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Giobbi

(10) **Patent No.: US 9,298,905 B1**
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(54) **BIOMETRIC PERSONAL DATA KEY (PDK) AUTHENTICATION**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

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G06F 21/35 (2013.01)
G06F 21/32 (2013.01)

(52) **U.S. Cl.**
CPC ***G06F 21/35*** (2013.01); ***G06F 21/32*** (2013.01)

(58) **Field of Classification Search**
CPC combination set(s) only.
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,759,060 A 7/1988 Hayashi et al.
4,993,068 A 2/1991 Piosenka et al.
5,187,352 A 2/1993 Blair et al.
5,296,641 A 3/1994 Stelzl
5,392,433 A 2/1995 Hammersley et al.
(Continued)

FOREIGN PATENT DOCUMENTS

WO WO 00/62505 10/2000
WO WO 01/22724 3/2001
(Continued)

OTHER PUBLICATIONS

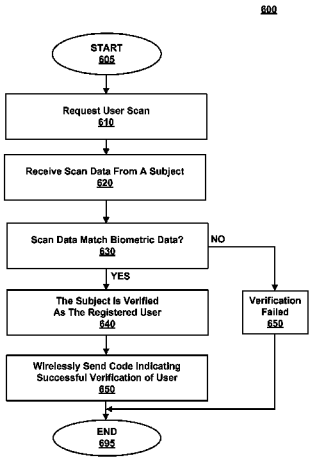
"Alliance Activities: Publications: Identity—Smart Card Alliance," Smart Card Alliance, 1997-2007, Retrieved on Jan. 7, 2007 from <URL:http://www.smartcardalliance.org/pages/publications-identity>, 3 pgs.
(Continued)

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(74) *Attorney, Agent, or Firm* — Patent Law Works LLP

(57) **ABSTRACT**

Systems and methods verifying a user during authentication of an integrated device. In one embodiment, the system includes an integrated device and an authentication unit. The integrated device stores biometric data of a user and a plurality of codes and other data values comprising a device ID code uniquely identifying the integrated device and a secret decryption value in a tamper proof format, and when scan data is verified by comparing the scan data to the biometric data, wirelessly sends one or more codes and other data values including the device ID code. The authentication unit receives and sends the one or more codes and the other data values to an agent for authentication, and receives an access message from the agent indicating that the agent successfully authenticated the one or more codes and other data values and allows the user to access an application.

18 Claims, 6 Drawing Sheets



MICROSOFT-1001

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,416,780	A	5/1995	Patel	
5,422,632	A	6/1995	Bucholtz et al.	
5,450,489	A	9/1995	Ostrover et al.	
5,619,251	A	4/1997	Kuroiwa et al.	
5,629,980	A	5/1997	Stefik et al.	
5,644,354	A	7/1997	Thompson et al.	
5,666,412	A	9/1997	Handelman et al.	
5,784,464	A	7/1998	Akiyama et al.	
5,825,876	A	10/1998	Peterson, Jr.	
5,857,020	A	1/1999	Peterson, Jr.	
5,892,825	A	4/1999	Mages et al.	
5,894,551	A	4/1999	Huggins et al.	
5,898,880	A	4/1999	Ryu	
5,917,913	A	6/1999	Wang	
5,928,327	A	7/1999	Wang et al.	
5,991,399	A	11/1999	Graunke et al.	
5,991,749	A	11/1999	Morril, Jr.	
6,016,476	A	1/2000	Maes et al.	
6,018,739	A	1/2000	McCoy et al.	
6,035,038	A	3/2000	Campinos et al.	
6,035,329	A	3/2000	Mages et al.	
6,038,334	A	3/2000	Hamid	
6,041,410	A *	3/2000	Hsu et al.	713/186
6,042,006	A	3/2000	Van Tilburg et al.	
6,055,314	A	4/2000	Spies et al.	
6,070,796	A	6/2000	Sirbu	
6,088,730	A	7/2000	Kato et al.	
6,104,334	A	8/2000	Allport	
6,121,544	A	9/2000	Petsinger	
6,148,142	A	11/2000	Anderson	
6,161,179	A	12/2000	Seidel	
6,185,316	B1	2/2001	Buffam	
6,209,089	B1	3/2001	Selitrennikoff et al.	
6,219,109	B1	4/2001	Raynesford et al.	
6,219,439	B1	4/2001	Burger	
6,247,130	B1	6/2001	Fritsch	
6,256,737	B1 *	7/2001	Bianco	G07C 9/00158 713/186
6,266,415	B1	7/2001	Campinos et al.	
6,295,057	B1	9/2001	Rosin et al.	
6,336,121	B1	1/2002	Lyson et al.	
6,336,142	B1	1/2002	Kato et al.	
6,363,485	B1	3/2002	Adams et al.	
6,367,019	B1	4/2002	Ansell et al.	
6,381,747	B1	4/2002	Wonfor et al.	
6,385,596	B1	5/2002	Wiser et al.	
6,392,664	B1	5/2002	White et al.	
6,397,387	B1	5/2002	Rosin et al.	
6,401,059	B1	6/2002	Shen et al.	
6,411,307	B1	6/2002	Rosin et al.	
6,424,715	B1	7/2002	Saito	
6,425,084	B1	7/2002	Rallis et al.	
6,434,535	B1	8/2002	Kupka et al.	
6,446,130	B1	9/2002	Grapes	
6,463,534	B1	10/2002	Geiger et al.	
6,480,188	B1	11/2002	Horsley	
6,490,443	B1	12/2002	Freeny, Jr.	
6,510,350	B1	1/2003	Steen, III et al.	
6,523,113	B1	2/2003	Wehrenberg	
6,529,949	B1	3/2003	Getsin et al.	
6,546,418	B2	4/2003	Schena et al.	
6,550,011	B1	4/2003	Sims, III	
6,563,805	B1	5/2003	Ma et al.	
6,564,380	B1	5/2003	Murphy	
6,628,302	B2	9/2003	White et al.	
6,632,992	B2	10/2003	Hasegawa	
6,647,417	B1	11/2003	Hunter et al.	
6,657,538	B1 *	12/2003	Ritter	G06F 21/32 340/5.8
6,667,684	B1	12/2003	Waggamon et al.	
6,683,954	B1	1/2004	Searle	
6,697,944	B1	2/2004	Jones et al.	
6,709,333	B1	3/2004	Bradford et al.	
6,711,464	B1	3/2004	Yap et al.	
6,775,655	B1	8/2004	Peinado et al.	
6,804,825	B1	10/2004	White et al.	
6,806,887	B2	10/2004	Chernock et al.	
6,850,147	B2	2/2005	Prokoski et al.	
6,853,988	B1 *	2/2005	Dickinson	G06F 21/32 380/277
6,873,975	B1	3/2005	Hatakeyama et al.	
6,950,941	B1	9/2005	Lee et al.	
6,963,971	B1	11/2005	Bush et al.	
6,973,576	B2	12/2005	Giobbi	
6,975,202	B1	12/2005	Rodriguez et al.	
6,983,882	B2	1/2006	Cassone	
7,012,503	B2	3/2006	Nielsen	
7,090,126	B2	8/2006	Kelly et al.	
7,112,138	B2	9/2006	Hedrick et al.	
7,137,012	B1	11/2006	Kamibayashi et al.	
7,191,466	B1	3/2007	Hamid et al.	
7,218,944	B2	5/2007	Cromer et al.	
7,249,177	B1	7/2007	Miller	
7,305,560	B2	12/2007	Giobbi	
7,529,944	B2	5/2009	Hamid	
7,574,734	B2	8/2009	Fedronic et al.	
7,587,611	B2	9/2009	Johnson et al.	
7,617,523	B2	11/2009	Das et al.	
7,644,443	B2	1/2010	Matsuyama et al.	
7,715,593	B1	5/2010	Adams et al.	
7,883,417	B2	2/2011	Bruzzese et al.	
7,904,718	B2	3/2011	Giobbi et al.	
2001/0026619	A1	10/2001	Howard et al.	
2001/0044337	A1	11/2001	Rowe et al.	
2002/0007456	A1	1/2002	Peinado et al.	
2002/0013772	A1	1/2002	Peinado	
2002/0014954	A1	2/2002	Fitzgibbon et al.	
2002/0015494	A1	2/2002	Nagai et al.	
2002/0023032	A1	2/2002	Pearson et al.	
2002/0026424	A1	2/2002	Akashi	
2002/0056043	A1 *	5/2002	Glass	G06F 21/32 713/179
2002/0071559	A1	6/2002	Christensen et al.	
2002/0073042	A1	6/2002	Maritzen et al.	
2002/0091646	A1 *	7/2002	Lake	G06Q 20/04 705/67
2002/0098888	A1	7/2002	Rowe et al.	
2002/0103027	A1	8/2002	Rowe et al.	
2002/0104006	A1	8/2002	Boate et al.	
2002/0108049	A1	8/2002	Xu et al.	
2002/0109580	A1	8/2002	Shreve et al.	
2002/0116615	A1	8/2002	Nguyen et al.	
2002/0129262	A1	9/2002	Kutaragi et al.	
2002/0138767	A1	9/2002	Hamid et al.	
2002/0140542	A1	10/2002	Prokoski et al.	
2002/0144117	A1	10/2002	Faigle	
2002/0150282	A1	10/2002	Kinsella	
2002/0152391	A1	10/2002	Willins et al.	
2002/0158750	A1	10/2002	Almalik	
2002/0174348	A1	11/2002	Ting	
2002/0178063	A1	11/2002	Gravelle et al.	
2002/0191816	A1	12/2002	Maritzen et al.	
2003/0036425	A1	2/2003	Kaminkow et al.	
2003/0046552	A1	3/2003	Hamid	
2003/0054868	A1	3/2003	Paulsen et al.	
2003/0054881	A1	3/2003	Hedrick et al.	
2003/0055689	A1	3/2003	Block et al.	
2003/0079133	A1	4/2003	Breiter et al.	
2003/0115474	A1	6/2003	Khan et al.	
2003/0127511	A1	7/2003	Kelly et al.	
2003/0139190	A1	7/2003	Steelberg et al.	
2003/0149744	A1	8/2003	Bierre et al.	
2003/0172037	A1	9/2003	Jung et al.	
2003/0176218	A1	9/2003	LeMay et al.	
2003/0186739	A1	10/2003	Paulsen et al.	
2004/0123127	A1	6/2004	Teicher et al.	
2004/0127277	A1	7/2004	Walker et al.	
2004/0128162	A1 *	7/2004	Schlotterbeck et al.	705/2
2004/0129787	A1	7/2004	Saito et al.	
2004/0209690	A1	10/2004	Bruzzese et al.	
2004/0209692	A1	10/2004	Schober et al.	
2004/0215615	A1	10/2004	Larsson et al.	
2004/0230488	A1	11/2004	Beenau et al.	
2005/0054431	A1	3/2005	Walker et al.	

