International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2163
Issue 03, Volume 6 (March 2019) - Special Issue www.ijirae.com
SPECIAL ISSUE - 5th Inter National Level Conference - "MEEMIC – 2019"

WEARABLE BIOMETRIC SYSTEM FOR PATIENT DATA ACQUISITION

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Manuscript History
Number: **IJIRAE/RS/Vol.06/Issue03/Special Issue/SI.MRAE10102**
Received: 20, February 2019
Final Correction: 05, March 2019
Final Accepted: 20, March 2019
Published: **March 2019**
Editor: Dr.A.Arul L.S, Chief Editor, IJIRAE, AM Publications, India

Abstract--Human body communication (HBC) is a short-range wireless communication in the vicinity of, or inside a human body by using the human body as a propagation medium. HBC is divided into two solutions: galvanic coupling and capacitive coupling. The former requires one pair of electrodes in both the transmitter (TX) and the receiver (RX), whereas the latter only requires a single electrode for the TX and the RX. The capacitive coupling makes it possible to miniaturize the size of device, and is more suitable for applications requiring the devices to be miniature enough. Since HBC can transfer in high data rates while maintaining low power consumption, and provide high security and easy integration within body-worn devices, HBC shows great potential for wearable devices. Moreover, as the proportion of biological tissues such as muscle, fat, and skeleton is different between individuals, the overall dielectric constants of human body are diverse, as well as the signal propagated through human body. The diverse HBC propagation signal can be utilized as the biometric trait to authenticate individuals. By means of employing the HBC as both the authentication and the communication approaches, the size of wearable devices will be more miniature. Due to the use of propagation signal between devices, the HBC authentication is suitable for wearable device regardless of the location.
Keywords—Biometric authentication; wearable system; human body communication; support vector machines; transreceiver

I. INTRODUCTION

With the rapid development of wearable technology, wearable devices are experiencing an exponential growth. Wearable devices are generally small, portable, low power consumption, and worn on the multiple locations on the user for diverse functions such as video recording, pedometer and health monitoring. As the information stored in the wearable devices are almost private, such as personal photo, video and health data measured by the biosensors including heart rate, blood pressure, and electrocardiogram, it is important to prohibit the unauthorized persons from accessing the wearable device. Biometric authentication is an excellent approach to solve this problem. Biometric authentication refers to verifying or identifying individuals based on the physical or behavioral characteristics such as face, fingerprint, hand geometry, iris, typing rhythm, voice, and gait. Biometric is inherently more reliable than the password-based authentication as biometric traits cannot be lost or forgotten. It is also more difficult to forge biometrics. A number of biometric characteristics have been in use for different applications. Several groups have studied the biometrics in the mobile platforms. Wang *et al.* and Liu *et al.* utilized the finger-vein recognition system for mobile devices. Klonovsetal. & Taoetal*.* Introduced EEG-based biometric and face recognition respectively.

Other researchers combined several biometrics such as face, voice, and teeth to provide a better performance. However, considering that the wearable devices may be worn on different position such as legs, the aforementioned biometric are not suitable for some wearable devices. In addition, the device of the authentication system must be small enough to be integrated into wearable devices. For this reason, some biometrics, like gait, typing rhythm, hand veins, DNA, hand geometry, and iris recognition are not acceptable for wearable application. Therefore, there is a need to propose a biometric trait which is small enough and suitable for wearable systems.

II.EXPRIMENTAL SETUP OF MEASUREMENT

The experimental setup fig.1 in these experiments, including a vector network analyzer (VNA) and two self-assembled electrodes. VNA and the electrodes were connected through two coaxial cables. The electrodes, which were capacitive coupled to human body, were fabricated with copper conductive cloth covered by plastic insulating tape. The dimension of the electrodes was 6 cm × 4.5 cm, and the distance between them was 70 cm. The VNA was set to transmit sinusoidal signals within the frequency band range between 300 KHz and 50 MHz, including 1601 discrete frequency points. In other words, the frequency interval between two adjacent points was 31.0625 KHz.

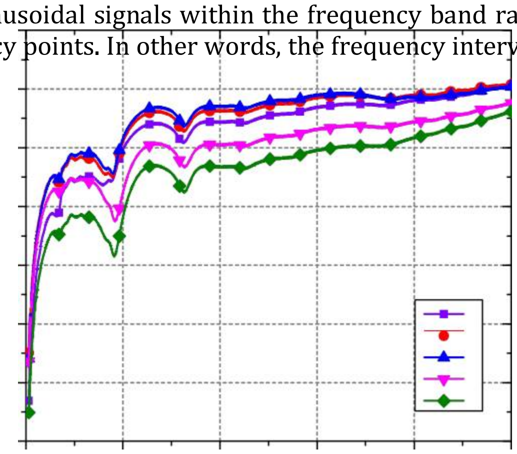

Fig .1. Frequency (MHz)

