

# Protecting Patient Confidential Data and Personal Health Record Using ECG Watermarking

Chetan<sup>#1</sup>, Satnam Singh<sup>\*2</sup>

<sup>#</sup>M.tech Scholar, SSCET, Badhani

<sup>\*</sup>AP, ECE Department, SSCET Badhani

<sup>1</sup>chetandhiman0023@gmail.com

<sup>2</sup>jeevanjot1999@gmail.com

## *Abstract—*

Personal Health Record is an emerging application of health information exchange that allows people to access and co-ordinate their lifelong health information. The patient's privacy and security is important in the protection of healthcare privacy and at the same time the patient has control over access to their own PHR. However, there have been wide privacy concerns as personal health information could be exposed to those third party servers and to unauthorized parties. The important challenges are risks of privacy exposure, flexible access, and efficient user revocation. To achieve security of personal health records one can use encryption to encrypt the data before outsourcing it. In this paper, we reviewed the literature on PHRs including design, functionality, implementation, applications, outcomes, and benefits. Although Primary care physicians play a key role in patient health, PHRs are likely to be linked to physician electronic medical record systems.

*Keywords—* PHRs, EMR, PCC.

## I. INTRODUCTION

Personal Health Record (PHR) refers to the internet-based portals or computer-based applications that records patient confidential information in electronic version. The availability of medical information on the web has made patients much more aware of symptoms, diagnostic tests, diseases, and treatment options. Most of the people now a day's keeps health records for themselves and their families [1, 2]. The patients confidential information sent through the public network should be protected and secure. Patient can control who will use his/her confidential health information, such as name, address, telephone number, and Medicare number and who can access data. Monitoring patients at their home can reduce the increasing traffic at hospitals and medical centres. The primary goal is to provide confidentiality, integrity, and availability. Many trials of electronic personal health record systems (PHRs) have shown that they supplement and improve patient and family access to knowledge for self-management of health and wellness issues [3]. PHRs were defined as electronic or paper-based collections of health or wellness data arising from multiple sources about an individual's health, that are managed, controlled, or shared by that

individual or designate. Growth in PHR use parallels the adoption of electronic medical record systems by primary care physicians. Primary care physicians play a predominant role in advising and supporting patients in education and health self management [4]. PHRs have the potential to change and possibly to improve patient-provider relationships, enhance patient-physician shared decision making, and enable the healthcare system to evolve toward a more personalized medical model [5]. The main aim of watermarking is to hide patient's confidential data and other physiological information in ECG images. ECG images is used because the size of ECG is large compared to other medical images. Patients ECG images and other physiological readings such as temperature, blood pressure, glucose reading, position, etc., are collected at homes by using Body Sensor Networks (BSNs) will be transmitted and diagnosed by remote patient monitoring systems. At the same cost that the patient confidentiality is protected against intruders while data traverse in open network and stored in hospital servers. The aim is to show that both the Host ECG and watermarked ECG signals can be used for diagnoses and the difference would be undetectable.

## **II. SYSTEM PARAMETERS**

System parameters relate to the characteristics of PHR systems

### **A. Content**

The information included in PHRs and who can use that information is great concern. Information from practitioner sources should use easy-to-understand language. Information entered by patients may not be as complete, accurate, and organized as data exchanged between healthcare providers [6, 7]. Content must be important,

understandable, and credible to patients and their caregivers. Physician experience has shown that patient problem lists, clinical notes, medication and allergy data, and laboratory and diagnostic test results can be shared with patients [8, 9]. An attempt should be made to adjust office workflows so physicians can discuss results with patients before they appear in online records.

### **B. Architecture**

Allowing patients to enter or view their own health data in their healthcare provider's EMR can convey much more to the patient than stand-alone PHRs, enabling patients to gather their entire fragmented medical history in one place. Information that patients may keep for their personal use may also be valued by healthcare providers. A personally controlled PHR, integrated with a primary care EMR, can manage communications for prescriptions and appointments at reasonable cost. System interoperability is critical to giving consumers access to health records in hospital, physician, and laboratory systems [10, 11, 12].

### **C. Privacy and Security**

Consumers are very much concerned about the privacy and security of their health information, Current security protection mechanisms need to be enhanced for record protection, but to maintain privacy, and security levels must not become so tight that health records are unusable. However wireless transmission of patient medical data, including the privacy, integrity, and confidentiality of the data, and the authentication and authorization of users are great concern [13, 14].

