A Survey on E-Health Care System

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Abstract

Dispensaries, Hospitals and Health Care Units exist and serve to the society since a long. As the technology develops day by day the focus on health care unit became a hot spot in current research domain. Researchers have been made attention on this area since few decades. It is of a multi disciplinary research domain. In this article authors have taken a survey to acknowledge regarding the state of art and also for future development. This domain has taken birth with the help of medical science and engineering. Nevertheless the management aspect can be ignored. It depicts some of the issues along with explanation of basic components to enrich the domain of research. Finally it proposes some basic techniques to carry over the work.

Keywords

Health Care Units, Disease Diagnosis, Multi Agent System, E-Health Care, Detection and Monitoring.

I. Introduction

The responsibility of health care units is to take care of human health element. Since a long people from the society take help of the health care units as well as the physicians. The major problem in this system is non availability of dispensaries in remote areas. Also the lack of diagnosis results as death of human being in most of the areas. So it requires the better quality service in specific time with less cost and better communication to remote areas. Starting from minor health problems to measure health problem some units can satisfy some extent but failure case is maximum. To establish a perfect system the role of management is equally important. This generates the multi agent system and is utilized in the health care units. The multi agent system consists of Hospital Management, Patient Management, Accounts Management, Diagnosis Management, and Physician's Management to provide best service.

For Intelligent e-health care system many authors have proposed many methods for detection, modeling and recognition earlier. Some of these are summarized as follows.

Intelligent method in research is considered as the soft computing method. Though the traditional methods are utilized the current research emphasizes on fast computing and less cost for which the intelligent methods have been applied and are applying still for better accuracy for different health problems. This can help to their health care units to update their service.

Some of the works on this area have been proposed by many researchers and are depicted in following section.

II. Health Care System

Basically Dispensaries are available in many small areas. Though it is not sufficient, it serves for minor health elements of people in the society and provides the awareness regarding precaution and monitoring. Though the unit is small it consists of patients, physicians, nurses, pathologists and some office staff to run the dispensary. All these facilities with developed technology and enhanced skilled people are available in hospitals. This concept has been utilized as multi agent system. A basic Multi agent system for the health care unit is shown in figure-1.
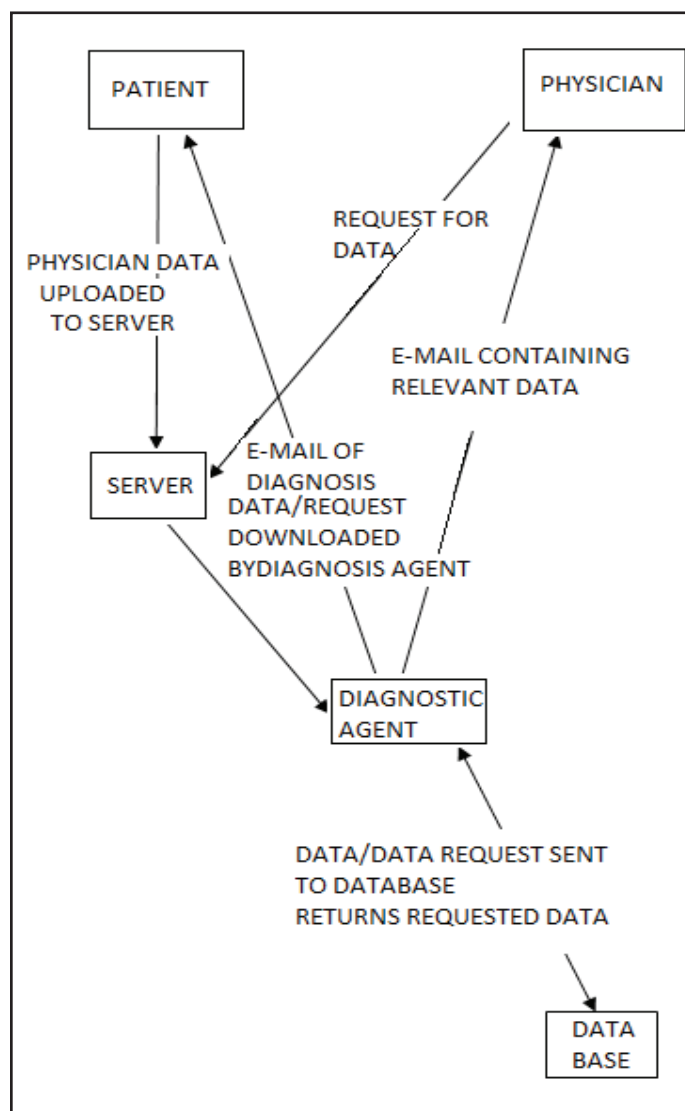

