Automated Diagnosis System of Cardiac Abnormalities Using XML Ontology

Nithya Jennifer.N, P. Selvaraj

Abstract — Electrocardiography is the recording of the electrical action of the heart. Generally this is a translation of the electrical movement of the heart over a period of time. Existing philosophy concentrates on diagnosing the 37 cardiovascular irregularities by utilizing XML cosmology and ontological mapping to distinguish the sickness obtained. This system does not tune-up the picture of the ECG before transforming as the commotion rate deceives to the determination report. In the proposed procedure, a picture acceptance of histogram check is detailed to correct the clamour procured in the info ECG Image. The accepted ECG specimen picture has been measured with its tallness and plentifulness to quantify the irregularities utilizing XML philosophy. Along these lines the proposed framework defeats the clashes confronted in the current framework, the execution as far as time and precision has been imagined graphically.

Index Terms— Histogram image validation, Cardiac abnormalities, Image segmentation, ECG diagnosis, XML ontology, Hypokalemia, XML cosmology

1 Introduction

PICTURE handling can be characterized as any sort of sign preparing in which the data for instance patient's data is a picture, in the same way as a photo or feature outline. The yield of data (picture) procedure is additionally either a picture or a gathering of qualities or parameters connected with the picture, the same concept used in Electrocardiogram (ECG). ECG alludes to the direct recording of semi periodical, musically rehashing little voltage signal (~1mV) synchronized by the heart, the bioelectric event generator [1, 2]. The term ECG was brought into therapeutic practice 100 years back by William Einthoven, who initially presented the crucial capacity of the ECG [1]. ECG gives electrophysiology that demonstrates a review of the cardiovascular health. The non-intrusive recording procedure and the visual elucidation facility have made it as a capable tool for the restorative experts to concentrate clinical data about patients' wellbeing. The beginning stage for electrocardiography is the discovery of R spikes of QRS-unpredictable and after that P and T waves mirroring the methodology of depolarization of the ventricles, atria & last re-polarization of ventricular myocardium respectively [3]. Researchers of biomedical field have set the standard amplitude and duration values of those peaks and their derivatives. Deviation from the standard quality and deviated stage connections of the subsequent ECG sign reflect irregularity of the human body. Along these lines, it is utilized as the essential demonstrative instrument of all heart illnesses. Arrhythmia, an infection brought about by inconsistency in heart mood has dependably been eccentric for brief time ECG Test [4].Those limitations often let physicians to prescribe costly hazardous diagnosis instead this non-invasive method. In spite of these highlighted drawbacks of ECG accuracy, it does not lose its zeal in patient's mind because of its cost-effectiveness and availability. Regarding this issues, a lot of researches have been carried out recently to make ECG analysis as accurate as possible. Current frameworks focuses on diagnosing the 37 heart abnormalities by using XML cosmology and ontological pattern to distinguish the infection obtained. By looking at the ECG motion in subtle element it is conceivable to infer various useful estimations from the trademark ECG waveform. These can then be used to review the therapeutic thriving of the patient, and more discriminatingly, spot any potential responses of the prescription on the cardiovascular state of mind. The most basic of these estimations is the "QT interval". In particular, medicine impelled prolongation of the QT between time (gathered Long QT Syndrome) can achieve a fast, unusual heart musicality known as torsade de pointes, which is oftentimes trailed by sudden cardiovascular downfall [18].

In the proposed system, a picture acceptance of histogram check is planned to correct the clamour gained in the information. The Validated ECG specimen picture has been measured with its stature and abundance to measure the anomalies utilizing XML metaphysics. Along these lines the proposed framework defeats the clashes confronted in the current framework and the execution regarding time and exactness has been pictured graphically. The framework likewise beats the matter of false forecast of disorder by substantiating the data picture abuse reference chart strategies that approves the component for extra process .The resultant of the anticipated framework creates the disorder diagnosing with an authentic info picture subsequently recognizing the mood ,endpoint and pivot positions of the bend.

1.1 ECG Wave Structure

To model ECG yield information and afterward to make derivations as to any heart anomalies that it may represent one must first comprehend the structure of the ECG waveform. Figure 1 shows the structure of ECG waves, alongside intervals, standard time, and voltage measures [5], [6]. The P wave represents atrial activation. The PR interim is the time from onset of atrial initiation to onset of ventricular activation.