### **D. Functionality**

PHR functionalities can be classified as: (1) information collection, (2) information sharing and

exchange, and (3) information self-management. Functionalities include sending and receiving electronic messages to and from doctors' offices; completing prescription renewal forms, appointments, and referral authorizations; viewing lists of current medications and allergies; and accessing health and practice information. Decision support can also assist patients in managing chronic illnesses, based on monitoring data. The nature of the patient's illness affects preference for functionalities.

### III. PHRS PURPOSE

The purposes of PHR are outlines as

- Easy Communication to patient
- Education and lifestyle change
- Health self-management
- Adoption, acceptance, and usability
- Acceptance and satisfaction

### IV. RESULT & DISCUSSION

We developed wavelet based ECG watermarking algorithm for protecting patient confidential data. Various ECG signals are used for the experimentation. We calculate various quality measures to evaluate the performance of the developed wavelet based ECG watermarking system.

We measure the quality of watermarked images in terms of PSNR (Peak Signal to Noise Ratio), MSE (Mean Square Error), Correlation and Percentage Residual Difference (PRD). The various quality

measures used in this thesis is calculated using following equations.

$$MSE = \frac{\sum_{M,N} (T(r,c) - T'(r,c))^2}{M * N}$$

$$PSNR = 10 \log_{10} \left[ \frac{R^2}{MSE} \right]$$

Where  $T(r, c)$  is the original image and  $T'(r, c)$  is the resultant watermark-image,  $r$  and  $c$  are the number of rows and columns in the input images, respectively.  $R$  is the maximum fluctuation in input image data type or is the maximum intensity value of image.

Similarly PRD measure of each sub-band is calculated as

$$WPRD_j = \sqrt{\frac{\sum_{i=1}^N (c_i - \tilde{c}_i)^2}{\sum_{i=1}^N (c_i^2)}}$$

where  $c_i$  is the original coefficient within sub-band  $j$  and  $\tilde{c}_i$  is the coefficient of sub-band  $j$  for the watermarked signal. The embedded text message of the implemented wavelet based ECG watermarking is shown in figure 1.

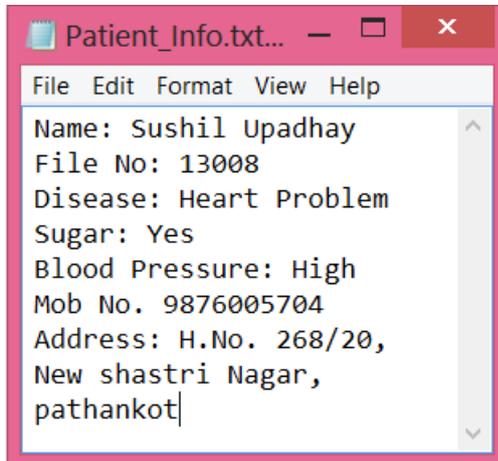


Figure 1: Patient Confidential information

The file contain general information of patient like address, phone number, file number, name as well as disease related reports.

Figure 2 shows the sample of Normal original ECG image A1. We take five normal ECG images of person and verify the average performance of implemented system in terms of PSD, PSNR, MSE, Normalized Cross correlation and Average Difference.

Figure 3 shows the wavelet ECG watermarked image A1 which is a original ECG image with patient confidential information.

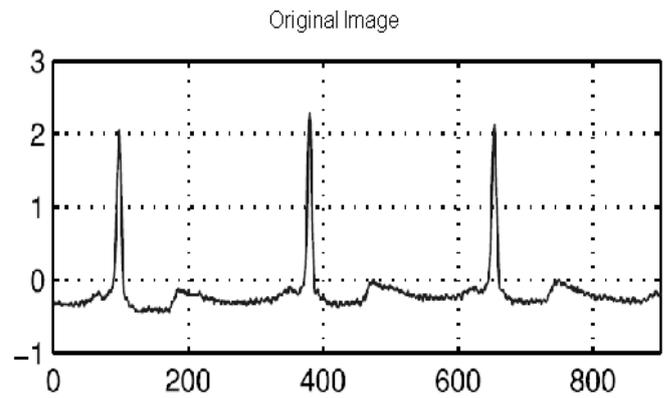


Figure 2: Original Normal ECG Image

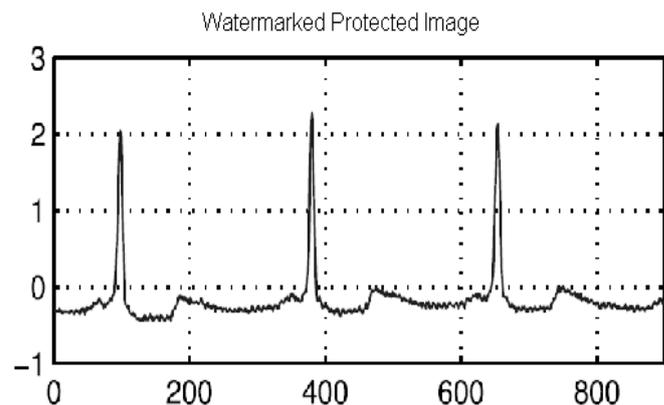


Figure 3: Wavelet based ECG Watermarked image

The wavelet based ECG watermarked image shown in figure 3 seems to be same as that of original image however the image contains patient information. The implemented ECG watermarking system hides the patient information efficiently and

at the same time preserves the image quality of sample ECG images.