Fig. 1: Generalized E-healthcare System

III. E-Health Care System

The e-health care unit is the developed version of the dispensaries and hospitals. This supports diagnosis, detection, health care as well as health monitoring service to near and far patients. Though the distant patients cannot contact in regular basis they may be communicated electronically and properly monitored. Various applications of multi-agent systems are studied.

Multi-agent system (MAS) is a collection of object oriented intelligent agents which combine together with an objective to solve a complex problem. In [1] a survey was made on intelligent decision support system implemented in the field of medical classification problems. Decision time got priority over decision accuracy in the work. A framework of intelligent agents was proposed based on neural network classification. Intelligent multi-agent system was found having more potential than the agent based system [2]. Authors designed a mobile multi-agent based information platform (MADIP) which can collect and analyze large data faced in patient monitoring using Internet [3]. Authors attempted to manage and

control the patient flow rate to avoid any hazardous condition using decision support system [4]. In [5] authors have tried agent based modeling and simulation using a software to test its application in health care system. ICU management, optimization of available hospital resources and control of spreading of infection in hospital was trailed using an agent based model[6]. Java language in JADE environment implemented to design a multi-agent system to collect, store, retrieve and analyze the patient data using wireless sensor networks. The reduction algorithm used reduce the data by 80% [7]. In [8] a general purpose middle ware architecture multi-agent system was implemented on JADE to fulfill the home health care demands.

E-Health care System can be defined as an IT enabled health care system which comprises of modern health care infrastructure connect with massive network, cloud computing and intelligent devices related to health care echo system. There is a big gap between the health care resources and health care demand between the developing and developed countries. Secondly doctor to patient ratio is also very very low in the developing and developed countries. Further to add there is a big difference in the health care resources between west and east. In order to keep a balance the personalized medical and health services in the above scenario E-Health Care system plays a major role in optimizing and rationalizing the health care services.

IV. Earlier Research on E-Health Care

For analyzing various diseases researchers have used various techniques like Neural Network, Data mining, Fuzzy logic, Data mining approach, Various Algorithms. 13 attributes of patients were taken for analysis of abnormality of heart to predict the heart disease using Cascaded Neural Network (CNN) classifier in [9]; where as 35 attributes for oral cancer were analyzed in [10] using Cascaded Correlation Neural Network (CCNN) for prediction of survival of the oral cancer patient. Analysis of symptoms to predict diabetes using multi layer neural network structure and Levenberg-Marquardt (LM) algorithm was proposed in [11]. Diagnosis being the important section in healthcare system researches made an evaluation of ANN in decision making system considering age, weight, height, lifestyle etc. for diagnosis of osteoporosis [12]. They have used MLP with supervised learning algorithm for the purpose to improve the machine learning algorithm for medical diagnosis. Taking heart diseases into consideration authors used a methodology using SAS (Statistical Analysis System) based software for heart disease diagnosis [13]. The ensemble model consists and three neural network models was tested using UCI machine learning repository for classification of heart diseases automatically. Further a neural network approach for providing prescription for heart disease [14]. Authors have normalized, coded the information, trend the data and compared the result of Radial Basis Function Network with 75 sample medicines. The researchers proposed a novel approach for classification and detection of cough using Multi Layer Perceptron (MLP) and Probabilistic Neural Network(PNN) [15]. In this regard researchers developed a filtering algorithm using Artificial Neural Network (ANN) for QRS detection [16]. The time varying noise characteristics are removed with the help of ANN filter. In [17], authors have taken an endeavour to detect influenza in shrewd way. The model has been composed utilizing cascaded Multi-Layer Perceptron (MLP).The network is trained by LM algorithm. In initial step the symptoms are bolstered to finalize the type of pathological tests. It is encouraged with seven attributes. Once the type of pathological test has been detected, its attributes are nourished to the second stage to choose with respect to influenza or some other because of chronic case. In [18] Disease diagnosis is very difficult task in the field of medicine. Many complex case patients appear in the hospital for survival. Heart disease is one of such task. It is predicted by examining the report of ECG, MRI, Blood pressure, diabetes in traditional manner. As it is a multilayer problem, authors have taken an attempt to diagnose through an intelligent decision system. It consists of two phases. In initial stage, the symptoms are considered to select the tests required. Some of the cases, it may not require for any test. For this purpose the multi layer perceptron network has been utilized. It has been trained with BP algorithm. Once the tests are chosen, further processing is done using the RBFN to detect the disease related to cardiac problem. RBFN with Gaussian Kernel function detects the problem accurately, that helps the physicians for further care.

