting sensor and reflected off the finger.

Another variation may be in the surface type of fingerprint sensor. It may be area (touch) type fingerprint sensor or a swipe type fingerprint sensor. **Figure 1(a)** shows an area (touch) type fingerprint sensor **12** mounted on the fingerprint reader device **10**. The user needs to simply touch or place its finger **14** on the fingerprint sensor **12** of fingerprint reader device **10**, as shown in **Figure 1(b). Figure 1(d)** shows another type of fingerprint reader device **20** having a roll (swipe) type fingerprint sensor **21**. The user needs to roll its finger over the fingerprint sensor **21** to give its fingerprint.

Accompanying **Figure 3** shows another form of the fingerprint reader device according to the present invention. It differs from the fingerprint reader device **110** of **Fig 2** in the sense that it allows bi-directional communication between the fingerprint reader device **210** and the companion device **219**. The output jack **216**

of the magnetic card reader **210** is adapted to be inserted into the microphone and audio lines of the companion device. The control and processing unit **214** receives instructions from the companion device **219** to perform operations and sends data and information back to the companion device. The Signal shaping Unit **215** is a Modem (Modulator-Demodulator) or an Encoder-Decoder, with an amplifier and a band pass filter. The information to be transmitted to the companion device is modulated or encoded by signal shaping unit **215** and sent to the companion device **219** through its microphone input line. On the other hand, the information being transmitted from the companion device **219** is received from its audio output line and is demodulated or decoded inside the fingerprint reader **210** by the signal shaping unit **215**. The control and processing unit **214** receives and sends digital signal to the Signal shaping unit **215**. A corresponding Signal shaping unit **221** (comprising of a Modem or an encoder-decoder) is implemented in the companion device as well. Rest of the organization of the fingerprint reader **210** is same as of fingerprint reader **110**.

Any of the left or right audio out line may be used as the main communication line for sending data from companion device **219** to fingerprint reader device **210**. Similarly, in case of stereo microphone line, any of the available channels may be used for sending data from the fingerprint reader device to the companion device. The block diagram in above figures is just for the clarity of the architecture. A person skilled in the art can however combine, add, remove or substitute some of these while still attaining the same functionality. For example, the encryption might be performed using a dedicated hardware accelerator such as an encryption engine.

Another example is where the control and processing unit and the signal shaping unit are combined together and realized using a single microcontroller by making use of its software and hardware peripherals. **Figure 4** shows one such a possible approach where hardware features such as Timer and UART of a microcontroller are used to efficiently modulate and demodulate FSK signals. On the modulator side, data bits generated by UART transmitter **47** are fed back into microprocessor **44** interrupt line. A timer compare unit **45** generates the correct frequency (Tone Encoder **46**) according to the incoming bit from UART transmitter **47**. The output of timer compare unit **45** is passed through a low pass filter **52** before sending to the output jack of magnetic card reader device. On the demodulator side, the signal received

from the output jack of magnetic card reader device is AC coupled to a voltage divider **48** whose mid-point is set to a specific value. Zero crossing time of the signal is achieved by comparing the signal to this specific value in comparator **49**. In software, the time difference between rising and falling edges is calculated by edge time measurement unit **50** using timer. The result of this is then sent to receiver port of UART peripheral **53**. Another possible manner in which FSK modulation scheme can be implemented is pure software based approach in which FSK libraries are used on the microcontroller. Similarly, the Encoder of the signal shaping unit may also be implemented on the microcontroller itself.

The control and processing unit may be used to perform additional task of processing the raw fingerprint image to extract the minutiae point information of the captured fingerprint. In that case, only the minutiae point information is communicated to the companion device (in encrypted or unencrypted form). This form of the fingerprint reader device is of particular use at applications where only the minutiae point information is required to perform a matching operation. As evident, such a fingerprint reader whose output is minutiae point information may again be constructed in form to support either only one-direction transmission or bi-directional transmission.

Figure 5(a) shows another possible embodiment of fingerprint reader device. The fingerprint reader device **63** comprises of a housing **64**, a fingerprint sensor **67** mounted on the housing **64**, a cable **65** extending out of the housing **64** and a jack **66** at the other end of the cable **65**. The jack **66** is adapted to be inserted into the headset port of the companion device such as computer, mobile phones, PDA etc. Such an embodiment allows one to place the fingerprint reader at a location convenient to the user.

Figure 5(b) shows yet another embodiment of the fingerprint reader device. The fingerprint reader device **68** comprises of a housing **70**, a fingerprint sensor **69** mounted on the housing, a cable **71** extending out of the housing **71**, terminating in two jacks **71** & **72**, adapted to be inserted into the microphone input and audio output ports of the companion device. This embodiment will be particularly useful for devices such as laptops, which have separate ports for microphone and audio.

The fingerprint reader device according to the present invention can be constructed in various shapes and sizes, and is not limited only to the shapes shown in present disclosure. The fingerprint sensor may be mounted in any fashion on the fingerprint reader device, as long as the sensor surface of the fingerprint sensor is accessible to the user from outside for touching or swiping its finger. It may be understood that any known one or more common protocols may be employed for communication between various blocks shown in the schematic diagrams.

Figure 6 describes a method of use of the above disclosed fingerprint reader device **110**. The method **310** begins in step **311** in which the user touches or swipes its finger over the fingerprint sensor **111** of the fingerprint reader device **110**. As a result of the interaction between the finger skin and fingerprint sensor surface, the fingerprint sensor **111** generates a waveform representative of the fingerprint, as described in step **312**. The analog waveform generated by fingerprint sensor **111** in step **312** is sent through signal conditioning block **112** followed by ADC **113** in step **313** to convert it into a digital signal representative of the captured fingerprint. The control and processing unit **114** then process the digital fingerprint data and prepares data for transmission which may be raw fingerprint image or minutiae point information (step **314**). It may optionally encrypt the data as well. The data to be transmitted is modulated over an analog signal carrier by Signal shaping block **115** and then sent into the companion device through its microphone input line in step **315**. Once into the companion device **119**, the received signal is demodulated to get back the information in digital form (step **316**) which is finally used to perform a transaction or operation in step **317**.

