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Literature Review of Heart Disease Monitoring using Internet of Things

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Abstract

An intelligent cardiac auscultation is the process of monitoring the heart beat signals variations of a patient monitoring system for monitoring the patient's health condition automatically through sensors based connected networks in Internet of Things (IoT). It detects the critical condition of a patient by processing sensors data and instantly provides push notification to doctors. There is no process of monitoring of a particular cardiac disease which can lead to loss of life due to improper checkups and not following the lifestyle proposed by the doctor. In our proposed system, coronary heart disease monitoring based on wireless sensors are used to monitor cardiac patient for 24/7 without any human intervention using piezoelectric sensors which is used to measure artery thickness by the flow of blood vessels and extract the waveform. The waveform is classified into normal and abnormal waveform. This abnormal waveform is sent to mobile application where it receives the data and plots the signal curves in real-time. The mobile application acts as the display device and has the capability to upload data to a cloud platform for further analysis and intimation is sent to the cardiologist. The authorized Cardiologist can get access to the cloud platform to get the dataset and results via any peripheral devices which are equipped with specific software and diagnose the results.

Keywords: - *Piezoelectric sensors, IoT, Mobile application*

INTRODUCTION

The term Internet of Things (IOT) has been around for quite a few years. It is gaining ground with the evolution of advanced wireless technology. The basic idea of this concept is the presence of a variety of objects – such as RFID, NFC, sensors, actuators, mobile phones. In this IOT technology, the RFID is the most important concept and it is necessary for internet of things. Different technologies in market like RFID, machine to machine communication, vehicle to vehicle communication etc are implemented using IOT. The main problem of IOT is facing scenario of security the potential Hackers who always eager to attack. The ability to code and track objects has allowed companies to become more efficient, speed up processes, reduce error, prevent theft, and incorporate complex and flexible organizational systems through IOT. The ―Internet of Things‖ refers to the coding and networking of everyday objects and things to render them individually machine-readable and traceable on the Internet Much existing content in the Internet of Things has been created through coded RFID tags.

IOT ELEMENTS

1. ***Sensing:*** The first step in IOT workflow is gathering information at a ―point of activity.‖ This can be information captured by an appliance, a wearable device, a wall mounted control or any number of commonly found devices. The sensing can be biometric, biological, environmental, visual or audible (or all the above). The unique thing in the context of IOT is that the device doing the sensing is not one that typically gathered information in this way. Sensing technology specific to this purpose is required.

2. ***Communication:*** This is where things start to get interesting. Many of the new IOT devices we are seeing today are not designed for optimal communication with cloud services. IOT devices require a means for transmitting the information sensed at the device level to a Cloud-based service for subsequent processing. This is where the great value. Inherent in IOT is created. This requires either Wi-Fi (wireless LAN based communications) or WAN (wide area network… i.e. cellular) communications.

3. ***Cloud Based Capture:*** Gathered data is transmitted to a cloud based service where the information coming in from the IOT device is aggregated with other cloud based data to provide useful information for the end user. The data

being consolidated can be information from other internet sources as well as from others subscribing with similar IOT devices.

4. ***Delivery of Information***: The last step is delivery of useful information to the end user. That may be a consumer, a commercial or an industrial user. It may also be another device in the M2M work flow. The goal in a consumer use case is to provide the information in as simple and transparent a method as possible.

Cloud Computing

The cloud is commonly used to refer to several servers connected to the internet that can be leased as part of a software or application service. Cloud-based services can include web hosting, data hosting and sharing, and software or application use. _The cloud can also refer to cloud computing, where several servers are linked together to share the load. This means that instead of using one single powerful machine, complex processes can be distributed across multiple smaller computers. A cloud server is a shared section of a server. It‘s allocated for your use (via a virtual environment) and controlled by the service or cloud provider. On your end, it appears that you are running your own compute and storage space. However—and this is an important point—there are usually a large number of other people using the same compute and storage resources within their own virtualized environment. Cloud servers offer you the ability to save on purchasing and management costs that would otherwise go to developing and maintaining your own infrastructure. Additionally, with cloud storage, you get billed for only the amount of storage you use, which means you can increase your compute and storage services and scale as needed. One of the advantages of cloud storage is that there are many distributed resources acting as one – often called federated storage clouds. This makes the cloud very tolerant of faults, due to the distribution of data. Use of the cloud tends to reduce the creation of different versions