In consultation with the doctor a screening expert system was approached by authors in [19] using fuzzy rules for early detection of coronary artery disease. For classification of ECG signal and beat recognition another method based on fuzzy neural network was attempted in [20]. Authors have normalized, coded the information, trend the data and compared the result of Radial Basis Function Network with 75 sample medicines. Fuzzy expert system for diagnosis of heart disease was purposed in [21]. Generic Fuzzy Expert system was designed having the interface of matlab and visual basic for user friendly graphic interface. In this context in [22] a fuzzy expert system was purposed considering 13 attributes for classification of heart disease in 4 distinguish levels depending upon the factor of risk of the disease. In [23] the authors had presented a context aware cardiac monitoring system for detection of cardiac arrhythmia. They had not only used ECG as an attribute but also had given emphasis on user's history like Blood Pressure, Stress and Anxiety. They proposed continuous monitoring of Premature Arterial Contraction (PAC) using smart sensors and cloud computing for detection of heart disease. The ambiguity of arrhythmia detection was over came by analyzing 24-48 hours Holter monitor ECG data with real time processing using smart phones [24]. Two smart phones are used for acquisition, display, feature extraction and beat classification to detect the cardiovascular disease. Authors use an ANFIS structure for e-healthcare system [25]. Further the ANFIS system is used for disease diagnosis and support to the patient as well as physicians. For the management of multi-agent system has been satisfied using rule based fuzzy parameters. The service can be provided through internet to the patient as well as the physician. The different situation of patient automatically informs to the doctor similarly the prescription of the doctor for diagnosis can inform to the pathology centre and vice versa. The result of detection communicated to both for desired medicine, monitoring and post care purpose. The performance found to be excellent to satisfy this part of intelligent system. Design of an intelligent fuzzy inference system for detection of abnormal cardiac condition utilizing four parameters such as ECG, Blood Pressure, Blood Sugar and Cholesterol have been proposed [26].. The system was designed using Sugeno defuzzification method. The system has been implemented by using MIT-BIH repository and MATLAB. and the result obtained out of this simulation shows an efficiency better than 95%.. An approach has been considered to diagnose heart diseases in an intelligent manner. The model is designed using fuzzy logic in which the rule based principle is applied to satisfy the objective [27]. Keeping view on multi agent system the model is developed. The diagnosis of the patient is performed

using Fuzzy Inference System (FIS). Once the pathological test results are obtained these will help to form the rules of the model and it works for the diagnosis in convenient way. Further the result of detection is communicated through internet or SMS for monitoring and post care purpose.