Figure 7 shows a variation of above method for bi-directional communication. The method **510** begins in step **511** in which the user touches or swipes its finger over the fingerprint sensor **211** of the fingerprint reader device **210**. As a result of the interaction between the finger skin and fingerprint sensor surface, the fingerprint sensor **211** generates a waveform representative of the fingerprint, as described in step **512**. The analog waveform generated by fingerprint sensor **211** in step **512** is sent through signal conditioning block **212** followed by ADC **213** in step **513** to convert it into a digital signal representative of the captured fingerprint. In the next step **514**, the companion device **219** requests information from the fingerprint reader device **210** by sending instruction as a modulated signal from its audio output

line. The control and processing unit **214** of fingerprint reader **210** acts upon this instruction and processes the fingerprint data to extract the requested information (step **515**). In step **516**, the requested information (either encrypted or without encryption) is modulated over an analog carrier and sent into the companion device **219** through its microphone input line. The companion device **219** then demodulates the received signal to get back the information in digital form (step **517**) which is finally used to perform a transaction as shown in step **518**.

Figure 8 describes a method of use of the disclosed fingerprint reader device **110**. The method **410** begins in step **411** in which the user touches or swipes its finger over the fingerprint sensor **111** of the fingerprint reader device **110**. As a result of the interaction between the finger skin and fingerprint sensor surface, the fingerprint sensor **111** generates a waveform representative of the fingerprint, as described in step **412**. The analog waveform generated by fingerprint sensor **111** in step **412** is sent through signal conditioning block **112** followed by ADC **113** in step **413** to convert it into a digital signal representative of the captured fingerprint. The control and processing unit **114** then process the digital fingerprint data and prepares data for transmission which may be raw fingerprint image or minutiae point information (step **414**). It may optionally encrypt the data as well. The digital information to be transmitted is sent serially into the companion device **119** through its microphone input line (step **415)** as direct digital communication without any modulation. The digital information may be encoded prior to transmission using an encoding scheme such as Manchester encoding implemented in signal shaping block **115** to prevent channel saturation. Once into the companion device **119**, the received signal is decoded or reconstructed to get back the information in digital form (step **416**) which is finally used to perform a transaction or operation in step **417**.

Figure 9 shows a variation of above method for bi-directional communication. The method **610** begins in step **611** in which the user touches or swipes its finger over the fingerprint sensor **211** of the fingerprint reader device **210**. As a result of the interaction between the finger skin and fingerprint sensor surface, the fingerprint sensor **211** generates a waveform representative of the fingerprint, as described in step **612**. The analog waveform generated by fingerprint sensor **211** in step **612** is sent through signal conditioning block **212** followed by ADC **213** in step **613** to convert it into a digital signal representative of the captured fingerprint. In the next

step **614**, the companion device **219** sends instructions to the fingerprint reader **210** in digital form (optionally encoded by an encoding scheme such as Manchester Encoding) serially without any modulation from its audio output line. The control and processing unit **214** of fingerprint reader **210** acts upon this instruction and processes the fingerprint data to extract the requested information (step **615**). In step 6**16**, the requested information (either encrypted or without encryption) is sent serially (optionally encoded by an encoding scheme such as Manchester Encoding) without any modulation into the companion device **219** through its microphone input line. The companion device **219** then demodulates the received signal to get back the information in digital form (step **617**) which is finally used to perform a transaction as shown in step **618.**

The presently disclosed fingerprint reader can be used in conjunction with most of the electronic media such as mobile phones, computers etc to read raw fingerprint image or to get minutiae point information of a fingerprint. Use of the disclosed device eliminates the need of a dedicated fingerprint scanner for every new type of application. Only the application software loaded into the companion electronic device needs to be modified as per the application in hand.

It is thus possible by way of the present invention to providing a cost effective and user friendly fingerprint reader device adapted to be used in conjunction with a companion electronic device such as mobile phone, computer, PDA etc. using the microphone or audio port of the companion device involving unidirectional or bi-directional communication of information relating to captured fingerprint information and its processing for useful authentication and transaction purpose in a secured manner.

We Claim:

1. A device for fingerprint capturing and image/information retrieval based thereon comprising:
   a fingerprint sensor means wherein finger is touched or swiped, to produce a waveform representative of the fingerprint,

   a signal conditioning block and ADC to convert the waveform representative of fingerprint into digital signal,

   a control and processing unit to control the functioning and/or processing of the digital signals representative of the captured fingerprint in a form suitable for communication to or with a companion electronic device;

   a signal shaping unit adapted to facilitate the transmission of the information to the companion electronic device;

   means adapted for establishing operative communication with companion electronic device; and
   a power unit adapted to provide power for the functioning of the fingure print capturing and image/information retrieval device.

2. A device as claimed in claim 1 wherein said means adapted for establishing operative communication with companion electronic device comprise an output jack adapted to be inserted into a microphone or audio input line of a companion electronic device.

3. A device as claimed in anyone of claims 1 or 2 wherein the signal shaping unit adapted to facilitate the transmission of the information to the companion electronic device involves generation of modulated signal or encoding the digital information for direct serial transmission over the communication link

4. A device as claimed in anyone of the claim 1 to 3 wherein means adapted for establishing operative communication with companion electronic device involves a signal setting unit adapted to facilitate unidirectional or

bidirectional communication link between the reader device and the companion device comprising.

5. A device according to claim 3 wherein the said signal shaping unit is adapted for modulating and/or demodulating the digital information using any of the modulation scheme including ASK, QPSK, MSK, MPSK, PSK etc. preferably FSK modulation.