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The QRS complex represents ventricular activation while the QRS term is the length of time of ventricular initiation. The ST-T wave depicts ventricular repolarization. The QT interim is the length of time of ventricular initiation and recovery. The U wave represents the time interval after depolarization in the ventricles [6].

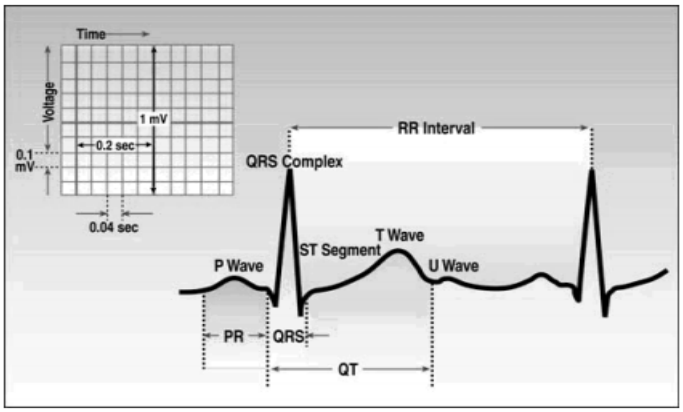

Fig 1 ECG wave structure [5]

2 Related Work

Various strategies have been proposed with diverse signal handling methodologies; some common approaches are template matching, numerical models (Pahlm and Sornmo, 1984), signal envelop (Nygards and Sornmo, 1983), matched filters, ECG slope criterion (Algra and Zeelenberg, 1987), dynamic time warping, syntactic methods (Kohler et al. 2002), hidden Markov models (Clavier et al. 2002), beat detection by neural networks (Xue et al. 1992; Shyuand et al. 2004), adaptive thresholding (Christov, 2004; Madeiro et al. 2007), time-frequency decompositions by wavelet transforms (Addison, 2005) and geometrical approach (Surez et al. 2007) [7,8,9].

The Standard Communications Protocol for Computer-Assisted Electrocardiography (SCP-ECG), which was proposed by the Project Team PT5-007 of CEN/TC 251 in 1993, gives determinations to the trade organization of ECG waveform information, patient data, and estimation results (European Committee for Standardization, 1993). Notwithstanding, the utilization of this standard was not fruitful because of a few impediments, and along these lines was never received by ECG product producers. The standard leaves an excess of degrees of opportunity in numerous territories, for example, subtle elements in data format with the result that it is difficult to produce generic SCP-based software [10].

Wang et al., (2004) proposed methods for managing ECG data by using XML for ECG representation. They developed tools to convert ECG from a specific database (MIT-BIH Arrhythmia) to data in XML format. This research initiates an XML-based approach to support ECG data storage. It provides hierarchical structure of ECG data representation. However, this research does not include ECG measurements and diagnosis approaches for decision support. It also focuses on only representation of ECG data from a specific database. The developed tools cannot be directly applied to ECG data from other sources [11].

An alternate study introduces a product innovation to change paper-based 12-lead electrocardiography (ECG) examination into (1) 12-lead ECG electronic diagnoses (e-diagnoses) and (2) mobile diagnoses (m-diagnoses) in emergency telemedicine. It adds to a DICOM-based 12-lead ECG data framework equipped for giving clinicians therapeutic pictures and waveform-based ECG conclusions through Picture Archiving and Communication System (PACS). The created PACS-subordinate 12-lead ECG data framework enhances 12-lead ECG administration and interoperability and empowers remote doctors to perform pervasive 12-lead ECG and picture determinations, which upgrades the productivity of crisis telemedicine. These discoveries demonstrate the viability and helpfulness of the PACS-subordinate 12-lead ECG data framework, which can be effectively embraced in telemedicine [12].

Trigo et al. aims at performing an extensive review on the current condition of undertakings of the interoperable trade of advanced ECG signals. It covers a survey on existing advanced ECG positions, a gathering of utilizations and cardiology settings utilizing such arrangements, an aggregation of the connections between such configurations, and a reflection on the current circumstance and foreseeable future of interoperable trade of computerized ECG signals. By overhauling past audits on the subject through fitting database mining, 39 computerized ECG designs, 56 applications, instruments or implantation encounters, 47 mappings/converters, and 6 connections between such arrangements have been found in the literature [13].