(56) **References Cited**

U.S. PATENT DOCUMENTS

2005/0074126	A1*	4/2005	Stanko	380/279
2005/0081040	A1	4/2005	Johnson et al.	
2005/0109836	A1	5/2005	Ben-Aissa	
2005/0229007	A1	10/2005	Bolle et al.	
2005/0251688	A1	11/2005	Nanavati et al.	
2005/0253683	A1	11/2005	Lowe	
2006/0022046	A1	2/2006	Iwamura	
2006/0058102	A1	3/2006	Nguyen et al.	
2006/0063575	A1	3/2006	Gatto et al.	
2006/0076401	A1	4/2006	Frerking	
2006/0113381	A1	6/2006	Hochstein et al.	
2006/0156027	A1	7/2006	Blake	
2007/0032288	A1	2/2007	Nelson et al.	
2007/0060319	A1	3/2007	Block et al.	
2007/0159301	A1	7/2007	Hirt et al.	
2007/0213048	A1	9/2007	Trauberg	
2007/0219926	A1	9/2007	Korn	
2007/0220272	A1	9/2007	Campisi et al.	
2008/0008359	A1	1/2008	Beenau et al.	
2008/0019578	A1	1/2008	Saito et al.	
2008/0188308	A1	8/2008	Shepherd et al.	
2009/0328182	A1	12/2009	Malakapalli et al.	
2010/0117794	A1	5/2010	Adams et al.	
2011/0126188	A1	5/2011	Bernstein et al.	
2013/0019295	A1*	1/2013	Park	H04L 9/3213 726/7
2013/0111543	A1*	5/2013	Brown	H04L 63/0884 726/1
2013/0276140	A1*	10/2013	Coffing	H04L 12/5895 726/27
2013/0331063	A1*	12/2013	Cormier	H04L 63/0272 455/411

FOREIGN PATENT DOCUMENTS

WO	WO 01/75876	10/2001
WO	WO 01/77790	10/2001
WO	WO 2005/050450	6/2005
WO	WO 2005/086802	9/2005

OTHER PUBLICATIONS

Amr Farouk, Ahmed A. Abdelhafez, "Authentication Mechanisms in Grid Computing Environment: Comparative Study," IEEE, 2012, pp. 1-6.

Antonoff, Michael, "Visiting Video Valley," Sound & Vision, Nov. 2001, pp. 116, 118-119.

"Applying Biometrics to Door Access," Security Magazine, Sep. 26, 2002, Retrieved on Jan. 7, 2007, from <URL:http://www.securitymagazine.com/CDA/Articles/technologies/3ae610eaa34d8010VgnVCM100000f932a8c0_>, 5 pgs.

BioPay, LLC, "Frequently Asked Questions (FAQs) About BioPay," BioPay, LLC, 2007, Retrieved on Jan. 7, 2007, from <URL:http://www.biopay.com/faqs-lowes.asp>, 5 pgs.

Blum, Jonathan, "Digital Rights Management May Solver the Napster "Problem"," Technology Investor Industrysector, Oct. 2000, pp. 24-27.

Debow, Yvette, "Credit/Debit Debuts in Midwest Smart Card Test," Computers in Banking, v6, n11, Nov. 1989, 4 pgs.

Dennis, Sylvia, "Digital Passports Need Not Infringe Civil Liberties," Newsbytes, Dec. 2, 1999, 2 pgs.

Fasca, Chad, "The Circuit," Electronic News, vol. 45 Iss. 45, Nov. 8, 1999, 2 pgs.

"Firecrest Shows How Truly Commercially-Minded Companies Will Exploit the Internet," Computergram International, Jan. 18, 1996, 2 pgs.

Kontzer, Tony, "Thomson Bets on Smart Cards for Video Encryption," www.informationweek.com, Jun. 7, 2001, 1 pg.

Lake, Matt, "Downloading for Dollars," Sound & Vision, Nov. 2000, pp. 137-138.

Lewis, Peter H., "Sony and Visa in On-Line Entertainment Venture," New York Times, v145, Nov. 16, 1995, 1 pg.

McIver, R. et al., "Identification and Verification Working Together," Bioscrypt, Aug. 27, 2004, Retrieved on Jan. 7, 2007, from <URL:http://www.ibia.org/membersadmin/whitepapers/pdf/15/Identification%20and%20 Verification%20Working%20Together.pdf>, 5 pgs.

"Micronas and Thomson Multimedia Showcase a New Copy Protection System that Will Drive the Future of Digital Television," www.micronas.com, Jan. 8, 2002, 3 pgs.

Nilsson, J. et al., "Match-On-Card for Java Cards," Precise Biometrics, White Paper, Apr. 2004, Retrieved on Jan. 7, 2007, from <URL:http://www.ibia.org/membersadmin/whitepapers/pdf/17/Precise%20Match-on-Card%20for%20Java%20Cards.pdf>, 5 pgs.

Nordin, B., "Match-On-Card Technology," Precise Biometrics, White Paper, Apr. 2004, Retrieved on Jan. 7, 2007, from <URL:http://www.ibia.org/membersadmin/whitepapers/pdf/17/Precise%Match-on-Card%20technology.pdf>, 7 pgs.

Paget, Paul, "The Security Behind Secure Extranets," Enterprise Systems Journal, Dec. 1999, 4 pgs.

PCT International Search Report, PCT/US04/38124, Apr. 7, 2005, 10 pgs.

PCT International Search Report, PCT/US05/43447, Feb. 22, 2007, 7 pgs.

PCT International Search Report, PCT/US05/46843, Mar. 1, 2007, 10 pgs.

PCT International Search Report, PCT/US07/11102, Oct. 3, 2008, 11 pgs.

PCT International Search Report, PCT/US07/11103, Apr. 23, 2008, 9 pgs.

PCT International Search Report, PCT/US07/11104, Jun. 26, 2008, 9 pgs.