6. A device according to claim 3 wherein the said signal shaping unit is adapted for direct serial communication of the digital information to the companion device, with or without any encoding scheme such as Manchester Encoding.

7. A device as claimed in anyone of claim 1 to 6 wherein, analog signal used for modulation is generated locally by using an oscillator comprising of simple analog components such as capacitor and inductor, or a frequency generator such as VCO or a digital microcontroller followed by a low pass filter.

8. A device as claimed in anyone of the claim 1 to 7 wherein, the signal shaping unit additionally contain an amplifier and/or a band pass filter for setting the amplitude and bandwidth of the modulated or encoded signal.

9. A device as claimed in anyone of the claim 1 to 8 wherein the power unit preferably contains a battery or a socket to take power from an external source or means for extracting the energy for device functioning from the audio port of the companion device.

10. According to claim 9 wherein said means for extracting the energy from the companion device involves audio frequencies which are sent via the audio output line of the companion device to energy harvester circuit comprising of a step-up transformer, a rectifier and filters to provide power to the magnetic card reader device.

11. A device as claimed in anyone of the claim 1 to 10 wherein the control and processing Unit is adapted to provide a temporary buffer for temporary storage of the data.

12. A device as claimed in anyone of the claim 1 to 11 wherein the control and processing Unit additionally contain an encryption chip for encrypting and decrypting the data for secure communication through the communication link.

13. A device as claimed in anyone of claims 1 to 12 comprises of

a fingerprint sensor upon which finger is touched or swiped, to produce a waveform representative of the fingerprint;

a signal conditioning block and ADC to convert the waveform representative of fingerprint into digital signal;

a power unit to provide power for device functions;

a power management unit to regulate the power and voltage in the device;

a control and processing unit to control the functioning, process the digital signals representative of the captured fingerprint to generate a data structure (like an image) representative of the fingerprint and adapt the same to send it to the compression electronic device (either with or without encryption);

a signal shaping unit to modulate or encode the digital information for transmission as modulated signal or as direct digital serial communication;

an output jack adapted to be inserted into the microphone input line of companion electronic media including mobile phones, computer etc. to provide a channel for transfer of data and information from device to any companion electronic device.

14. A device as claimed in anyone of claims 1 to 12 comprises of

a fingerprint sensor upon which finger is touched or swiped, to produce a waveform representative of the fingerprint;

a signal conditioning block and ADC to convert the waveform representative of fingerprint into digital signal;

a power unit to provide power for device functions;

a power management unit to regulate the power and voltage in the device;

a control and processing unit to control the functioning of the device, process the digital signals representative of the captured fingerprint to generate a data structure (like an image) representative of the fingerprint and send it to the compression electronic device (either with or without encryption);

a signal shaping unit to send and receive the modulated signal or through serial direct digital transmission with or without encoding;

an output jack that acts a communication channel for bi-directional transfer of data between fingerprint reader device and any said companion electronic device.

15. A device as claimed in anyone of claims 1 to 12 comprises of

a fingerprint sensor upon which finger is touched or swiped, to produce a waveform representative of the fingerprint;

a signal conditioning block and ADC to convert the waveform representative of fingerprint into digital signal;

a power unit to provide power for device functions;

a power management unit to regulate the power and voltage in the device;

a control and processing unit to control the functioning of the device, process the digital signals representative of the captured fingerprint to extract minutiae point information of the fingerprint and send them to compression device in encrypted or unencrypted form;

a signal shaping unit to modulate or encode the digital information for transmission as modulated wave or as direct digital serial communication;

an output jack adapted to be inserted into the microphone input line of companion electronic media including mobile phones, computer etc. to provide a communication channel for transfer of data from the device to the companion electronic device.

16. A device as claimed in anyone of claims 1 to 12 comprises of

a fingerprint sensor upon which finger is touched or swiped, to produce a waveform representative of the fingerprint;

a signal conditioning block and ADC to convert the waveform representative of fingerprint into digital signal;

a power unit to provide power for device functions;

a power management unit to regulate the power and voltage in the device;

a control and processing unit to control the functioning of fingerprint reader device, process the digital signals representative of the captured fingerprint to

extract minutiae point information of the fingerprint and send them to compression device in encrypted or unencrypted form;

a signal shaping unit to send and receive the modulated signal or through serial direct digital transmission with or without encoding;

an output jack that acts a communication channel for bi-directional transfer of data between the device and any said companion electronic device.

17. A device as claimed in anyone of claims 1 to 16 wherein said control and processing unit comprise a single or separate microcontroller.

18. A system for transaction and operation based on processed fingerprint comprising :

(I) A device for fingerprint capturing and image/information retrieval based thereon comprising:

a fingerprint sensor means wherein finger is touched or swiped, to produce a waveform representative of the fingerprint,

a signal conditioning block and ADC to convert the waveform representative of fingerprint into digital signal,

a control and processing unit to control the functioning and/or processing of the digital signals representative of the captured fingerprint in a form suitable for communication to or with a companion electronic device;

signal shaping unit to modulate or encode the digital information for transmission as modulated wave or as direct digital serial communication

means adapted for connecting with companion electronic device; and

a power unit to provide power for device functions; and

(II) companion electronic media adapted for receiving the representative inputs of the said captured and processed fingerprint inputs from said

device for desired transaction and operation based on processed fingerprint.

19. A system as claimed in claim 18 comprising a channel for transfer of data and /or information from said device to said companion electronic device.

20. A system as claimed in anyone of claims 18 or 19 comprising a communication channel for transfer of data between said device and said companion electronic device.

21. A system as claimed in anyone of claims 18 to 20 wherein said means adapted for establishing operative communication with companion electronic device comprise an output jack adapted to be inserted into a microphone (and audio line for bi-directional communication) input line of said companion electronic device.