A review of recent developments in the field of "patch" devices primarily designed for very long-term monitoring of cardiac arrhythmic events was proposed in this paper. These devices hold promise for a variety of cardiac monitoring applications. The capacity to obtain longitudinal cardiac activity data by patch devices may have significant implications for device selection, monitoring duration, and care pathways for arrhythmia evaluation and atrial fibrillation surveillance. In their research the new devices allow for the development of novel diagnostic algorithms with the goal of finding patterns and correlations with exercise and drug regimens [14], [15].

Implementation of an open-source ECG system to visualize XML files obtained from GE MAC5500 ECG machines, without using their specific platform, and a way to automatically detected heart abnormalities based on ECG. It deals with reading, displaying and processing data from a medical electrocardiograph. There is need to further tests and validate each component for accuracy and clinical relevance by working closely with doctors [16].

Bernardo Gonçalves presents an application-autonomous ontological examination of the electrocardiogram (ECG) grounded in the Unified Foundational Ontology. By exploring the phenomena hidden cardiological exam, they deal with the sub-domains of human heart electrophysiology and anatomy. They plot an ECG Ontology based upon the OBO Relation Ontology. In addition, the space metaphysics outlined takes motivation both in the

Foundational Model of Anatomy and in the Ontology of Functions proposed under the sponsorship of the General Formal Ontology (GFO) exploration program [17]

3 ARCHITECTURE

ECG frameworks have been created to serve as strong decision aids to doctors diagnosing cardiovascular condition. By inspecting the ECG signal, instructive estimations can be gotten from the waveform that in turn prompt a particular heart condition. Then again, no framework has been accounted for computerized recognition of heart irregularities that are recorded through ECG waveforms. The framework gives automated support to physicians by coordinating ECG waveform information, information depictions and the cardiovascular diagnosis rules. Diagnosing the illness is carried out without the physician speculating by utilizing waveforms.

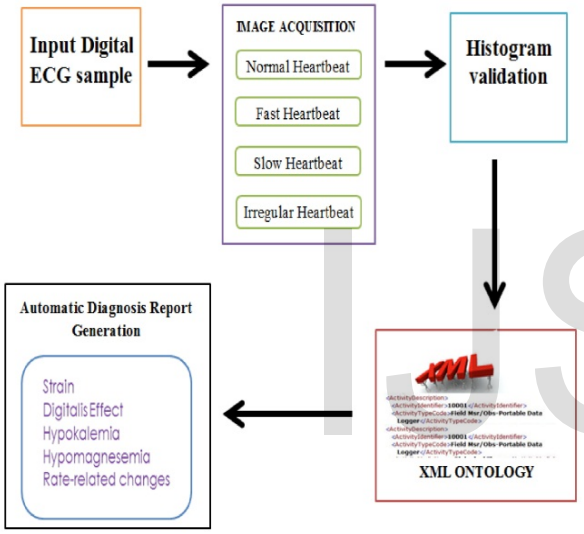

Fig 2 Software architecture in each node

An acceptance procedure is consolidated in the proposed framework to expel the noise data from the entered picture as it gets the exactness of the diagnosis report. An ontological mapping is intended to distinguish the heart expectations of curves and xml schema is exploited in a way to guide the ontological blueprint data with the inputted image.

The proposed framework defeats the issue of false expectation of disorder by accepting the data picture utilizing histogram procedures that accepts the pixel for further processing. The resultant of the anticipated framework produces the disorder judgment with a substantial information picture along these lines distinguishing the musicality, endpoint and axis positions of the curve. In view of the different channels and radio affiliations accessible, FAARS produces autonomous reconfiguration plans that opens up for changes of system setups just in the regions where link failures occurred while pertaining configurations in sectors identified in failure locations.

4 METHODOLOGY AND DESIGN

The process of analyzing ECG signal can be divided into the following stages: preprocessing and the feature extraction. The algorithm of the proposed analysis technique is as follows:

Step 1: Image Acquisition
Step 2: Histogram image validation and segmentation
Step 3: Ontology and XML Schema Mapping
Step 4: ECG Abnormality Detection and Diseases Diagnosis