PCT International Search Report, PCT/US07/11105, Oct. 20, 2008, 10 pgs.

Pope, "Oasis Digital Signature Services: Digital Signing without the Headaches," Internet Computing—IEEE, vol. 10, Oct. 2006, pp. 81-84.

"SAFModuleTM: A Look Into Strong Authentication," saflink Corporation, Retrieved on Jan. 7, 2007, from <URL:http://www.ibia.org/membersadmin/whitepapers/pdf/6/SAFmod_WP.pdf>, 8 pgs.

Sapsford, Jathon, "E-Business: Sound Waves Could Help Ease Web-Fraud Woes," Wall Street Journal, Aug. 14, 2000, 2 pgs.

"Say Hello to Bluetooth," Bluetooth Web site, Jun. 2000, 4 pgs.

"Smart Cards and Biometrics White Paper," Smart Card Alliance, May 2002, Retrieved on Jan. 7, 2007, from <URL: http://www.securitymanagement.com/library/smartcard_faqtech0802.pdf>, 7 pgs.

"Thomson Multimedia Unveils Copy Protection Proposal Designed to Provide Additional Layer of Digital Content Security," www.thompson-multimedia.com, May 30, 2001, 2 pgs.

Van Winkle, William, "Bluetooth, the King of Connectivity," Laptop Buyer's Guide and Handbook, Jan. 2000, pp. 148-153.

Wade, Will, "Using Fingerprints to Make Payments at POS Slowly Gaining Popularity," Credit Union Journal, International Biometric Group, Apr. 21, 2003, Retrieved on Jan. 7, 2007, from <URL:http://www.biometricgroup.com/in_the_news/04.21.03.html>, 3 pgs.

Wallace, Bob, "The Internet Unplugged," InformationWeek.com, Dec. 13, 1999, pp. 22-24.

Weber, Thomas E., "In the Age of Napster, Protecting Copyright is a Digital Arms Race," Wall Street Journal, Jul. 24, 2000, 3 pgs.

"What is a File?," Apr. 30, 1998, URL: http://unixhelp.ed.ac.uk/editors/whatisafile.html, accessed Mar. 11, 2010 via http://waybackmachine.org/1998061500000* /http://unixhelp.ed.ac.uk/editors/whatisafile.html, 1 pg.

Yoshida, Junko, "Content Protection Plan Targets Wireless Home Networks," www.eetimes.com, Jan. 11, 2002, 2 pgs.

Simon Liu and Mark Silverman. 2001. "A Practical Guide to Biometric Security Technology". IT Professional 3, 1 (Jan. 2001). 27-32. DOI=10. 1109/6294.899930 http://dx.doi.org/10.1109/6294.899930.

Smart Card Alliance Report, "Contactless Technology for Secure Physical Access: Technology and Standards Choices", Smart Card Alliance, Oct. 2002, p. 1-48.

* cited by examiner

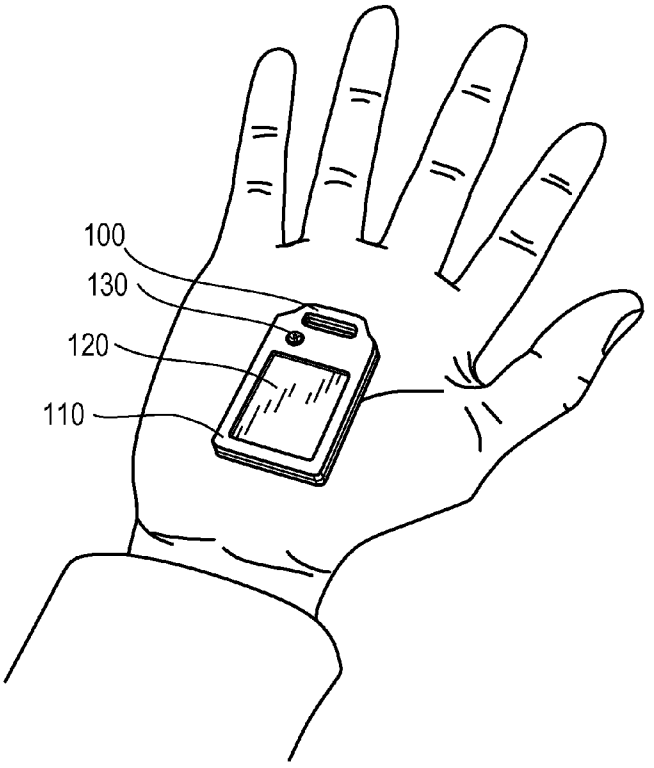

100
130
120
110

FIG. 1

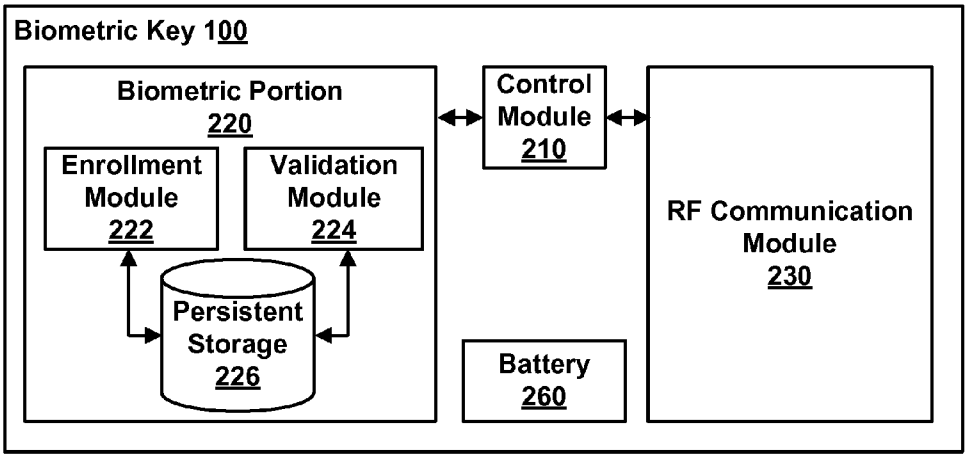

Biometric Key 100
Biometric Portion 220
Enrollment Module 222
Validation Module 224
Persistent Storage 226
Control Module 210
Battery 260
RF Communication Module 230

FIG. 2

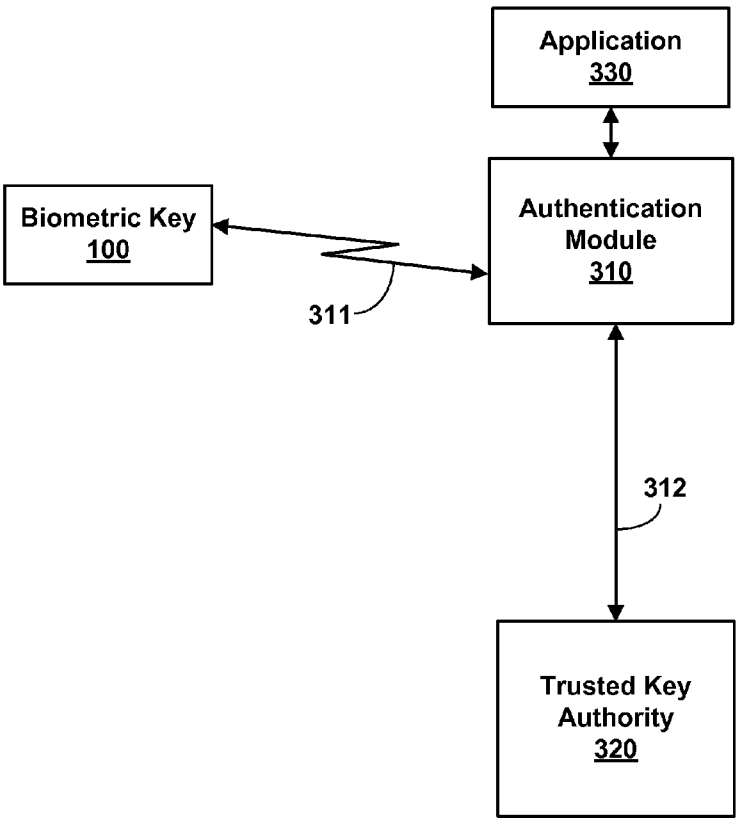

Application
330
Biometric Key
100
Authentication
Module
310
311
312
Trusted Key
Authority
320