22. A system as claimed in anyone of claims 18 to 21 wherein said companion electronic device comprises
    a. provision for input jack or other cooperative connection with said device
    b. signal shaping unit realised using hardware or software or both adapted to set amplitude and bandwidth of the received signals
    c. microcontroller means adapted for performing or operations based upon the received signals.

23. A method transaction and operation based on processed fingerprint involving the system as claimed in anyone of claims 18 to 22 comprising

providing a fingerprint reader device comprising of a fingerprint sensor, a signal conditioning block and ADC, a power unit, a power management unit, a control and processing unit, a signal shaping block and an output jack; Touching or swiping of the finger over the fingerprint sensor;

Processing the captured fingerprint and extracting the information to be communicated (either raw fingerprint image or extracted minutiae points) to the companion electronic device;

Modulating the information to be transmitted over an analog carrier and sending it into the companion device through its microphone input line;

Demodulation of received signal inside the companion device, and using it for carrying a transaction.

24. A method transaction and operation based on processed fingerprint involving

the system as claimed in anyone of claims 18 to 22 comprising

providing a fingerprint reader device comprising of a fingerprint sensor, a signal conditioning block and ADC, a power source, a power management unit, a control and processing unit, a signal shaping block and an output jack;

Touching or swiping of the finger over the fingerprint sensor;

The companion electronic device requests information from the fingerprint reader by sending instructions as a modulated signal from its audio line;

Processing the captured fingerprint and extraction of the requested information by control and processing unit of fingerprint reader;

Modulating the information to be transmitted on an analog carrier and sending the modulated signal into the companion device through its microphone input line;

Demodulation of received signal inside the companion device, and using it for carrying a transaction.

25. A method transaction and operation based on processed fingerprint involving the system as claimed in anyone of claims 18 to 22 comprising

providing a fingerprint reader device comprising of a fingerprint sensor, a signal conditioning block and ADC, a power source, a power management unit, a control and processing unit, a signal shaping block and output jack;

Touching or swiping of the finger over the fingerprint sensor;

Processing the captured fingerprint and extracting the information to be communicated to the companion electronic device;

serial direct transmission of digital information without any modulation (the digital information may be encoded using an encoding scheme such as Manchester encoding before transmission) into the microphone input line of the companion device;

Decoding or reconstructing the received signal inside the companion device, and using it for carrying a transaction.

26. A method transaction and operation based on processed fingerprint involving the system as claimed in anyone of claims 18 to 22 comprising

providing a fingerprint reader device comprising of a fingerprint sensor, a signal conditioning block and ADC, a power source, a power management unit, a control and processing unit, a signal shaping block and an output jack;

Touching or swiping of the finger over the fingerprint sensor;

The companion electronic device requests information from the fingerprint reader by sending instructions in digital form (optionally encoded) serially from its audio line;

Processing the captured fingerprint and extraction of the requested Information by control and processing unit of fingerprint reader;

The requested information is sent serially (optionally encoded with an encoding scheme such as Manchester encoding) without any modulation, into the companion device through is microphone input line;

Decoding or reconstruction of received signal inside the companion device, and using it for carrying a transaction.

27. A system according to claim 22 wherein the companion device such as mobile phone having suitable application software loaded in it adapted to use the fingerprint details for doing an operation.

Dated this the 3rd day of December, 2012

GUPTA, Nalin

GUPTA, Shailesh

ABSTRACT

TITLE: A FINGERPRINT READER DEVICE AND METHOD OF USE.

A fingerprint reader device for reading fingerprint of any user is disclosed and a system where the fingerprint reader device is adapted to be used in conjunction with a companion electronic device such as mobile phone, computer, PDA etc. and a method of use of such system for desired transaction/operation. The fingerprint reader according to the present invention captures the fingerprint of a user, processes it and sends the useful data (with or without encryption) to the companion device via an output jack adapted to be inserted into the microphone port of the companion device. Bi-directional communication with the companion device is also disclosed where the companion device sends signal containing information to the fingerprint reader from its audio output line. The fingerprint reader device is thus having prospects of user friendly application in wide scale for effecting secured transactions/operations for a variety of purposes.
(Figure 2)