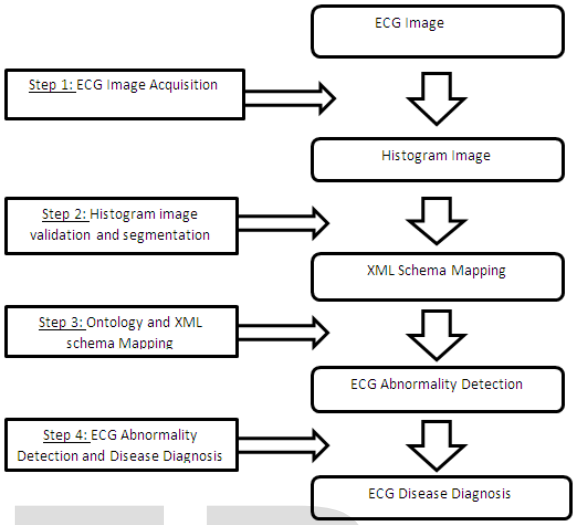

Fig 3 ECG Development Framework

The process for converting ECG image data to a histogram image, the schema mapping, implementing the ontology, and diagnosing disease is illustrated in Figure 3. It is divided into four, described in the following sections.

Step 1: Image Acquisition

A database is a vital prerequisite in contemplating the examples, edges, time, and force points of interest of heart sounds. Another database was made utilizing examples gathered from Ramachandhra Hospital, Chennai. Image obtaining in picture handling once in a while is the introductory setup and long haul upkeep of the equipment used to catch the pictures. The real equipment gadget can be anything from a desktop scanner to a gigantic optical telescope. On the off chance that the equipment is not legitimately arranged and adjusted then visual relics can be delivered that can confound the picture handling. One of the types of picture securing in picture handling is known as on-going picture procurement. This normally includes recovering pictures from a source that is consequently catching pictures. The data obtained from the patient's scan stored in a database, is then processed into a picture which is later loaded into the ECG system. The figure below shows the image acquisition which is then transformed into histogram image and improve its quality. The image is then validated and segmented as shown in the next step.

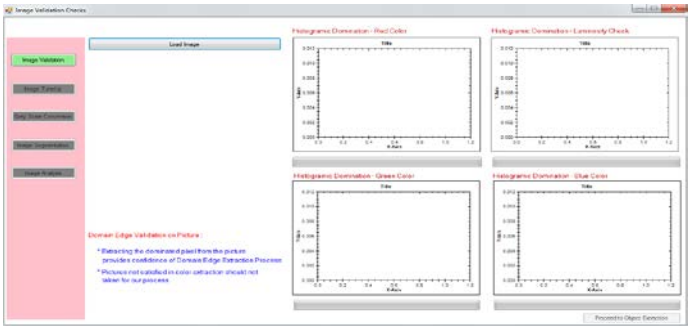

Fig 4 Image acquisition

Step 2: Histogram image Validation and Segmentation

Information will be in electrical action arrangement, approve the state of heart. Generally time-space ECG signs are utilized. New modernized ECG recorders use recurrence data to discover obsessive condition.

Picture division is done to improve and/or change the representation of a picture into something that is more important and simpler to analyze. The division is used to spot articles and limits (lines, bends, and so on.) in pictures. All the more accurately, picture division is the methodology of relegating a mark to each pixel in a picture such that pixels with the same name impart certain characteristics. The after effect of picture division is a situation of sections that on the whole cover the whole picture, or a set of forms removed from the picture.

Each of the pixels in a district is comparative as for some trademark or registered property, for example, shade, power, or composition. Contiguous locales are essentially distinctive concerning the same characteristic(s). At the point when connected to a stack of pictures, commonplace in medicinal imaging, the ensuing shapes after picture division can be utilized to make 3D reproductions with the assistance of insertion calculations like Marching blocks. Sign contains commotion segments because of different sources that are stifled amid preparing of ECG sign. Preparing signs were fragmented and named by gathering of master ECG experts. We will examine just routines which don't utilize outside references (ECG, CP or different channels).

Fig 5 Image Segmentation

Step 3: Ontology and XML Schema Mapping

Cosmology arrangement emerged out of the need to incorporate heterogeneous databases ones created autonomously and accordingly each one having their own information vocabulary. XML Schema reports are utilized to characterize and approve the substance and structure of XML data. Schema Component is the nonspecific term for the building obstructs that form the unique information model of the outline.