III.EXPERIMENTAL EVOLUTION

Depending on the application, a biometric authentication system can operate either in the verification or identification mode. In the biometric verification mode, only one person who is authorized has the right to enter the system, and the biometric features are compared with the unique template of the authorized person stored in the system database. In the biometric identification mode, the biometric features are compared with all templates stored in the system database, and thus the system could identify the identities of the users. In some other applications, the system should accomplish both verification and identification. LIBSVM, a library for SVM, is employed to estimate the performance of the HBC authentication shows the process of the authentication by using SVM. In the data analysis, the data obtained in previous 7 times including were used as templates to train SVM classifier, and then, SVM models was established. Whereas, the 200 groups of data gained in the last time which add up to 320,200 serve as test data and were predicted by the SVM models acquired before. The performance of HBC biometric authentication could be obtained by comparing the predicted labels with the true labels.

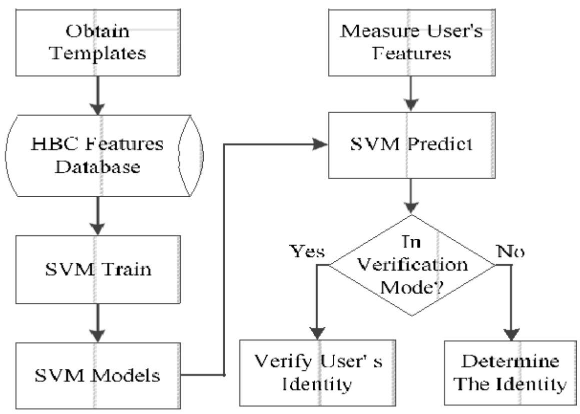

Fig.2. Flow chart representing the authentication steps by using support vector machine

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IV. BLOCK DIAGRAM

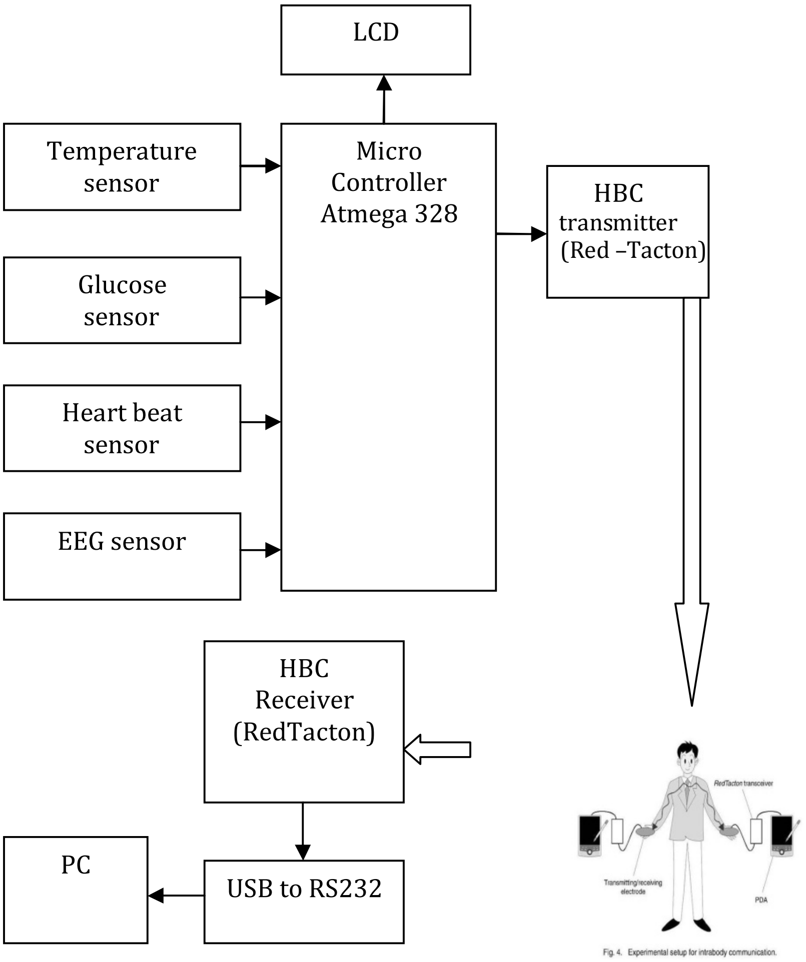

Fig.3.block diagram of human body communication

RedTacton uses the minute electric field emitted on the surface of the human body. Technically, it is completely distinct from wireless and infrared .A transmission path is formed at the moment a part of the human body comes in contact with a RedTacton transceiver. Physically separating ends the contact and thus ends communication Using RedTacton, communication starts when terminals carried by the user or embedded in devices are linked in various combinations according to the users. Communication is possible using anybody surfaces, such as the hands, fingers, arms, feet, face, legs or toes. RedTacton works natural, physical movements. Transmission occurs by the action triggered by touching, holding, sitting and so on.