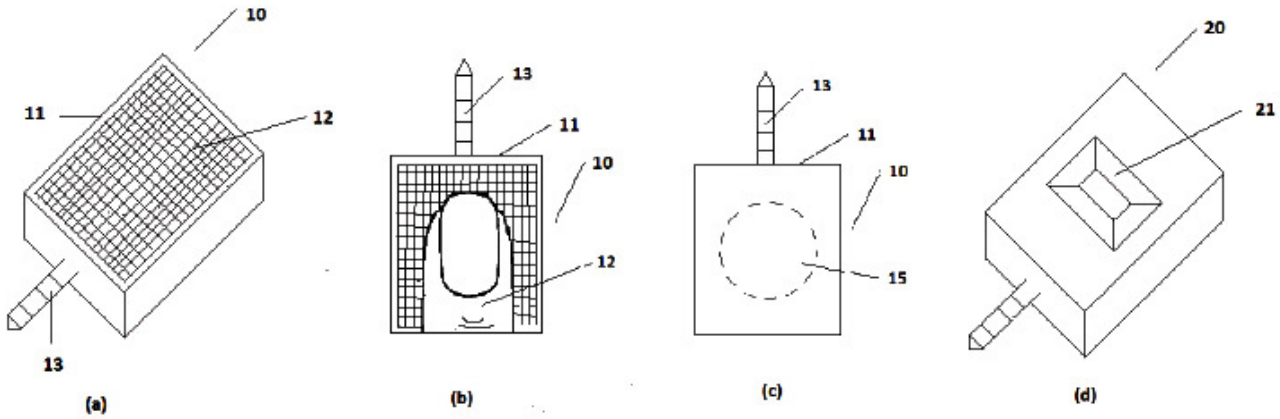

Fig. 1

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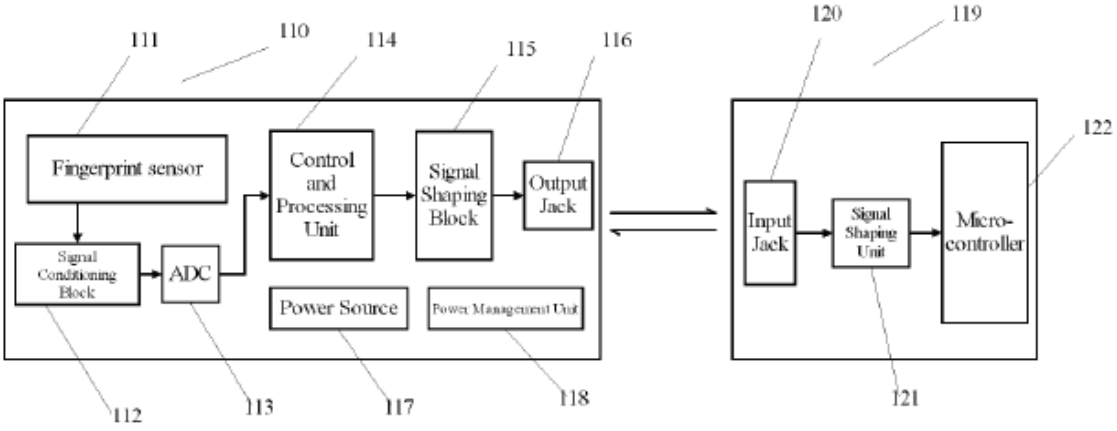

Fig. 2

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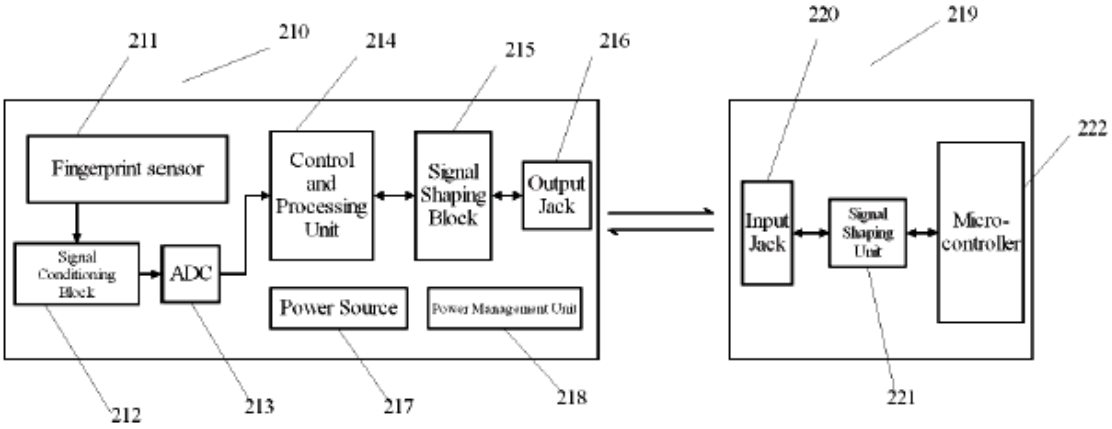

Fig. 3

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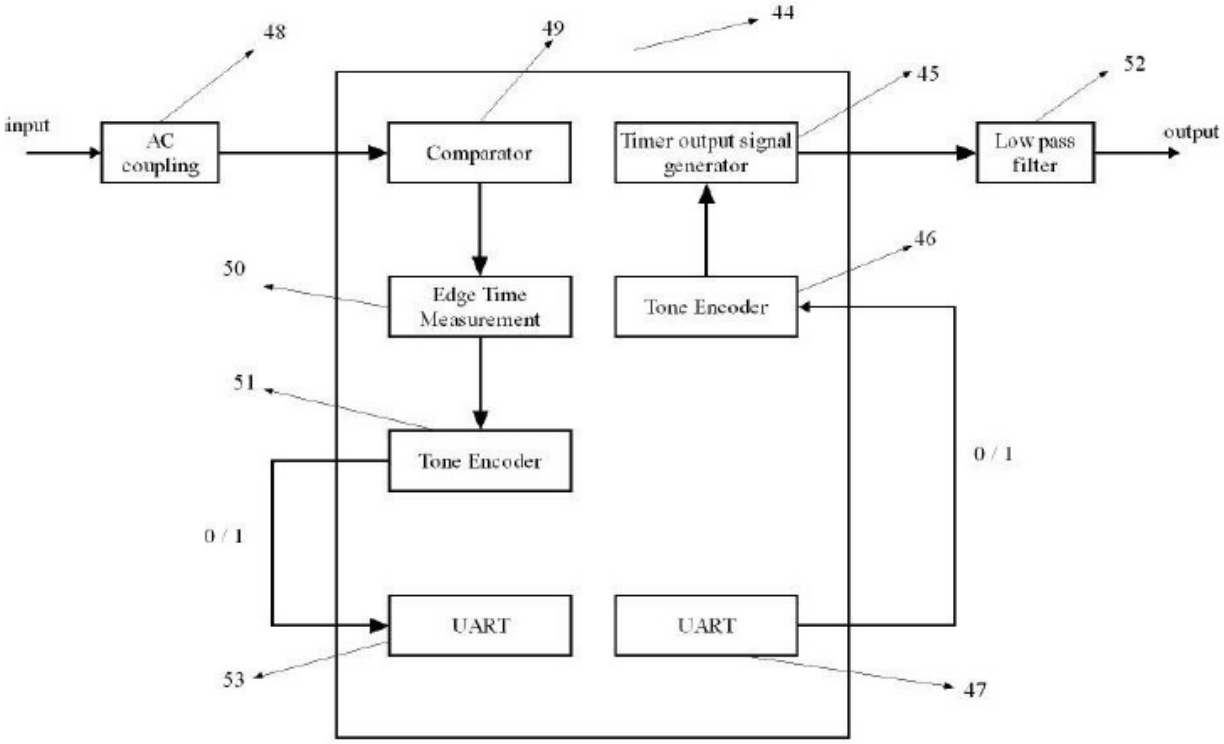