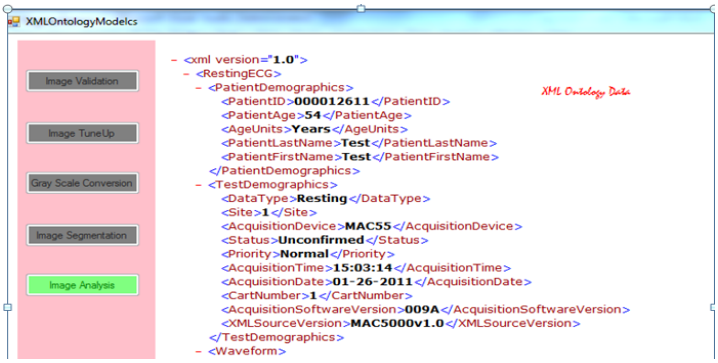

Fig 6 Ontology and Schema mapping

Step 4: ECG Abnormality Detection and Disease Diagnosis

The Signal contains commotion parts because of different sources that are stifled amid transforming of ECG signal. In this module utilized as a part of Wavelet change - gives great time determination and poor recurrence determination at high frequencies and great recurrence determination and poor time determination at low frequencies. Resolution of the sign is changed by separating operations.

From the features acquired using the algorithm, and using some derived features such as wavelet, statistical analysis was carried out to find out patterns that differ with the diseases.

5 SOFTWARE IMPLEMENTATION

A graphical user interface (GUI) with an input segment to provide the raw ECG signal and a separate report generation section is needed for the physician. The user interface form, termed as "Main Form" is designed for the end-user or physician. It contains five menus namely "Image Validation", "Image Tune Up", "Gray Scale Conversion", "Image Segmentation" and "Image Analysis (Diagnosis)". Being motivated by this, a rule based architecture is designed based on the well-known software development models like the waterfall model. This system will extract the characteristic feature of ECG signal with the comparison of predefined standard parameters and predict the diagnosis based on abnormalities found on that ECG signal. It will also provide a series of ECG graph in customizable format. A series of log files attached with the patient's name, age, weight & sex has been collected and the functionality of the software was checked by a renowned physician for the approval of hospital use. The figure below shows the GUI used by the physician to perform the following steps: validation, improvement of the image, segmentation, extraction and finally detection and diagnosis of the heart diseases.

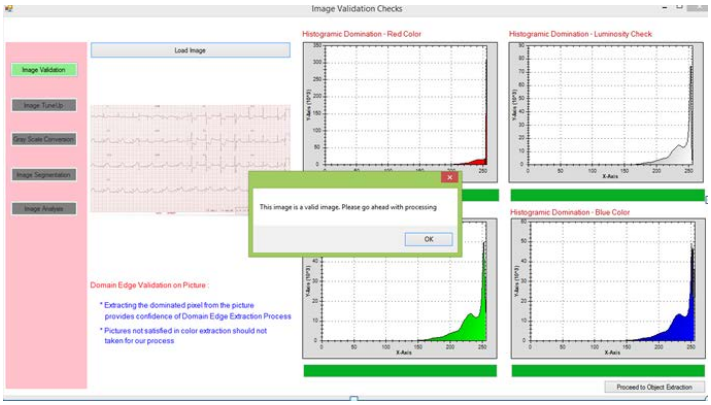

Fig 7 GUI for the Physician

6 RESULTS AND DISCUSSION

Results were dead set for both Interoperability and Accuracy (affectability, specificity, general exactness). The framework had the capacity to diagnose every single ECG with heart rates, heart musicality, anomalous ECG estimations, and conceivable analytic discoveries. Consequently, it was reasoned that the framework exhibited interoperable ability in light of the fact that it had the capacity display all analysis brings about a program from the encoded representation of the open standard HL7 Ontology.

For affectability, from 132 ECGs with a mixture of irregular conditions, 125 ECGs were diagnosed effectively as indicated by the doctor's determination.

The extent of ECGs with irregular conditions that the model can identify effectively will be no less than 91%. For specificity, from 120 typical ECGs, 108 ECGs were accurately diagnosed by the model as ordinary without discovering any unusual conditions. The model also misdiagnosed some ECGs. The general precision of the model was ascertained by considering the aggregate number of examples and the aggregate number of mistakes from affectability and specificity tests. Thus, the model manages to produce results according to the patient's diagnosis.