A preprocessing step in the field of medical data set classification was proposed in [28]. Using F- Score formula the F- Score value is calculated. If the F-Score value is greater than the mean value then the particular feature is selected which behaves as a redundant in huge medical data. In consultation with the doctor a screening expert system was approached [29] using fuzzy rules for early detection of coronary artery disease. Authors have proposed in [30] to classify the coronary heart disease patient from 12 led ECG signal for 10 seconds. They have used 504 features extracted from ECG signal for heart beat representation and classification. They used random forest classifier and Support Vector Machine (SVM) classifiers for the purpose. These authors have used Rotation Forest (RF) ensemble classifiers of 30 machine learning algorithms to compare the classification ability using three different data sets. In this context researchers used Genetic Algorithm (GA) in medical diagnosis. They improved a new learning technique that is Cost Sensitive Case Based Reasoning (CSCBR) for introducing unequal misclassification cost into case base reasoning model. The shortcomings of conventional CBR were modified and overcame to reduce the cost by reducing the number of tests, to speed-ate for loss consumption of time and improved the accuracy. Machine learning based expert system algorithm for optimization of the goal. They have used Optimal Decision Path Finder (ODPF) algorithm for this novel approach[30]. Real coded genetic algorithm based system was proposed for selection of critical clinical parameter for diagnosis of heart diseases. The algorithm reduced the required number of parameters for efficient diagnosis of the heart disease. Novel approach for risk stratification was made for cardiac disease in women. They proposed cost sensitive K-Nearest Neighbor (KNN) to the clinical data set for reduction costly invasive tests. Investigated of classification through voting with the data mining technique KNN enhances the accuracy of the cardiac disease diagnosis. A multilayer NN approach was made to using a decision support system for diagnosis of cardiac diseases. Using MLP with 40 attributes and encoding schemes 5 types of heart diseases were classified. Back-propagation algorithm with 3 assessment methods that is cross validation holdout and bootstrapping were used. Diagnosis of heart problem by analyzing the sound with the help of digital signal processor and matlab are one such process. The Genetic Algorithm (GA) and Support Vector Machine(SVM) hybrid algorithm was stated for selection of attributes in data mining for prediction of heart disease [31]. Authors have attempted to discriminate the cough sound using neural network [32]. The acoustic features and spectral components in cough are used to make its counting automated in [33, 34]. Authors have compared the performance of various sensors used in cough detection. Android Application was used for early detection of heart disease with the help of android phone VCIRS as decision makers and pulse sensor Arduino as heart rate detector. By the authors a technique was developed in extension to the previous work using Co-Active Neuro Fuzzy Inference System (CANFIS) in. The CANFIS model a combination of Neural Network and Fuzzy Inference System being integrated with Genetic Algorithm auto tuned the CANFIS Parameters for optimal selection of attributes to detect the heart disease.

To analyze the electrocardiogram (ECG) signal authors have attempted with various techniques like wavelet transform, Hill Bert transform, hybrid wavelet and time plane base method, variable threshold method and wavelet packets [35,36,37,38,39,40] to analyze the abnormality of the heart function of patients. From the previous study [35-40] authors developed a new real time QRS detection algorithm using 'C' language [18]. In this regard a filtering algorithm using Artificial Neural Network (ANN) for QRS detection. The time varying noise characteristics are removed with the help of ANN filter. Data pre-processing and feature extraction using MATLAB for detection of cardiac abnormality is one such attempt. Fourier Transform (FT) method of analysis has been done to determine the R-peak contents of an ECG signal to analyze the patients' health condition. However, FT analysis provides only the frequency component of any signal. The analysis will be more versatile and informative if both time and frequency information are investigated. For an adaptive window size, wavelet analysis can take care of both time and frequency component of a signal adequately. This makes it as a potential feature extraction technique for this work. Subsequently an attempt is made to estimate the base line drift removal of the signal to obtain the main signal using wavelet decomposition. Next to it discrete wavelet transform have been applied to enrich the result. So the result is obtained in such a manner that the beat rate of the subject is exhibited. It is the easier way to decide the condition of the patient along with the observation of the ECG signal.

V. Proposal for Future Trend

A few points have been proposed for future research on this area.

1. As there are multiple agents for the health care unit, each sub unit should be designed appropriately for better accuracy.
2. For management researchers, the optimal management must be developed to manage each modules.
3. Intelligent methods have to be used for enhanced diagnosis job.
4. Monitoring of remote patients have to be well benefited.
5. Telemedicine system is to be taken care, that can provide prompt service round the clock.

References

[1] Salem, H.; Attiya, G.; Fishawy, N.,"A Survey of Multi-Agent based Medical Classification Problems", International Journal of Computer Applications, Vol. 123, No. 10, August 2015; pp. 20-25

[2] Asadi, R.; Mustapha, N.; Sulaiman, N.,"A Framework For Intelligent Multi Agent System Based Neural Network Classification Model", International Journal of Computer Science and Information Security, Vol. 5, No. 1, pp. 168-174, 2009.

[3] Chuan, J.; Su C.J.,"Mobile multi-agent based, distributed information platform (MADIP) for wide-area e-health monitoring", Computers in industry 59, pp. 55-68, 2008.

[4] Benhajji, N.; Roy, D.;Anciaux, D.,"Patient-centered multiagent system for health care", IFAC-Papers on line 48-3, pp. 710-714, 2015.