FIG. 3

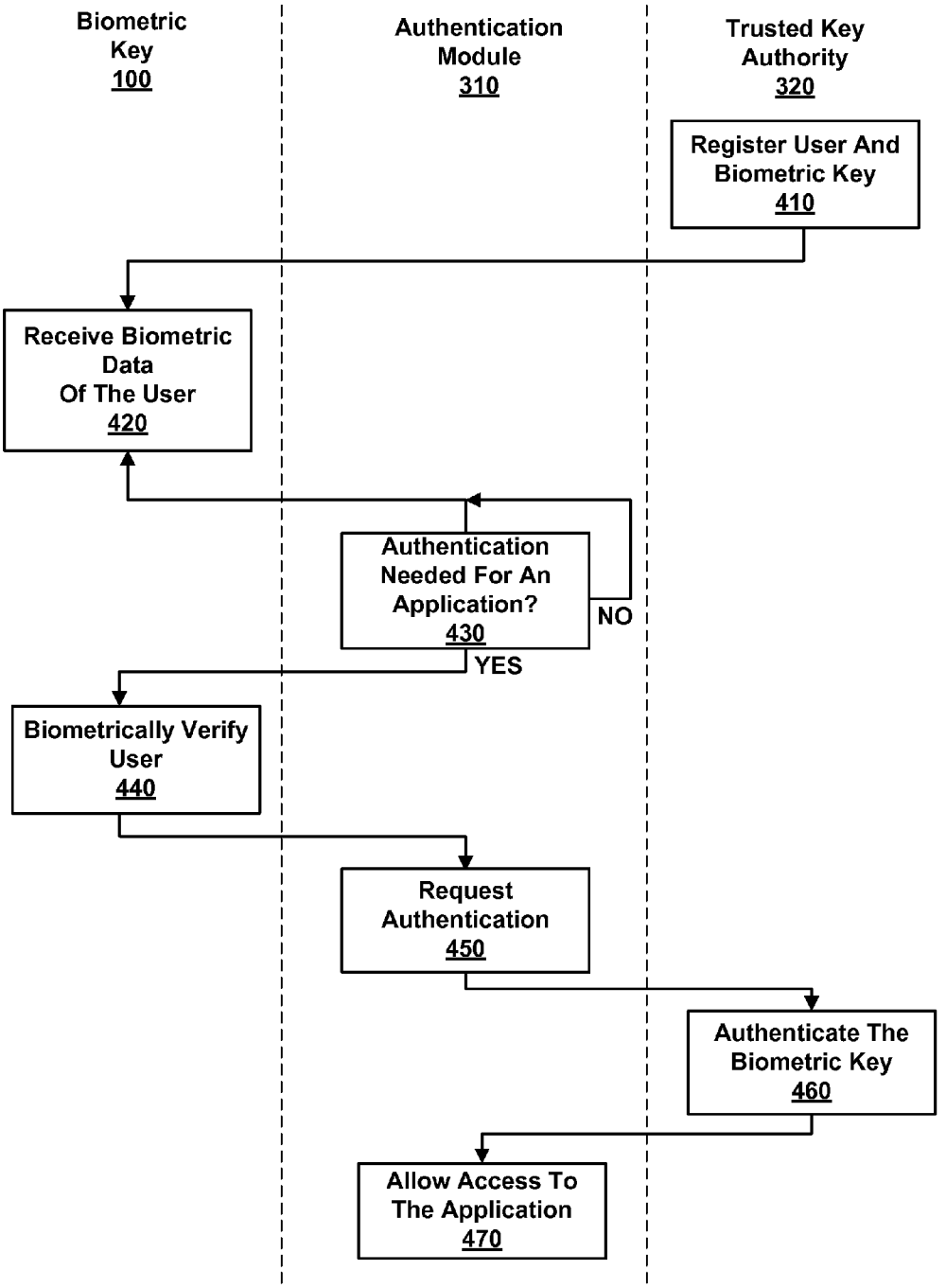

Biometric Key 100
Authentication Module 310
Trusted Key Authority 320
Register User And Biometric Key 410
Receive Biometric Data Of The User 420
Authentication Needed For An Application? 430
NO
YES
Biometrically Verify User 440
Request Authentication 450
Authenticate The Biometric Key 460
Allow Access To The Application 470

FIG. 4

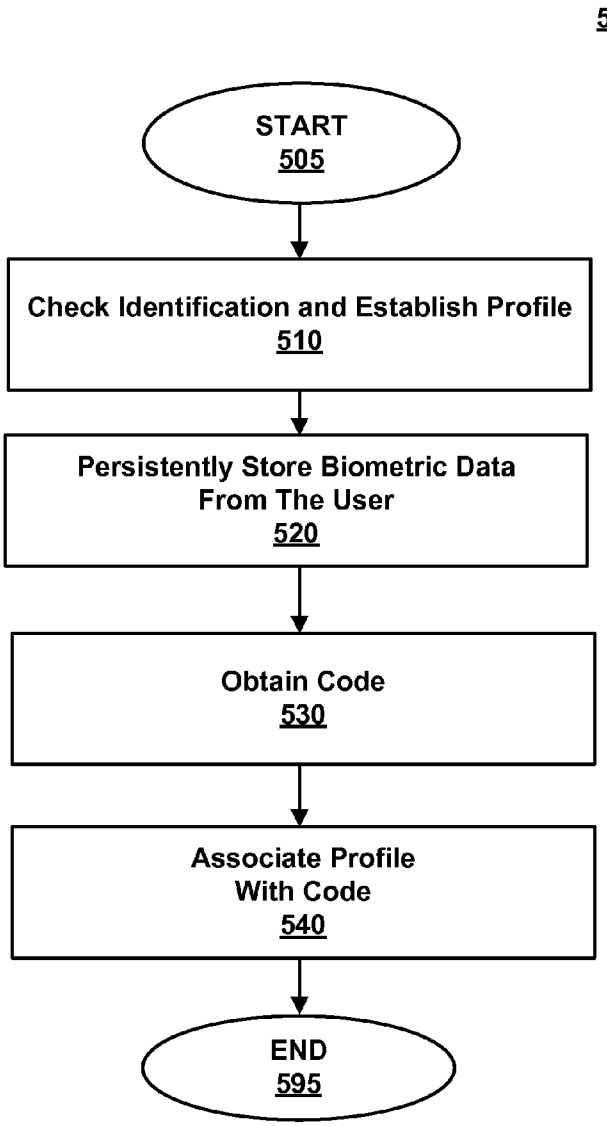

500
START
505
Check Identification and Establish Profile
510
Persistently Store Biometric Data From The User
520
Obtain Code
530
Associate Profile With Code
540
END
595