LITERATURE SURVEY

G. Papanastasiou, M. C. Williams ,M. R. Dweck; S. Mirsadraee, N. Weir ; A. Fletcher, C. Lucatelli, D. Patel , E. J. R. van Beek, D. E. Newby, S. I. K. Semple (2018) [6], proposed a multimodality quantitative assessments of myocardial perfusion using dynamic contrast enhanced magnetic resonance and 15Olabelled water positron emission tomography imaging where where a Kinetic modelling of myocardial

perfusion imaging data allows the absolute quantification of myocardial blood flow (MBF) and can improve the diagnosis and clinical assessment of coronary artery disease (CAD). The performance measures obtained was between (r=0.83-0.92).Issue of this system is that the Positron emission tomography (PET) imaging can help to find comparative performance but results produced by PET cannot be accurate for Obstructive CAD detection.

Stefano Fiorentini, Lars Mølgaard Saxhaug, Tore Grüner Bjåstad, Espen Holte ,Hans Torp, Jørgen Avdal (2018) [16], proposed a maximum velocity estimation in coronary arteries using 3D tracking doppler where commercial ultrasound system was locally modified to perform trans-thoracic, 3D high frame-rate imaging of the coronary arteries. Results from simulation also show that 3D tracking Doppler performance is acceptable up to 10 cm depth and 75◦ beam-to-flow angle. Results from simulations based on realistic coronary flow data suggest that the method can improve the accuracy of maximum velocity measurements in patients. Issue in this paper is that thickness of Blood measurement cannot be made by fat deposit in blood as only amount of blood flow to test through ultrasound high frequency sound waves is measured.

Yihui Cao, Qinhua Jin, Yundai Chen, Qinye Yin, Xianjing Qin, Jianan Li, Rui Zhu, Wei Zhao (2018) [19], proposed an automatic side branch ostium detection and main vascular segmentation in intravascular optical coherence Tomography Images where a fully automatic method for side branch ostium detection and main vascular segmentation. The evaluated performance of the presented method by comparing the manual and automatic detection and measurement results. .A total of 4618 images from 22 pullback runs were used to evaluate the performance of the presented method. The validation results of side branch detection were TPR=82.8%, TNR=98.7%, PPV=86.8%, NPV=98.7%. The average ostial distance error (ODE) was 0.22mm, and the DSC of main vascular segmentation was 0.96.In conclusion, the qualitative and quantitative validation indicated that the presented. Issue of this paper is Detection and Segmentation is a time consuming process.

Nikolas Lessmann, Bram Van Ginneken, Majd Zreik, Pim A. de Jong, Bob D. de Vos, Max A. Viergever, Ivana Išgum (2018) [13], proposed automatic calcium scoring in low-dose chest CT using deep neural networks with dilated convolutions where a method for automatic detection of coronary artery, thoracic aorta, and cardiac

valve calcifications in low-dose chest CT using two consecutive convolutional neural networks. This method was trained and evaluated on a set of 1744 CT scans from the National Lung Screening Trial. Linearly weighted kappa coefficients for risk category assignment based on per subject coronary artery calcium were 0.91 and 0.90 for soft and sharp filter reconstructions, respectively. These results demonstrate that the presented method enables reliable automatic cardiovascular risk assessment in all low-dose chest CT scans acquired. The issue of this paper result is not well suited for coronary artery calcification (CAC) automatic cardiovascular risk assessment is not that accurate.