Fig. 4

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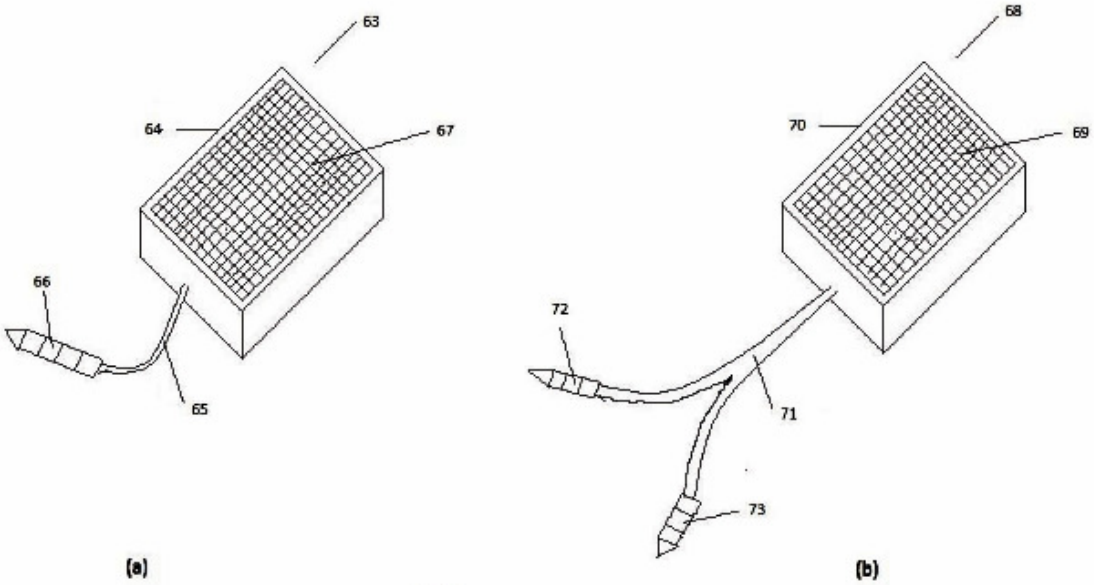

Fig 5

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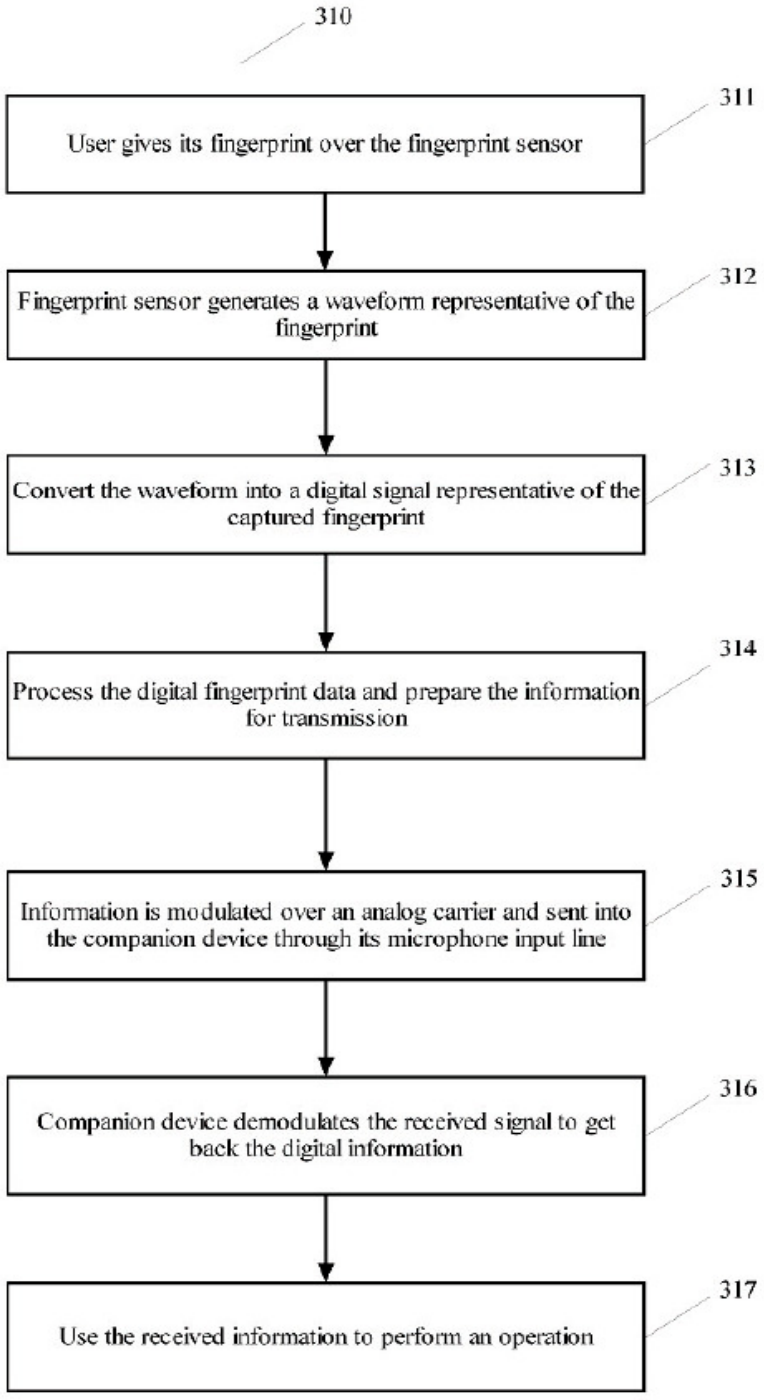