FIG. 5

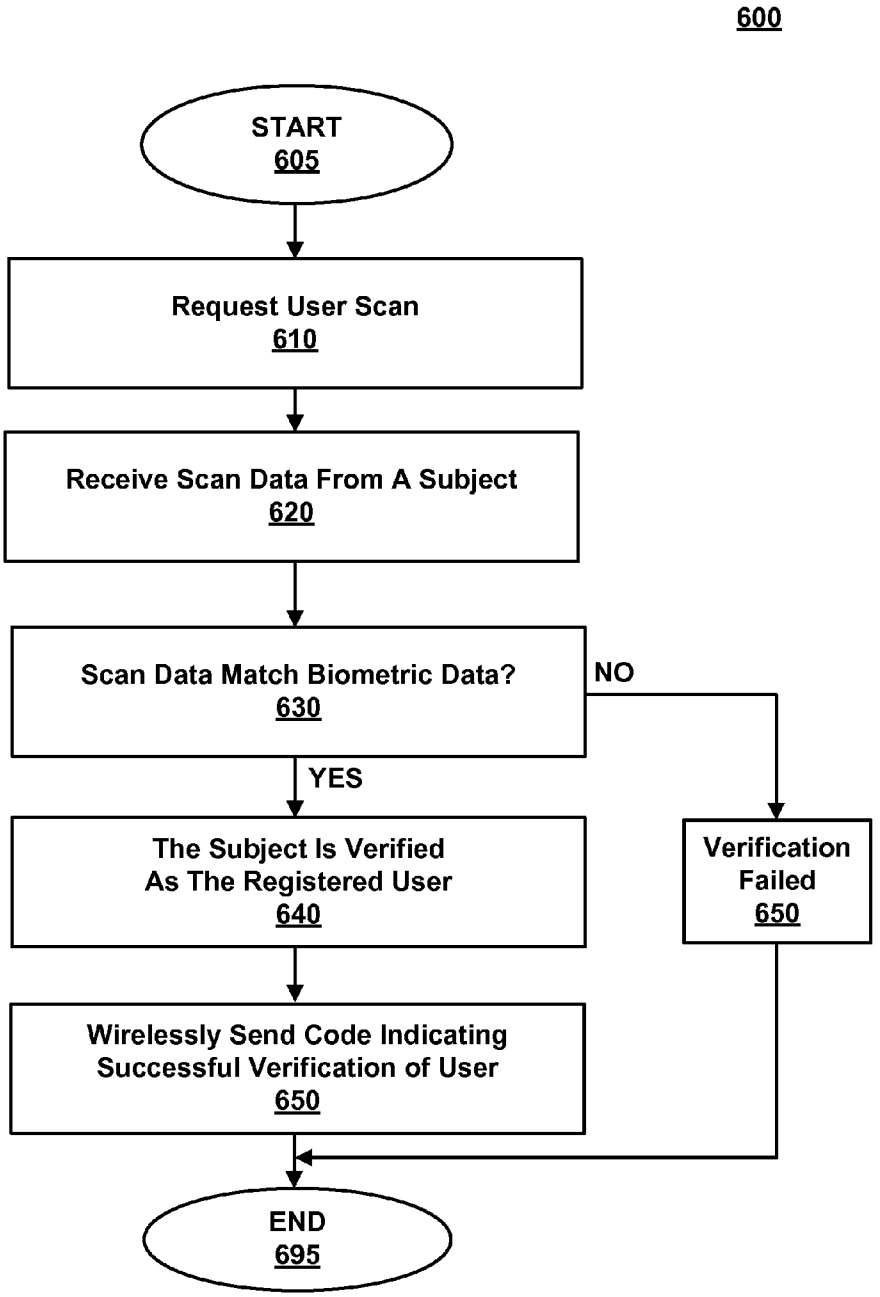

600
START
605
Request User Scan
610
Receive Scan Data From A Subject
620
Scan Data Match Biometric Data?
630
NO
YES
The Subject Is Verified
As The Registered User
640
Verification
Failed
650
Wirelessly Send Code Indicating
Successful Verification of User
650
END
695

FIG. 6

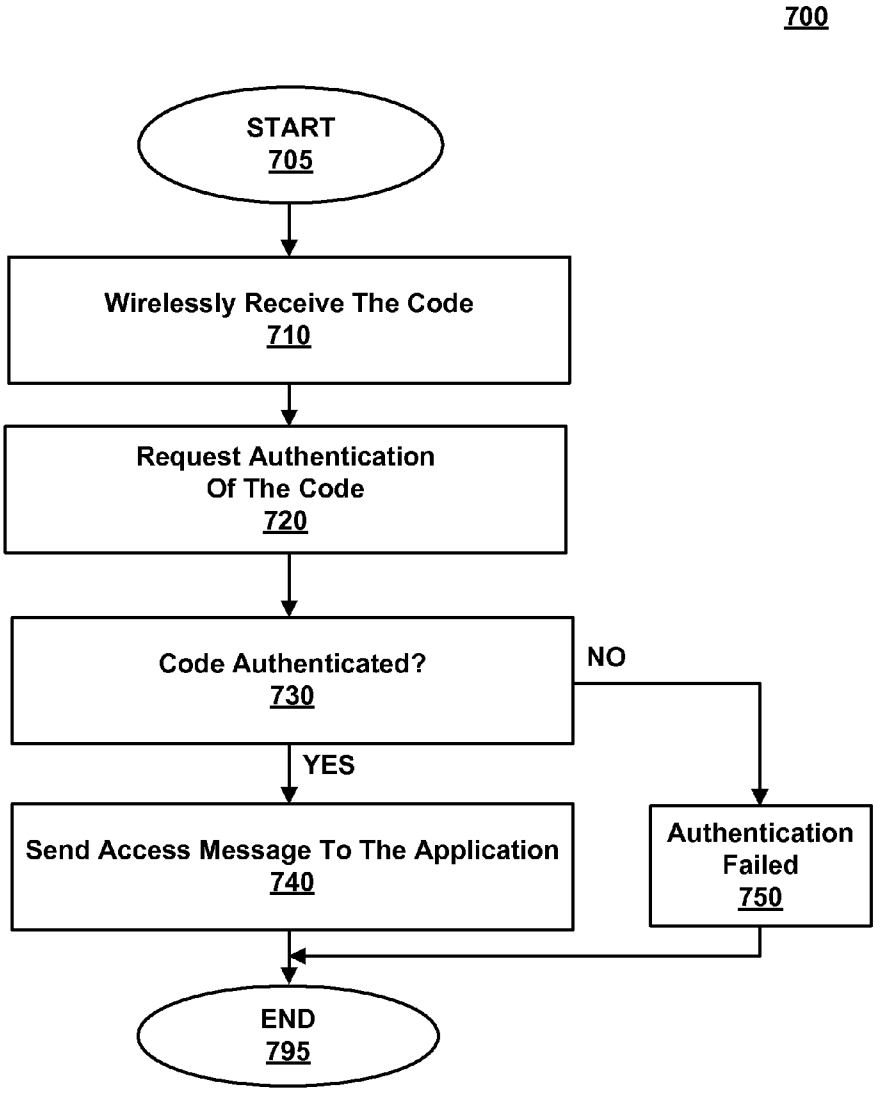

700
START
705
Wirelessly Receive The Code
710
Request Authentication
Of The Code
720
Code Authenticated?
730
NO
YES
Send Access Message To The Application
740
Authentication
Failed
750
END
795

FIG. 7

BIOMETRIC PERSONAL DATA KEY (PDK) AUTHENTICATION

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims priority, under 35 U.S.C. §120, to U.S. patent application Ser. No. 13/710,109 filed Dec. 10, 2012 and entitled "Biometric Personal Data Key (PDK) Authentication" which claims priority to U.S. patent application Ser. No. 11/314,199, filed Dec. 20, 2005 and entitled "Biometric Personal Data Key (PDK) Authentication," which claims the benefit of U.S. Provisional Application No. 60/637,538, filed on Dec. 20, 2004, and of U.S. Provisional Application No. 60/652,765, filed on Feb. 14, 2005, the entire contents of which are hereby incorporated by reference.

FIELD OF THE INVENTION

The present invention relates generally to computerized authentication, and more specifically, to an authentication responsive to biometric verification of a user being authenticated.

BACKGROUND

Conventional user authentication techniques are designed to prevent access by unauthorized users. One technique is to require a user being authenticated to provide secret credentials, such as a password, before allowing access. Similarly, a PIN number can be required by an ATM machine before allowing a person to perform automated bank transactions. A difficulty with this technique is that it requires the user to memorize or otherwise keep track of the credentials. A uses often has multiple sets of credentials (e.g., passwords and PINs) and it can be quite difficult to keep track of them all.

Another technique that does not require the user to memorize credentials is to provide the user with an access object such as a key (e.g., an electronic key) that the user can present to obtain access. For example, a user can be provided with a small electronic key fob that allows access to a building or other secured location. A difficulty with using access objects is that authentication merely proves that the access object itself is valid; it does not verify that the legitimate user is using the access object. That is, illegitimate user can use a stolen access object to enter a secured location because the user's identity is never checked.

Some hybrid authentication techniques require the user to provide both an access object and credentials. The user is authenticated only upon providing both items. Of course, this solution does not resolve the problem of making the user memorize credentials.

Therefore, there is a need for systems and methods for verifying a user that is being authenticated that does not suffer from the limitations described above. Moreover, the solution should ease authentications by wirelessly providing an identification of the user.

SUMMARY

The present invention addresses the above needs by providing systems and methods for authentication responsive to biometric verification of a user being authenticated. In one embodiment, an integrated device includes a persistent storage to persistently stores a code such as a device identifier (ID) and biometric data for a user in a tamper-resistant format, and a verification module, in communication with the persistent storage, to receive scan data from a biometric scan for comparison against the biometric data, and if the scan data matches the biometric data, wirelessly sending a code for authentication.

In one embodiment, a method for verifying a user during authentication of an integrated device, includes persistently storing biometric data for the user in a tamper-resistant format; responsive to receiving a request for biometric verification of the user, receiving scan data from a biometric scan; comparing the scan data to the biometric data to determine whether the data match; and responsive to a determination that the scan data matches the biometric data, wirelessly sending a code for authentication.