Yuanwei Li, Chin Pang Ho, Matthieu Toulemonde, Navtej Chahal, Roxy Senior, Meng-Xing Tang (2018) [20], proposed fully automatic myocardial segmentation of contrast echocardiography sequence using random forests guided by shape model where in this paper, a demonstration is made of how to overcome the above limitations of classic RF by presenting a fully automatic segmentation pipeline for myocardial segmentation in full-cycle 2D MCE data. The performance measure achieved in RF training takes 7.1 minutes for 1 tree. Given a test image, RF segmentation takes about 25.5s using 20 trees but tree prediction can be parallelized so that it takes 1.3s per tree. Our sequence dataset Datset2 is small and only based on 6 subjects. Increasing the training data on this set can allow us to train better models than the one derived from Dataset1 which comprises only ES and ED frames.

Ling Zhang, Andreas Wahle, Zhi Chen, John J. Lopez, Tomas Kovarnik, Milan Sonka (2018) [9], proposed predicting locations of high-risk plaques in coronary arteries in Patients receiving stating therapy where a machine-learning approach demonstrated that location specific prediction of future plaque phenotypes related to MACE is feasible, thus improving risk stratification in patients with established coronary artery disease. Performance measures obtained using local vascular characteristics in spatial context (42.6%) and systemic/demographic information (20.4%). The SVM-based feature selection and imbalanced data learning approaches predict high-risk plaque locations better than the previously clinical predictors and underline the importance of local factors on development of high-risk plaques. The issue of this paper is limited resolution of VH-IVUS does not allow direct measurement of thin fibrous caps (<65μm), and recent study questions

the accuracy of the histological correlation of VH-IVUS characterization.

Juan Wang, Huanjun Ding, Fatemeh Azamian Bidgoli, Brian Zhou ,Carlos Iribarren, Sabee Molloi, Pierre Baldi (2017) [7], proposed detecting cardiovascular disease from mammograms with deep learning where Coronary artery disease is a major cause of death in women. The FROC analysis shows that the deep learning approach achieves a level of detection similar to the human experts. The calcium mass quantification analysis shows that the inferred calcium mass is close to the ground truth, with a linear regression between them yielding a coefficients. The performance measure of determination was 96.24%. The issue of this paper is FROC analysis shows that the deep learning approach achieves a level of detection similar to the human experts but not accurate.

Antonis I. Sakellarios, Lorenz Räber, Christos V. Bourantas, Themis P. Exarchos, Lambros S. Athanasiou, Gualtiero Pelosi, Konstantinos C. Koskinas, Oberdan Parodi, Katerina K. Naka, Lampros K. Michalis, Patrick W. Serruys, Hector M. Garcia-Garcia, Stephan Windecker, Dimitrios I. Fotiadis (2017) [3], proposed prediction of atherosclerotic plaque development in an in vivo coronary arterial segment based on a multi-level modeling Approach where a multilevel modeling approach, which can be used for prediction of plaque growth. The approach is based on modeling of blood flow, LDL transport as well as macrophages migration and foam cells formation. The performance achieved is show that ESS and LDL concentration have a good correlation with the changes in plaque area [R2 = 0.365 (P= 0.029, adjusted R2 = 0.307) and R2 = 0.368 (P = 0.015, adjusted R2 = 0.342), respectively] whereas the introduction of the variables of oxidized LDL, macrophages and foam cells as independent predictors improves the accuracy in predicting regions potential for atherosclerotic plaque development [R2=0.847 (P=0.009, adjusted R2=0.738)].The issue in this paper are advanced computational models need to be used to increase the accuracy to predict regions which are prone to plaque development.

Kalia Orphanou, Athena Stassopoulou, Elpida Keravnou (2016) [8], proposed Dynamic Bayesian networks (DBNs) are temporal probabilistic graphical models that model temporal events and their causal and temporal dependencies. Temporal abstraction (TA) is a knowledge-based

process which abstracts raw temporal data into higher level interval-based concepts. an extended DBN model which integrates TA methods with DBNs applied for prognosis of the risk for coronary heart disease (CHD). The Performance measure obtained was 72%.The issue in this paper is to assess the robustness of the model against the chosen cut-off values for deriving the temporal abstractions.