Fig 6

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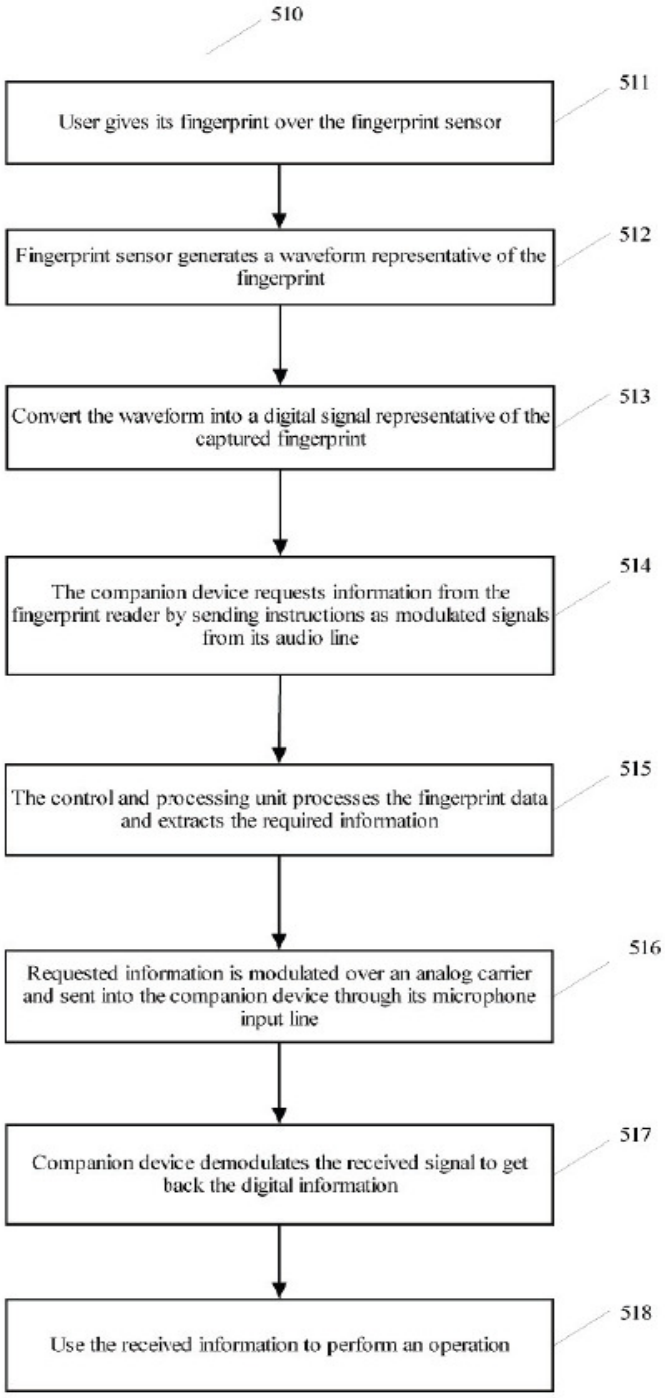

Fig. 7

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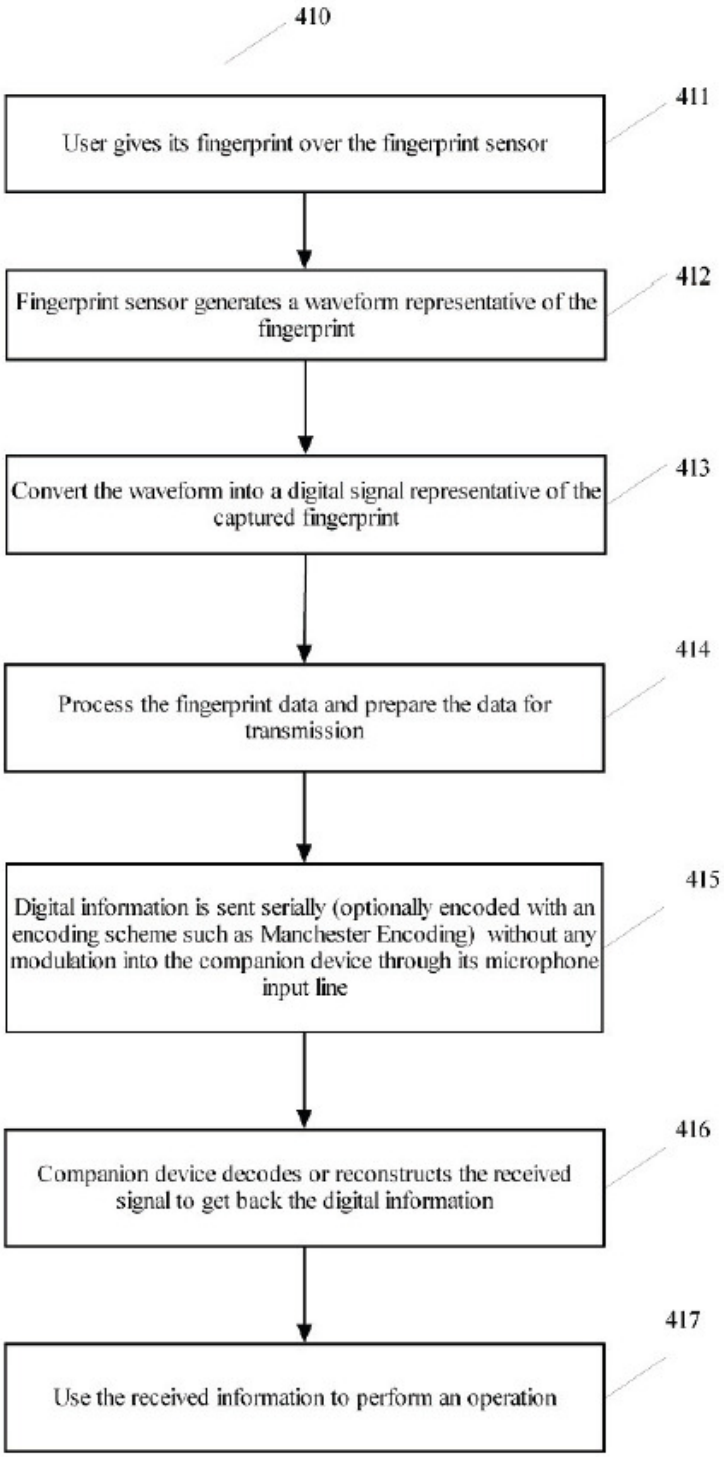