7 CONCLUSION AND FUTURE WORK

Subsequently the exactness of the proposed sickness judgment framework was enhanced by taking after the xml based ontological pattern. The examples of almost 37 diseases were gathered from the individuals with diverse sorts of maladies (37 sorts) and the histogram approval is carried out to lessen the clamour rate. The xml pattern has been assembled by emulating the HL7 medicinal specialized gadget standard. At last we have measured the precision of the xml diagram by 10 fold cross approval. Future work can enhance comprehension of ECG diagnosis and add to a more precise ECG diagnosis model. More definite estimation of the ECG waveform can likewise be actualized for a more extensive scope of diagnosis. Additionally, a consideration of a preparatory morphological grouping with data of beat number and beat type in the current ontology may be beneficial.

REFERENCES

1. "Human-heart", Available: http://en.wikipedia.org/wiki/Humanheart
2. "ECG", Available: http://en.wikipedia.org/wiki/Electrocardiogram
3. R. M. Rangayyan, "Biomedical Signal Analysis, A Case Study approach", IEEE Press Series in Biomedical Engineering, Wiley, Pp. 14-19,183-190, 2002
4. Haiying Zhou, Kun Mean Hou, Laurent Gineste, Christophe De Vaulx" A New System Dedicated to Real-time Cardiac Arrhythmias Tele-assistance and Monitoring" Journal of Universal Computer Science, vol. 12, no. 1, pp.30-44, 2006
5. D. Jenkins and S. Gerred (1996). ECG Library.[Online].Available: http://www.ecglibrary.com/ecghome.html
6. T. Tinnakornsrisuphap and Richard E. Billo, "An Interoperable System for Automated Diagnosis of Cardiac Abnormalities from Electrocardiogram Data", IEEE Journal of Biomedical and Health Informatics, Vol.9, May 2014
7. B. Kohler, C. Henning and R. Orglmeister, "The principles of software QRS detection", IEEE Engineering in Medicine and Biology, pp.42-57, 2002.
8. Su´arez, K.V., Silva, J.C., Berthoumieu, Y., Gomis, P., Najim, M " Ecg beat Detection using a Geometrical Matching Approach"IEEE Transactions on Biomedical Engineering 54(4), pp.641–650, 2007
9. Martinez, J.P., Almeida, R., Olmos, S., Rocha, A.P., Laguna, P" A wavelet-based ECG delineator: evaluation on standard databases" IEEE Transactions on Biomedical Engineering 51, pp.570–581, 2004
10. Chiarugi M1, Buccianti P, Decanini L, Balestri R, Lorenzetti L, Franceschi M, Cavina E, "What you see is not what you get, A plea to remove a 'normal' appendix during diagnostic laparoscopy", PubMed, pp.243-245, 2001.
11. H Wang, F Azuaje, G Clifford, B Jung, N Black, "Methods and Tools for Generating and Managing ECGML-Based Information", IEEE Computers in Cardiology, Vol. 31, pp. 573-76, 2004Jui-Chien Hsieh, Hsiu-Chiung Lo, "The Clinical Application of a PACS-Dependent 12-Lead ECG and Image Information System in E-Medicine and Telemedicine", Journal of Digital Imaging, pp. 501-503, 2010.
12. Trigo JD, Alesanco A, Martinez I, and Garcia J, "A review on digital ECG formats and the relationships between them", IEEE Trans. Inf Technol Biomed, pp. 432-444, 2012.
13. Lobodzinski SS, "ECG patch monitors for assessment of cardiac rhythm abnormalities", Prog Cardiovasc Dis, pp. 224-229, 2013
14. Masudul Haider Imtiaz, Md. Adnan Kiber, "Design and Implementation of a Real-Time Automated ECG Diagnosis (AED) System", Global Journal of Researches in Engineering Electrical and Electronics Engineering, Vol. 13, 2013
15. Teodoru R Popa, Andrei C. Mocanu, "Medical Data Storage, Visualization and Interpretation: A Case Study Using a Proprietary ECG XML Format", Faculty of Automation, Computers and Electronics, University of Craiova, RO-200440 Romania, 2011.
16. Bernardo Gonçalves, Veruska Zamborlini, Giancarlo Guizzardi , "An Ontological Analysis of the Electrocardiogram", Electronic Journal of Communication, Information and Innovation Health, Vol. 3,pp. 1-26, 2009.
17. Thidarat Tinnakornsrisuphap and Richard E. Billo, "An Interoperable System for Automated Diagnosis of Cardiac Abnormalities from Electrocardiogram Data", IEEE Journal of Biomedical and Health Informatics, Vol.9, 2014