Xinglong Liu, Fei Hou, Hong Qin, Aimin Hao (2016) [18], proposed robust optimization-based coronary artery labeling from X-Ray angiograms a novel coronary artery labeling system from X-ray angiograms. The uniqueness of of this system is its simultaneous handling on labeling as well as various applications for physiological parameter extraction. At the labeling stage, formulate the labeling problem using an energy optimization approach solved by belief propagation without the need of explicit feature extraction, registration, and tracking. The Performance measure obtained is 150 seconds for Coronary Artery Labeling. The issue of this paper is shortcomings due to low quality of images. Due to dynamic movements of heart, the imaging quality is very poor, unavoidably causing severe artifacts if the contrast agent is not injected steadily, and unfortunately, this scenario is extremely challenging for all cardiovascular processing methods.

Abolfazl Khedmati, Alireza Nikravanshalmani, Afshin Salajegheh (2016) [1], proposed a semi-automatic detection of coronary artery stenosis in 3D CTA for detection of coronary artery stenosis, from 3D computed tomography angiography (CTA), is applicable for inspecting heart diseases. A semi-automatic method is used where the stages include 3D CTA pre-processing, vessel enhancement, coronary artery segmentation, centreline extraction, arteries cross-section diameter estimation, and stenos is detection. The authors consider two types of performance evaluations results for stenos is detecting, more than 50%, on 18 real data. In the first type, a sensitivity of 88.89% and a positive predictive value (PPV) of 88.89% are obtained, and in the second type, a sensitivity of 44.2%, and a PPV of 34.27% is achieved. The issue in this paper is to use more features on centerline longitude like tissues features, and to combine them with geometric features, i.e. diameter, or area of vessel cross-section to detect stenosis.

Nabiul Islam, Sudip Misra (2016) [12], proposed “Catch the Pendulum” the problem of asymmetric data delivery in

electromagnetic nano networks where the network of novel nano-material based nanodevices, known as nanoscale communication networks. The problem of asymmetric data delivery in such nano networks-based systems and propose a simple distance-aware power allocation algorithm, named catch-the-pendulum, which optimizes the energy consumption of nano DESs for communicating data from the underlying nano networks to radio frequency (RF) based macro-scale communication networks. The algorithm exploits the periodic change in mean distance between a nano DES, inserted inside the affected coronary artery, and the NM, fitted in the intercostals space of the rib cage of a patient suffering from a CHD. The performance measure obtained is only 50%. The issue of this paper is that heart wall deforming factors, including segmental and area strain, translational and tethering, and specific deformations need to be focused which is not concentrated in this paper.

Weijian Cong, Jian Yang, Danni Ai ,Yang Chen, Yue Liu, Yongtian Wang (2016) [17], proposed quantitative analysis of deformable model based 3-D reconstruction of coronary artery from multiple angiograms where a novel mean composited external force back-projective composition model is proposed and integrated into the deformable model framework for the 3-D reconstruction of coronary arteries from multiple angiograms. The experimental results of performance measure demonstrate the effectiveness and robustness of the proposed model, which can achieve a mean space error of 0.570mm and a mean re-projection error of 0.351mm.The issue in this paper is that the deformable curve may evolve to its closet boundaries instead of the true topology structures of the vascular centerlines when large curvature variances are present for the vessel segments.

Samuel E. Schmidt, Claus Holst-Hansen, John Hansen, Egon Toft, Johannes J. Struijk (2015) [14], proposed a acoustic features for the identification of coronary artery disease in which the current study identified new features, describing changes in the low frequency part of the signal, for the diagnosis of CAD patients. Known features from the higher frequencies performed poorly in the recordings from the electronic stethoscope, which is probably due to noise from various sources, such as motion artifact which is a specific problem for the hand held electronic stethoscope. The diagnostic performance of the current CAD score is close to the widely used ECG exercise tests, but if the

noise problems would be solved the features from high and low frequency bands might supplement each other well and thereby improve the performance of the stethoscope based CAD-score. The performance measure obtained is the area under the receiving operating characteristic for the CAD score was 0.73 (95% CI: 0.69-0.78.The issue of this paper is further improvements in potential in heart sounds for the diagnosis of CAD are necessary to gain clinical relevance.