Fig. 8

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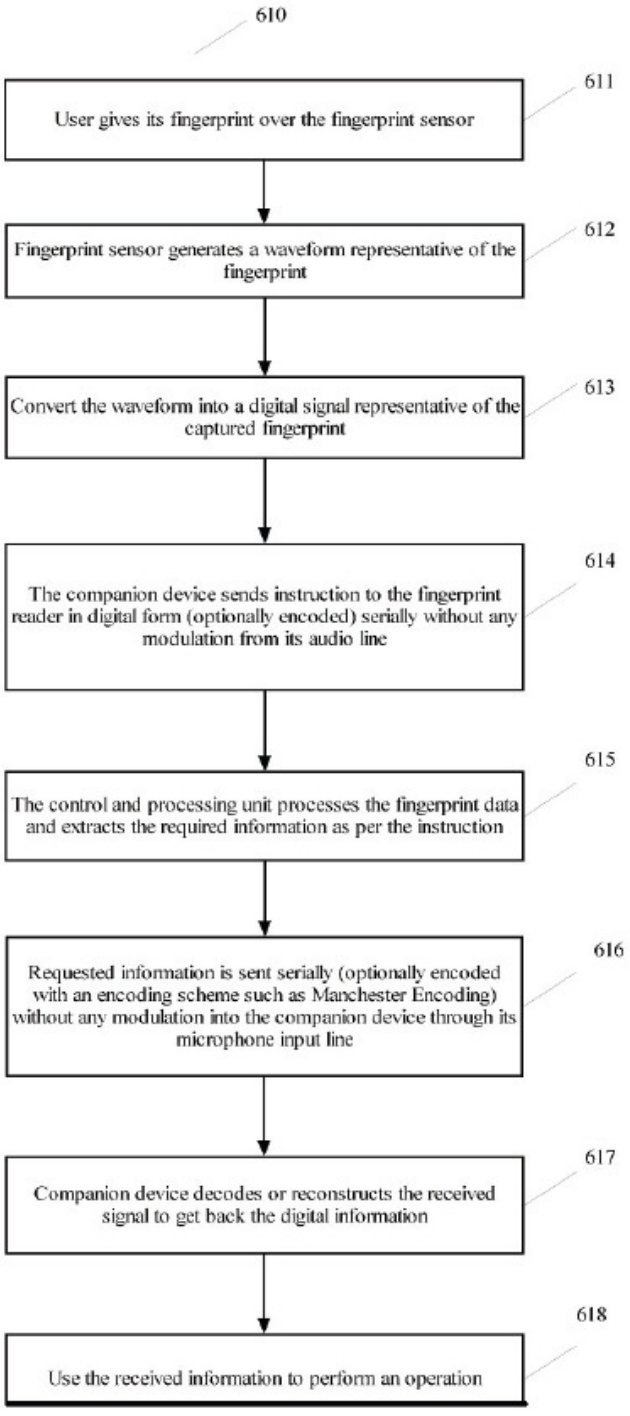

Fig. 9

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FORM 5

THE PATENTS ACT,1970
(39 of 1970)
&
THE PATENTS RULES,2003

DECLARATION AS TO INVENTORSHIP

[See Section 10(6) and rule 13(6)]

1. We, **GUPTA, Nalin**; An Indian Citizen; B-111, RK Hall of Residence, IIT Kharagpur, Kharagpur-721302, West Bengal, India; **GUPTA, Shailesh;** An Indian Citizen;C-109, Azad Hall of Residence, IIT Kharagpur, Kharagpur-721302, West Bengal, India

hereby declare that the true and first inventors of the invention disclosed in the complete specification filed in pursuance of our application numbered 1521/KOL/2011 dated 03.12.2011
are

2. INVENTOR(S)

1. (a) Name : **GUPTA, NALIN;**
   (b) Nationality : An Indian Citizen;
   (c) Address : B-111, RK Hall of Residence, IIT Kharagpur, Kharagpur-721302, West Bengal, India

2. (a) Name : **GUPTA, SHAILESH;**
   (b) Nationality : An Indian Citizen;
   (c) Address : C-109, Azad Hall of Residence, IIT Kharagpur, Kharagpur-721302, West Bengal, India

Dated this 3rd day of December, 2012

Signature 

Name of the signatory **NALIN GUPTA**

Name of the signatory **SHAILESH GUPTA**

~~**3. DECLARATION TO BE GIVEN WHEN THE APPLICATION IN INDIA IS FILED BY THE APPLICANT(S) IN THE CONVENTION COUNTRY:-**~~

~~We the applicant(s) in the convention country hereby declare that our right to apply for a patent in India is by way or assignment from the true and first inventor(s).~~

~~Dated this day of 2009~~

~~Signature~~

~~Name of the signatory~~

~~**4. STATEMENT** (to be signed by the additional inventor(s) not mentioned in the application form)~~

~~I/We assent to the invention referred to in the above declaration, being included in the complete specification filed in pursuance of the stated application.~~

To,
The Contoller of Patent
The Patent Office
Kolkata