[5] Silverman, B.G.; Hanrahan, N.; Bharathy, G.; Gordon, K.; Johnson, D.,"A systems approach to healthcare: Agent-based modeling,community mental health and population well-being", Artificial Intelligence in Medicine 63, pp. 61–71, 2015.

[6] Ferrer, J.; Salmon, M.; Temime, L.,"Nosolink: An agent-based approach to link patient flows and staff organization with the circulation of nosocomial pathogens in an intensive

care unit" Procedia Computer Science 18, pp. 1485-1494, 2013

[7] Vaidehi, V.; Vardhini, M.; Yogeshwaran, H.; Inbasagar, G.; Bhargav, R.; Hemalathac, C. S.,"Agent Based Health Monitoring of Elderly People in Indoor Environments Using Wireless Sensor Networks", Procedia Computer Science 19, pp. 64-71, 2013.

[8] Armentia, A.; Gangoiti, U., Priego, R., Estévez, E.; Marcos, M.,"A Multi-Agent Based Approach to Support Adaptability in Home Care Applications", IFAC Papers On Line 48-10, pp. 001-006, 2015

[9] Chitra, R.; Seenivasagam, V.,"Heart Disease Prediction System Using Supervised Learning Classifier", Bonfring International Journal of Software Engineering and Soft Computing, Vol. 3, pp. 1-7, 2013.

[10] Sharma N, Om H,"Cascade Correlation Neural Network Model for Classification of Oral Cancer", WSEAS Transactions on Biology and Biomedicine, Vol. 11, pp. 45-51, 2014.

[11] Temurtas H, Yumusak N, Temurtas F,"A comparative study on diabetes disease diagnosis using neural networks", Expert Systems with Applications 36: pp. 8610–8615, 2009.

[12] Shaikh, A.B.; Sarim, M.; Raffat, S.K.; Ahsan, K.; Nadeem, A.; Siddiq, M.,"Artificial Neural Network: A Tool for Diagnosing Osteoporosis", Research Journal of Recent Sciences Vol. 3(2), pp. 87-91, 2014.

[13] Das, R.; Turkoglu, I., Sengur, A.,"Effective diagnosis of heart disease through neural networks ensembles", Expert Systems with Applications, 36, pp. 7675–7680, 2009.

[14] Hannan, S.A.; Mane, A.V.; Manza, R.R.; Ramteke, R.J., "Prediction of Heart Disease Medical Prescription Using Radial Basis Function", IEEE, 2010.

[15] Moshou, D.; Chedad, A.; Hirtum, A.V.; Baerdemaeker, J.D.; Berckmans, D.;Ramon, H.,"D. Moshou, "An intelligent alarm for early detection of swine Epidemics based on neural networks", Transactions of the ASAE American Society of Agricultural Engineers, Vol. 44(1), pp. 167–174, 2001.

[16] Xue, Q.; Hu,Y.H.; Tompkins, W.J.,"Neural-Network-Based Adaptive Matched Filtering For QRS Detection", IEEE transactions on biomedical engineering, Vol. 39, No. 4, pp. 317-329, 1992.

[17] Sarangi,L.N.;Mohanty,M.N.;Patnaik, S.,"Design of MLP Based Model for Analysis of Patient Suffering from Influenza", Procedia Computer Science 92, pp. 396-403, 2016.

[18] Sarangi, L.N.; Mohanty,M.N.; Patnaik, S.,"An Intelligent Decision Support System for Cardiac Disease Detection", IJCTA, pp. 2137-2143, 2015.

[19] Pal, D.; Mandana, K. M.; Pal, S.; Sarkar, D.; Chakraborty, C.,"Fuzzy expert system approach for coronary artery disease screening using clinical parameters", Journal of knowledge based system, Vol. 36, pp. 162-174, 2012.

[20] Osowski S, Hoai L.T.,"ECG beat recognition using fuzzy hybrid neural network", IEEE Transactions on Biomedical Engineering, Vol. 48, No. 11, pp. 1265–1271, 2001.

[21] Sikchi S.S, Sikchi S, Ali S.M,"Design of fuzzy expert system for diagnosis of cardiac diseases", International Journal of Medical Science and Public Health, Vol. 2, Issue 1, pp. 56-61, 2013.