Other embodiments include corresponding systems, apparatus, and computer programming products, configured to perform the actions of the methods, encoded on computer storage devices. These and other embodiments may each optionally include one or more of the following features. For instance the operations further include registering an age verification for the user in association with the code. For instance the operations further include establishing a secure communication channel prior to sending the code for authentication. For instance the operations further include receiving a request for the code without a request for biometric verification, and responsive to receiving the request for the code without a request for biometric verification, sending the code without requesting the scan data. For instance, the features include: the code is registered with a trusted authority, and the code can be authenticated to a third party by the trusted authority; the code uniquely identifies the integrated device; the code indicates that the biometric verification was successful; persistently storing biometric data includes permanently storing biometric data; the biometric data and the scan data are both based on a fingerprint scan by the user, an LED to be activated for requesting the biometric scan.

In one embodiment, a method for authenticating a verified user, includes receiving a code associated with a biometrically verified user; requesting authentication of the code; receiving an authentication result; and in response to the authentication result being positive, providing access to an application.

In one embodiment, a system includes an integrated device (e.g. a biometric key) to store biometric data for a user in a tamper resistant format, and if scan data can be verified as being from the user by comparing the scan data to the biometric data, wirelessly sending a code; and an authentication module to receive the code and send the code to a trusted authority for authentication, and responsive to the code being authenticated, allowing the user to access an application.

Other embodiments include corresponding systems, apparatus, and computer programming products, configured to perform the actions of the methods, encoded on computer storage devices. These and other embodiments may each optionally include one or more of the following features. For instance, the operations further include registering the code with a trusted authority, wherein requesting authentication of the code includes providing the code to the trusted authority and wherein receiving an authentication result comprises receiving the authentication result from the trusted authority. For instance the operations further include registering a date of birth or age with the trusted authority. For instance the operations further include establishing a secure communications channel with an integrated device, wherein the code associated with the biometrically verified user is received from the integrated device. For instance the features include: the integrated device receives an authentication request from

the authentication module, and in response, requests a biometric scan from the user to generate the scan data; when the integrated device cannot verify the scan data as being from the user, it does not send the code.

Advantageously, user authentication is bolstered with highly reliable biometric verification of the user in an integrated device. Furthermore, a keyless environment relieves authorized users from having to memorize credentials, and of having to physically enter credentials or keys. In addition, the integrated device can be authenticated for an application that is open to the public (i.e., in an open loop system).

The features and advantages described in the specification are not all inclusive and, in particular, many additional features and advantages will be apparent to one of ordinary skill in the art in view of the drawings, specifications, and claims. Moreover, it should be noted that the language used in the specification has been principally selected for readability and instructional purposes and may not have been selected to delineate or circumscribe the inventive matter.

BRIEF DESCRIPTION OF THE DRAWINGS

The teachings of the present invention can be readily understood by considering the following detailed description in conjunction with the accompanying drawings.

FIG. **1** is a schematic diagram illustrating a biometric key for providing authentication information for a biometrically verified user according to one embodiment of the present invention.

FIG. **2** is a block diagram illustrating functional modules within the biometric key according to one embodiment of the present invention.

FIG. **3** is a block diagram illustrating a system for providing authentication information for a biometrically verified user.

FIG. **4** is a flow chart illustrating a method for providing authentication information for a biometrically verified user.

FIG. **5** is a flow chart illustrating a method for enrolling biometric data of the user with the biometric key.

FIG. **6** is a flow chart illustrating a method for verifying a subject presenting the biometric key according to one embodiment of the present invention.

FIG. **7** is a flow chart illustrating a method for authenticating a verified user of the biometric key according to one embodiment of the present invention.

DETAILED DESCRIPTION

Systems and methods for authentication responsive to biometric verification of a user being authenticated are described. Generally, biometric verification uses biometric data to ensure that the user of, for example, a biometric key, is the person registered as an owner. Biometric data is a digital or analog representation of characteristics unique to the user's body. For example, a fingerprint of a subject can be compared against previously-recorded biometric data for verification that the subject is the registered owner of the biometric key. Then, the biometric key itself can be authenticated.

Although the embodiments below are described using the example of biometric verification using a fingerprint, other embodiments within the spirit of the present invention can perform biometric verification using other types of biometric data. For example, the biometric data can include a palm print, a retinal scan, an iris scan, hand geometry recognition, facial recognition, signature recognition, or voice recognition.

FIG. **1** is a schematic diagram illustrating an example of a biometric key **100** for providing authentication information for a biometrically verified user according to one embodiment of the present invention. In one embodiment, the biometric key **100** comprises a frame **110**, a scan pad **120**, and an LED **130**. In one embodiment, biometric key **100** has a small form factor (e.g., the size of an automobile remote control) such that it can be unobtrusively carried by a user. In one embodiment, the biometric key **100** is integrated into another object or device. A device having an integrated biometric key **100** is occasionally referred to herein as an "integrated device." For example, in one embodiment, the biometric key **100** is integrated into a mobile phone (e.g. a cellular phone or smartphone), tablet, laptop, mp3 player, mobile gaming device, watch, key fob or other mobile device, thereby making the biometric key **100** unobtrusive to carry.

Frame **110** can be formed by plastic, metal or another suitable material. Frame **110** is shaped to secure scan pad **120**, and includes a perforation for attachment to, for example a key chain or clip. In one embodiment, frame **110** is formed from a unitary molding to protect biometric data. Accordingly, frame **110** cannot be opened to expose the underlying components unless it is broken.

Scan pad **120** can be, for example, an optical scanner using a charge coupled device, or a capacitive scanner. Scan pad **120** can be sized to fit a thumb or other finger. Biometric key **100** of the present embodiment includes LED **130** that lights up to request a fingerprint scan from a user. In one embodiment, LED **130** can also confirm that user verification and/or authentication has completed.

Biometric key **100** can authenticate a user for various purposes. For example, biometric key **100** can allow keyless entry into homes and autos. In another example, biometric key **100** can log a user onto a computer system or point of sale register without typing in credentials. In still another example, biometric key **100** can verify that an enrolled user is above a certain age (e.g., before allowing access to a slot machine in a casino). In some embodiments, biometric key **100** operates without biometric verification, and request a fingerprint scan from a user only when biometric verification is needed for the particular use.

FIG. **2** is a block diagram illustrating biometric key **100** according to one embodiment of the present invention. Biometric key **100** comprises control module **210**, biometric portion **220**, RF communication module **230**, persistent storage **240**, and battery **250**. Biometric key **100** can be formed from a combination of hardware and software components as described above. In one embodiment, biometric key **100** comprises a modified key fob.

Control module **210** coordinates between several functions of biometric key **100**. In one embodiment, control module **210** provides a verification code upon successful verification of the user. More specifically, once biometric portion **220** indicates that a fingerprint scan matches biometric data that was collected during enrollment, control module **210** can trigger RF communication module **230** for sending a code indicating that the user was verified. In another embodiment, control module **210** can work in the opposite direction by detecting a request for verification from RF communication module **230**, and then requesting verification of the user from biometric portion **210**. Note that control module **210** of FIG. **2** is merely a grouping of control functions in a central architecture, and in other embodiments, the control functions can be distributed between several modules around biometric key **100**.

Biometric portion **220** comprises enrollment module **222**, validation module **224**, and biometric data base **226**. In one

embodiment, enrollment module **222** registers a user with biometric key **100** by persistently storing biometric data associated with the user. Further, enrollment module **222** registers biometric key **100** with a trusted authority by providing the code (e.g., device ID) to the trusted authority. Or conversely, the trusted authority can provide the code to biometric key **100** to be stored therein.

Validation module **224** can comprise scan pad **120** (FIG. **1**) to capture scan data from a user's fingerprint (e.g., a digital or analog representation of the fingerprint). Using the scan data, validation module **214** determines whether the user's fingerprint matches the stored biometric data from enrollment. Conventional techniques for comparing fingerprints can be used. For example, the unique pattern of ridges and valleys of the fingerprints can be compared. A statistical model can be used to determine comparison results. Validation module **224** can send comparison results to control module **210**.

In other embodiments, validation module **224** can be configured to capture biometric data for other human characteristics. For example, a digital image of a retina, iris, and/or handwriting sample can be captured. In another example, a microphone can capture a voice sample.