A. Identification Mode

In identification mode, the performance of the authentication system is evaluated by the identification rate. The identification rate is computed as

$$\text{Rate} = \frac{\text{correct predicted caNdsec}}{\text{Total caNdsec}} \times 100\%$$

Applying support vector machines as the authentication algorithms, the identification becomes a multiclass classification problem. However, support vector machines are formulated for two-class problems which could not be applied to a multiclass problem directly. In view of this problem, two types of approaches including one-against-all and one-against-one are introduced to solve it. Applying support vector machines as the authentication algorithms, the identification becomes a multiclass classification problem. However, support vector machines are formulated for two-class problems which could not be applied to a multiclass problem directly. In view of this problem, two types of approaches including one-against-all and one-against-one are introduced to solve it.

B. Verification Mode

To confirm whether the visitor is the authorized person, the features of the visitor should be compared with the referential feature stored in the database. The performance of the verification system can be evaluated by the equal error rate (EER) and the area under the curve (AUC).

The EER refers to the error rate which the false accept rate (FAR) equals the false reject rate (FRR), and the AUC refers to the area under the operator feature curve (ROC). The EER and AUC range between 0 and 1. The ROC curve is a function of the matching score, which plots the FAR on the x-axis and the "1-FRR" on the y-axis. The matching score is the similarity between two biometric features. A high AUC value with a low EER means a high performance of the verification system. Considering that the feature in the low band would affect the performance of HBC authentication, only the features within the frequency band range of 9.6MHz to 50MHz is used to evaluate the performance of HBC authentication in the verification mode shows the ROC curves by using SVM. In these figures, the volunteers are labeled from A to T are the ROC curves by using C-SVM with linear, polynomial and RBF kernel function, respectively. are the ROC curves by using nu-SVM with linear, polynomial and RBF kernel function, respectively.

In the only two of the volunteers have the AUC value of less than one, others have the AUC value of one. There are three of the volunteers having the AUC value of less than one. In addition, the numbers of volunteers that have the AUC value of less than one are five and six. Thus the linear and polynomial kernel function outperform the RBF in the HBC authentication.. AUCs and EERs. By comparison, it can be found that no matter what kind of SVM is used, the lowest average EERs are obtained by adopting the polynomial function as the kernel, and the linear function is just slightly inferior to the polynomial function. Therefore, the polynomial function is the most suitable for the HBC verification. Moreover, it is apparent that the average AUCs with the C-SVM are larger than the AUCs with the nu-SVM, and the EERs with the C-SVM are less than the EERs with the nu-SVM. Consequently, C-SVM is superior to nu- SVM in the HBC verification. Lastly, the highest AUC and the lowest EER achieved 0.9993 and 0.24% by using the C- SVM with the polynomial function. Then, the receiver enters the normal working mode and starts to process the RF input signal coming from the transmitter. The measured receiver input impedance. A sub-millimeter-sized fully integrated HBC transceiver is implemented with the 65 nm CMOS process. To eliminate the undesired interference to the low-frequency human physiological signals. The experiment results show that, in biometric identification mode, identification rate of 98% is achieved, and in biometric verification mode, the equal error rate (EER) is 0.24%, the average area under the curve (AUC) of receiver operating characteristic (ROC) reaches 0.9993.

TABLEI. IDENTIFICATION RATE

Experiment	Data Segment	Band (MHz)	C-SVM Linear	C-SVM Polynomial	C-SVM RBF	nu-SVM Linear	nu-SVM Polynomia	nu-SVM RBF
I	1-1601	0.3-50	88.5%	79.5%	83.5%	89.0%	88.5%	84.5%
II	101-1601	3.4-50	91.0%	81.0%	91.5%	88.5%	87.5%	88.0%
III	201-1601	6.5-50	92.0%	90.0%	91.0%	90.0%	90.0%	90.5%
IV	301-1601	9.6-50	98.0%	93.5%	94.5%	94.5%	91.0%	92.5%
V	38-201	9.6-50	98.0%	93.5%	93.5%	96.0%	90.5%	92.0%
VI	75-401	9.6-50	97.5%	96.0%	94.0%	91.5%	92.5%	92.5%
VII	150-:801	9.6-50	98.0%	94.0%	94.0%	95.0%	91.0%	92.0%

V. CONCLUSION

This paper proposes a rapid biometric verification for application in wearable devices. The results indicate that there is significantly different transmission gain among individuals, and the transmission gain for the same individual is steady over a period of time. Therefore, the model proposed in this paper may be a potential solution for rapid verification for wearable devices. In the near future, the biometric verification based on HBC will be achieved in a wearable prototype.

ACKNOWLEDGEMENT

We are thankful to the management of Sengunthar College of Engineering, Tiruchengode, Tamil Nadu for providing all the amenities to complete this work successfully.

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