[22] Ali.Adeli, Mehdi.Neshat,"A Fuzzy Expert System for Heart Disease Diagnosis", Proceeding of the International multi conference of Engineers and computer scientists, Vol. 1,

March, 2010, pp. 17-19.

[23] Forkan, A.; Ibrahim Khalil, I.; Tari, Z.,"Context-aware Cardiac Monitoring for Early Detection of Heart Diseases", Computing in Cardiology 40, pp. 277-280, 2013

[24] Oresko, J.J.; Huang,S.; Sun, Y.; Duschl,H.; Cheng, A.C.,"A Wearable Smartphone-Based Platform for Real-Time Cardiovascular Disease Detection Via Electrocardiogram Processing", IEEE transactions on information technology in biomedicine, Vol. 14, No. 3, pp. 734-740, 2010.

[25] Sarangi,L.N.; Mohanty, M.N.; Patnaik, S.,"Design of ANFIS Based E-Health Care System for Cardio Vascular Disease Detection", IISA, Springer, 2015.

[26] Sarangi, L.N.; Mohanty, M.N.; Patnaik, S.,"Detection of Abnormal Cardiac Condition using Fuzzy Inference System"IJAAC Inder Science Publisher, 2015.

[27] Sarangi, L.N.; Mohanty,M.N.;Patnaik, S.,"Cardiac Diagnosis and Monitoring System Design using Fuzzy Inference System", RICE, IEE Conference, 2016.

[28] Polat, K.; Gunes, S.,"A new feature selection method on classification of medical datasets: Kernel F-score feature selection", Journal of Expert Systems with Applications, Vol. 36, 20, pp. 10367–10373, 2009.

[29] Pal D, Mandana K. M, Pal S, Sarkar D, Chakraborty C,"Fuzzy expert system approach for coronary artery disease screening using clinical parameters", Journal of knowledge based system, Vol. 36, pp. 162-174, 2012.

[30] Chi, C.L.; Street, W.N.; Katz, D.A.,"A decision support system for cost-effective diagnosis", Artificial Intelligence in Medicine, ARTMED 1139, pp. 1-13, 2010.

[31] Tan, K.C.; Teoh, E.J.; Yua, Q.; Goh, K.C.,"A hybrid evolutionary algorithm for attribute selection in data mining", Journal of Expert system with applications, Vol. 36, pp. 8616-8630, 2009.

[32] Smith, J.A.; Woodcock, A.,"New Developments in the Objective Assessment of Cough", Lung, 186(1), pp. S48-S54, 2008

[33] Smith, J.A,"Ambulatory methods for recording cough" Pulmonary Pharmacology & Therapeutics, 20, pp. 313-318, 2007.

[34] Barry, S.J.; Dane, A.D., Morice, A.H.; Walmsley, A.D.,"The automatic recognition and counting of cough", 2:8, Cough, 2006.

[35] Majumder, S.; Dhar, S.; Sinha, A.; Roy, A.,"A hybrid wavelet and time plane based method for QT interval measurement for ECG signals", Proceedings of Ninth International Conference on Signal Processing, ICSP, pp. 2120–2123, 2008.

[36] Pandey, S.; Ayub,"Wavelet Based R Peak Detection ECG Signals Using Matlab", Journal of Basic and Applied Engineering Research, Oct. Vol. 1, No. 2, pp. 101-103, 2014.

[37] Kohli, S.S.; Makwana, N.; Mishra, N.; Sagar, B.,"Hilbert Transform Based Adaptive ECG R-Peak Detection Technique", International Journal of Electrical and Computer Engineering (IJECE), Vol. 2, No. 5, pp. 639-643, 2012.

[38] Bensegueni, S.; Bennia, A.,"R-PEAK detection using wavelet transforms technique", U.P.B. Sci. Bull., Series C, vol. 77, Iss. 3, pp. 135-148, 2015.

[39] Birle, A.; Malviya, S.; Mittal, D.,"A Novel Technique of R-Peak Detection for ECG Signal Analysis: Variable Threshold Method", International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE), Vol. 4, Issue 5, pp. 1167-1169, 2015

[40] Singh, O.; Sunkaria, R.K.,"A Robust R-peak Detection Algorithm using Wavelet Packets", International Journal of Computer Applications, Vol. 36, No. 5, pp. 0975 – 8887, 2011.

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