Persistent storage **226** persistently stores biometric data from one or more users which can be provided according to specific implementations. In one embodiment, at least some of persistent storage **226** is a memory element that can be written to once but cannot subsequently be altered. Persistent storage **226** can include, for example, a ROM element, a flash memory element, or any other type of non-volatile storage element. Persistent storage **226** is itself, and stores data in, a tamper-proof format to prevent any changes to the stored data. Tamper-proofing increases reliability of authentication because it does not allow any changes to biometric data (i.e., allows reads of stored data, but not writes to store new data or modify existing data). Furthermore, data can be stored in an encrypted form.

In one embodiment, persistent storage **226** also stores the code that is provided by the key **100** responsive to successful verification of the user. As described above, in one embodiment the code is a device ID or other value that uniquely identifies biometric key **100**. In one embodiment, the code is providing during the manufacturing process and the biometric data are provided during an enrollment of the user. In other embodiments, the code is provided during enrollment and/or the biometric data are provided during manufacturing. Further, in some embodiments persistent storage **226** stores other data utilized during the operation of biometric key **100**. For example, persistent storage **226** can store encryption/decryption keys utilized to establish secure communications links.

Radio frequency (RF) communication module **230** is, for example, a transceiver or other mechanism for wireless communication. RF communication module **230** can send and receive data (e.g., the code) as modulated electromagnetic signals. In one embodiment, RF communication **220** can be optimized for low-power usage by, for example, using short-range transceivers. RF communication module **230** can actively send out connection requests, or passively detect connection requests.

Battery **260** can be a conventional power source suitable for the components of biometric key **100**. Battery **260** can be either replaceable or rechargeable. Alternatively, battery **260** can be embedded within key **100** such that the key must be discarded or recycled upon expiration of the battery.

FIG. **3** is a block diagram illustrating a system **300** for providing authentication information for a biometrically verified user. System **300** comprises an authentication module **310** in communication with biometric key **100**, a trusted key authority **320**, and an application **330**.

Authentication module **310** is coupled in communication with biometric key via line **311** (i.e., a wireless medium such as EM signals), and with trusted key authority **320** via line **312** (e.g., a secure data network such as the Internet, or a cell network). Authentication module **310** can include one or more of, for example, a computerized device, software executing on a computerized device, and/or a reader/decoder circuit. In one embodiment, authentication module **310** servers as a gatekeeper to application **330** by requiring the code indicating successful biometric verification of the user prior to allowing access to the application. Further, in one embodiment, authentication module **310** provides the code to trusted key authority **320** in order to verify that it belongs to a legitimate key (e.g., when application **330** is security-critical). Authentication module **310** can send a message to application **330**, or otherwise allow access to the application, responsive to a successful authentication by trusted key authority **320**.

Application **330** is a resource that can be accessed by a verified and authenticated user. Application **330** can be, for example, a casino machine, a keyless lock, a garage door opener, an ATM machine, a hard drive, computer software, a web site, a file, a financial account (e.g. a savings account, checking account, brokerage account, credit card account, credit line, etc.) and the like. In one embodiment, a file includes medical information such as a medical record, insurance information or other healthcare information. Application **330** can execute on the same system as authentication module **310** or on another system in communication with the system of the authentication module. In one embodiment, application module **330** allows access by a user after receiving a message from authentication module **310**. At that point, application **330** can allow direct use by the user, or require that communications continue to pass through authentication module **310** for continued authentication.

Trusted key authority **320** is a third-party authority that is present in some embodiments in order to provide enhanced security. In one embodiment, trusted key authority **320** verifies that a code from a biometric key is legitimate. To do so, the trusted key authority **320** stores a list of codes for legitimate biometric keys. The list can be batched or updated each time a new user/key is enrolled. In one embodiment, trusted key authority **320** can also store a profile associated with a biometric key. The profile describes the user associated with the key, the key itself, the trusted key authority, and/or other relevant information. In one embodiment, the functionality of trusted key authority **320** is provided by a server or other computerized device.

In an open system, where unknown users can attempt authentication (e.g., in a public grocery store), trusted key authority **320** provides verification that a key presenting a certain code is legitimate. By contrast, in a closed system, only known users are legitimate (e.g., owners of a home), the trusted key authority **320** can be maintained locally and serves to verify that the key belongs to one of the limited number of users that can use the system.

FIG. **4** is a flow chart illustrating a method **400** for authenticating a biometrically verified user using a trusted key authority (e.g., authority **320**). A biometric key (e.g., biometric key **100**) is registered **410** with the trusted key authority. The code (e.g., device ID) of the key is stored by the trusted key authority. Additionally, a user is enrolled **420** with the biometric key as described below with reference to FIG. **5**.

In various situations, authentication of the key is needed **430** (e.g., by authentication module **310**). In one embodiment, authentication can be required prior to allowing access to an

application (e.g., application **330**). For example, a user can be standing proximate to a slot machine in a casino which requires that a user be over the age of 21. The slot machine can detect the biometric key in the user's pocket, and, in response, spawn a conspicuous pop-up window on the slot machine requesting age verification. Alternatively, the biometric key can blink an LED. In other embodiments, biometric verification is not necessary and only the key itself is authenticated.

The biometric key establishes communication with the authentication module using various techniques. In one embodiment, the key and authentication module engage in preliminary data exchanges to determine who and/or what they are (e.g., to ascertain that they belong to the same system). These data exchanges can include challenge-response dialogs, hashing algorithms, and the like in order to ensure that the biometric key and authentication module are themselves legitimate. Further, in one embodiment the key and authentication module establish a secure communications channel. The key performs the biometric verification of the user **440** as described below with reference to FIG. **6**. If the biometric verification of the user is successful, the key provides its code over the secure communications channel.

The code is utilized to authenticate the biometric key itself **450**, **460** as described below with reference to FIG. **7** and profile information is received. Responsive to successful authentication of the key, access is allowed 470 to the application. In the slot machine example, a new pop-up window can be spawned to indicate a successful age verification.

FIG. **5** is a flow chart illustrating a method **500** for enrolling biometric data of the user with the biometric key according to one embodiment of the present invention. An agent checks **510** an identification of the user and establishes a profile. The agent can be, for example, a government official, a notary, and/or an employee of a third party which operates the trusted key authority, or another form of witness. The agent can follow standardized procedures such as requiring identification based on a state issued driver license, or a federally issued passport in order to establish a true identity of the user.

The profile describes the user and can include, for example, the user's name, date of birth, age, passwords, account numbers, preferences etc. In some embodiments, the profile stores no or only limited information about the user. For example, the agent might store the date of birth of the user in the profile, but not store any other information about the user. In addition, the profile describes the biometric key and/or key authority. For the biometric key, the profile can store a value indicating the status of the key, such as whether the key is in-service, out-of-service, abandoned, lost, stolen etc. For the key authority, the profile can store a value identifying the key authority.

The agent also collects and persistently stores **520** biometric data from the user. To do so, a fingerprint or eye retina can be scanned and converted to data which is then persistently stored in the biometric key. In one embodiment, the agent does not retain the biometric data. Since this step occurs under control of the agent, the agent can be certain that the biometric data stored within the key matches the user who presented the identification. The agent also obtains the code (e.g., device ID) from the biometric key in which the biometric data was stored. The agent associates the code and the profile using a table and/or other data structure.

FIG. **6** is a flow chart illustrating a method **600** for verifying a subject presenting the biometric key according to one embodiment of the present invention. In response to an authentication request, a user scan is requested **610** (e.g., by a blinking LED). Once the subject provides a fingerprint, scan data is received **620**. Scan data is compared for a match **630** to previously-stored biometric data. If there is no match, then verification fails **650**.

If there is a match, the subject is verified **640** as the user. The code indicating a successful verification is wirelessly sent **650** from the biometric key (e.g., by RF communication module **230**).

FIG. **7** is a flow chart illustrating a method **700** for authenticating a biometric key according to one embodiment of the present invention. The code is wirelessly received **710**. A request for authentication of the code is sent to the trusted key authority **720**. The trusted key authority determines whether the code is authentic **730** (i.e., it was created through an established enrollment process) and has a valid status (e.g., has not expired). If authentication is successful, the trusted key authority sends an access message to the application to allow user access and/or provide additional information from the profile **740** (such as the user's age). If authentication is not successful, authentication fails **750** and the message to the application indicates that the user should be denied access.

In some embodiments, the biometric key provides multiple codes and/or other data values. For example, the key can provide a device ID code that the authentication module can provide to the trusted key authority in order to authenticate the key, and the key can provide a secret decryption value that can be used to communicate with the biometric key. As used herein, the term "code" is intended to include one or more of these values, depending upon the specific embodiment.