We take five normal ECG images of different person having different quality and embed the patient information shown in figure 1. The various performance metric evaluated for the developed system is shown in table 1.

**Table 6.1 Various Quality Measures of Normal ECG images**

Normal ECG Image	%P SD	PSNR	MSE	Normalize Cross-correlation	Average Difference
A1	0.0216	73.5376	0.0029	1.0000	0.0056
A2	0.1112	59.5541	0.0721	0.9999	0.0385
A3	0.1316	58.3207	0.0957	0.9998	0.0524
A4	0.1228	58.4639	0.0926	0.9998	0.0589
A5	0.1302	58.543	0.0935	0.9998	0.0567

## v. CONCLUSION

The aim of this paper is to describe the PHR system, their merits, their features and benefits to consumers/patients. We found many relevant papers, indicating a generally growing interest in PHR use. We implement the wavelet based ECG signal watermarking which hides the patient

confidential information in ECG images. The performance of the developed system is evaluated in terms of various quality metrics. The developed system performs efficiently to hide the information and at the same time preserve image quality.

## REFERENCES

- [1] Bliemel M, Hassanein K. Consumer satisfaction with online health information retrieval: a model and empirical study. *e-Service J* 2007;5:53–83.
- [2] Rideout V, Neuman T, Kitchman M, et al. *e-Health and the Elderly: How Seniors Use the Internet for Health Information*. Menlo Park, CA: Kaiser Family Foundation, 2005.
- [3] Taylor H. Two in five adults keep personal or family health records and almost everybody thinks this is a good idea. *Health Care News* 2004.
- [4] Demiris G, Afrin LB, Speedie S, et al. Patient-centered applications: use of information technology to promote disease management and wellness. *J Am Med Inform Assoc* 2008;15:8–13.
- [5] Kaelber DC, Jha AK, Johnston D, et al. A research agenda for personal health records (PHRs). *J Am Med Inform Assoc* 2008;15:729–36 .
- [6] Earnest MA, Ross SE, Wittevrongel L, et al. Use of a patient-accessible electronic medical record in a practice for congestive heart failure: patient and physician experiences. *J Am Med Inform Assoc* 2004;11:410–17.
- [7] Wuerdeman L, Volk L, Pizziferri L, et al. How accurate is information that patients contribute to their electronic health record? *AMIA 2005 Symposium Proceedings*. 2005:834–8.

- [8] DeLenardo C. Web-based tools steer patient-focused care. *Nurs Manage* 2004;35:60–4 .
- [9] Halamka JD, Mandl KD, Tang PC. Early experiences with personal health records. *J Am Med Inform Assoc* 2008;15:1–7.
- [10] Tang PC, Ash JS, Bates DW, et al. Personal health records: definitions, benefits, and strategies for overcoming barriers to adoption. *J Am Med Inform Assoc* 2006;13:121–5.
- [11] Stolyar A, Lober WB, Drozd DR, et al. Feasibility of data exchange with a patient-centered health record. *AMIA 2005 Conference Proceedings*; 2005. 2005:1123.
- [12] Tang PC, Lee TH. Your doctor's office or the Internet? Two paths to personal health records. *N Engl J Med* 2009;360:1276–8.
- [13] Win KT, Susilo W, Mu Y. Personal health record systems and their security protection. *J Med Syst* 2006;30:309–15.
- [14] Masys D, Baker D, Butros A, et al. Giving patients access to their medical records via the Internet: the PCASSO experience. *J Am Med Inform Assoc* 2002;9:181–91.
- [15] Hess R, Bryce CL, Paone S, et al. Exploring challenges and potentials of personal health records in diabetes self-management: implementation and initial assessment. *Telemed J E Health* 2007;13:509e18.
- [16] Tang PC, Ash JS, Bates DW, et al. Personal health records: definitions, benefits, and strategies for overcoming barriers to adoption. *J Am Med Inform Assoc* 2006;13:121e5.