The order in which the steps of the methods of the present invention are performed is purely illustrative in nature. The steps can be performed in any order or in parallel, unless otherwise indicated by the present disclosure. The methods of the present invention may be performed in hardware, firmware, software, or any combination thereof operating on a single computer or multiple computers of any type. Software embodying the present invention may comprise computer instructions in any form (e.g., source code, object code, interpreted code, etc.) stored in any computer-readable storage medium (e.g., a ROM, a RAM, a magnetic media, a compact disc, a DVD, etc.). Such software may also be in the form of an electrical data signal embodied in a carrier wave propagating on a conductive medium or in the form of light pulses that propagate through an optical fiber.

While particular embodiments of the present invention have been shown and described, it will be apparent to those skilled in the art that changes and modifications may be made without departing from this invention in its broader aspect and, therefore, the appended claims are to encompass within their scope all such changes and modifications, as fall within the true spirit of this invention.

In the above description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the invention. It will be apparent, however, to one skilled in the art that the invention can be practiced without these specific details. In other instances, structures and devices are shown in block diagram form in order to avoid obscuring the invention.

Reference in the specification to "one embodiment" or "an embodiment" means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the invention. The appearances of the phrase "in one embodiment" in various places in the specification are not necessarily all referring to the same embodiment.

Some portions of the detailed description are presented in terms of algorithms and symbolic representations of operations on data bits within a computer memory. These algorith-

mic descriptions and representations are the means used by those skilled in the data processing arts to most effectively convey the substance of their work to others skilled in the art. An algorithm is here, and generally, conceived to be a self-consistent sequence of steps leading to a desired result. The steps are those requiring physical manipulations of physical quantities. Usually, though not necessarily, these quantities take the form of electrical or magnetic signals capable of being stored, transferred, combined, compared, and otherwise manipulated. It has proven convenient at times, principally for reasons of common usage, to refer to these signals as bits, values, elements, symbols, characters, terms, numbers, or the like.

It should be borne in mind, however, that all of these and similar terms are to be associated with the appropriate physical quantities and are merely convenient labels applied to these quantities. Unless specifically stated otherwise as apparent from the discussion, it is appreciated that throughout the description, discussions utilizing terms such as "processing" or "computing" or "calculating" or "determining" or "displaying" or the like, refer to the action and processes of a computer system, or similar electronic computing device, that manipulates and transforms data represented as physical (electronic) quantities within the computer system's registers and memories into other data similarly represented as physical quantities within the computer system memories or registers or other such information storage, transmission or display devices.

The present invention also relates to an apparatus for performing the operations herein. This apparatus can be specially constructed for the required purposes, or it can comprise a general-purpose computer selectively activated or reconfigured by a computer program stored in the computer. Such a computer program can be stored in a computer readable storage medium, such as, but is not limited to, any type of disk including floppy disks, optical disks, CD-ROMs, and magnetic-optical disks, read-only memories (ROMs), random access memories (RAMs), EPROMs, EEPROMs, magnetic or optical cards, or any type of media suitable for storing electronic instructions, and each coupled to a computer system bus.

The algorithms and modules presented herein are not inherently related to any particular computer or other apparatus. Various general-purpose systems can be used with programs in accordance with the teachings herein, or it may prove convenient to construct more specialized apparatuses to perform the method steps. The required structure for a variety of these systems will appear from the description below. In addition, the present invention is not described with reference to any particular programming language. It will be appreciated that a variety of programming languages can be used to implement the teachings of the invention as described herein. Furthermore, as will be apparent to one of ordinary skill in the relevant art, the modules, features, attributes, methodologies, and other aspects of the invention can be implemented as software, hardware, firmware or any combination of the three. Of course, wherever a component of the present invention is implemented as software, the component can be implemented as a standalone program, as part of a larger program, as a plurality of separate programs, as a statically or dynamically linked library, as a kernel loadable module, as a device driver, and/or in every and any other way known now or in the future to those of skill in the art of computer programming. Additionally, the present invention is in no way limited to implementation in any specific operating system or environment.

It will be understood by those skilled in the relevant art that the above-described implementations are merely exemplary, and many changes can be made without departing from the true spirit and scope of the present invention. Therefore, it is intended by the appended claims to cover all such changes and modifications that come within the true spirit and scope of this invention.

What is claimed is:

1. A method comprising:

persistently storing biometric data of a legitimate user and an ID code on an integrated device;

responsive to receiving a request for a biometric verification of a user, receiving, from a biometric sensor, scan data from a biometric scan performed by the biometric sensor;

comparing the scan data to the biometric data to determine whether the scan data matches the biometric data;

responsive to a determination that the scan data matches the biometric data, wirelessly sending the ID code for comparison by a third-party trusted authority against one or more previously registered ID codes maintained by the third-party trusted authority; and

responsive to receiving an access message from the third-party trusted authority-indicating that the third-party trusted authority successfully authenticated the ID code, allowing the user to complete a financial transaction.

2. The method of claim **1**, further comprising:

registering an age verification for the user in association with the ID code.

3. The method of claim **1**, wherein an indication that the biometric verification was successful is sent with the ID code.

4. The method of claim **1**, wherein the biometric data includes data from one or more of a fingerprint, palm print, a retinal scan, an iris scan, a hand geometry, a facial recognition, a signature recognition and a voice recognition.

5. The method of claim **1**, wherein the integrated device comprises one or more of a mobile phone, tablet, laptop, mp3 player, mobile gaming device, watch and a key fob.

6. The method of claim **1**, wherein completing the financial transaction includes accessing an application.

7. The method of claim **1**, wherein completing the financial transaction includes accessing one or more of a casino machine, a keyless lock, an ATM machine, a web site, a file and a financial account.

8. The method of claim **1**, further comprising:

responsive to determining the action does not require biometric verification, receiving a request for the ID code without a request for biometric verification; and

responsive to receiving the request for the ID code without a request for biometric verification, sending the ID code for authentication without requesting the scan data.

9. An integrated device comprising:

a persistent storage media that persistently stores biometric data of a user and an ID code;

a validation module, coupled to communicate with the persistent storage media, that receives scan data from a biometric scan for comparison against the biometric data, and that sends the ID code for comparison by a third-party trusted authority against one or more previously registered ID codes maintained by the third-party trusted authority; and

a radio frequency communication module that receives an access message from the third-party trusted authority indicating that the third-party trusted authority successfully authenticated the ID code sent to the third-party

trusted authority based on the comparison of the ID code and allowing the user to—complete a financial transaction.

10. The integrated device of claim **7**, wherein the ID code is transmitted to the third-party trusted authority over a network.

11. The integrated device of claim **7**, wherein an age verification is registered in association with the ID code.

12. The integrated device of claim **7**, wherein the integrated device comprises one or more of a mobile phone, tablet, laptop, mp3 player, mobile gaming device, watch and a key fob.

13. A system, comprising:

an integrated hardware device that persistently stores biometric data of a legitimate user and an ID code in the integrated hardware device, and that wirelessly sends the—ID code; an authentication circuit that receives the ED code and sends the ID code to a third-party trusted authority for authentication, and that receives an access message from the third-party trusted authority indicating that the third-party trusted authority successfully authenticated the ID code and allows the user to complete a financial transaction; and

the third-party trusted authority operated by a third party, the third-party trusted authority storing a list of legitimate codes and determining the authentication of the ID code received based on a comparison of the ID code received and the legitimate codes included in the list of the legitimate codes.

14. The system of claim **11** wherein the integrated hardware device receives an authentication request from the authentication circuit, and in response, requests a biometric scan from a user to generate scan data and, when the integrated hardware device cannot verify the scan data as being from the legitimate user, the integrated hardware device does not send the ID code.

15. The system of claim **11**, wherein the integrated hardware device comprises one or more of a mobile phone, tablet, laptop, mp3 player, mobile gaming device, watch and a key fob.

16. The system of claim **11**, wherein the biometric data includes data based on one or more of a fingerprint, palm print, a retinal scan, an iris scan, a hand geometry, a facial recognition, a signature recognition and a voice recognition.

17. The system of claim **11**, wherein completing the financial transaction includes accessing one or more of a casino machine, a keyless lock, an ATM machine, a web site, a file and a financial account.

18. The system of claim **11**, wherein completing the financial transaction includes accessing an application.

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