Sethuraman Sankaran, Leo Grady ,Charles A. Taylor (2015) [15], proposed fast computation of hemodynamic sensitivity to lumen segmentation uncertainty where Patient-specific blood flow modeling combining imaging data (such as CT scans) and computational fluid dynamics can aid in the assessment of functional significance of coronary artery disease. A good performance measure is obtained using the machine learning algorithm, with a correlation coefficient of 0.91 and mean absolute error of < 0.01, compared to sensitivities calculated using the stochastic collocation method. The issues of this system are the uncertainty in flow and pressure at bifurcations is not calculated using CFD for the ground truth, hence they are not captured using the perturbation model used in this work.

Mayurachat Ning Gulari, Mostafa Ghannad-Rezaie, Paula Novelli, Nikos Chronis ,Theodore Cosmo Marentis (2015) [11],proposed a implantable X-Ray-based blood pressure microsensor for coronary In-Stent restenosis surveillance and prevention where an X-ray-addressable blood pressure (X-BP) microsensor. The X-BP has a column of radio-opaque liquid that changes its length with blood pressure. The X-BP allows for the noninvasive evaluation of the pressure drop across a stent and the fractional flow reserve (FFR) on radiographs. The performance measure obtained is 25%. The issue of the paper is that there is no improved x-ray receptor resolutions that are on the way will help improve the performance of the sensor.

Anirban Mukhopadhyay, Zhen Qian, Suchendra M. Bhandarkar, Tianming Liu, Szilard Voros, Sarah Rinehart (2015) [2], proposed a morphological analysis of the Left Ventricular endocardial Surface Using a Bag-of-Features Descriptor where works that studies the relationship between coronary artery stenosis and the morphological alterations in the LV endocardial surface using high-resolution MDCT data and demonstrates its potential predictive value for the diagnosis of the incidence and severity of CAD. The overall performance measure used is 90.62%.The

Issue of this paper is coronary arterial stenoses lead to myocardial ischemic events, there is an underlying gradual and complex process that precedes the clinical manifestation of myocardial infarction.

Didem Yamak, Prasad Panse, William Pavlicek, Thomas Boltz, Metin Akay (2014) [5],proposed non-calcified coronary atherosclerotic plaque characterization by dual energy computed tomography where overlap between CT attenuations measured in lipid and fibrous plaques shows that the mean density might not be an appropriate measure to characterize plaque composition. The Performance measure obtained in cross validation was used to assess the prediction accuracy of the models on phantom data were found to be 7.36%, 5.74%, 5.70% and 5.23% for ANN, SVM, RF and majority voting approach respectively. The issue of this paper is that there were no histopathological findings of the patient plaques. The findings were within comparable ranges with the previously published data on density measurements,. The small number of observations is the other limitation of this study.

Marcin Marzencki, Behrad Kajbafzadeh, Farzad Khosrow-khavar, Kouhyar Tavakolian, Bozena Kaminska, Carlo Menon (2014) [10], proposed diastolic timed vibrator noninvasive pre-hospitalization treatment of acute coronary ischemia, a novel method intended for pre-hospitalization treatment of patients with acute coronary ischemia that can be safely applied by a minimally trained individual prior to or during patient transportation to hospital. The Performance measure obtained is 70%. The issue of this paper is that the major challenge in implementing the device consists in reliable synchronization of the generated vibrations with the heart cycle of the subject.

Dalin Tang, Chun Yang, Jie Zheng, Gador Canton, Richard G. Bach, Thomas S. Hatsukami, Liang Wang, Deshan Yang, Kristen L. Billiar, Chun Yuan (2013) [4], proposed image-based modeling and precision medicine patient-specific carotid and coronary plaque assessment and predictions where atherosclerotic plaques may rupture without warning and cause acute cardiovascular events such as heart attack and stroke. The performance measure obtained is 80.1%. The issues of this paper is transforming to clinical applications could be even more challenging.

CONCLUSION

Thus Coronary Heart Disease Monitoring based on Wireless Sensors will be much benefitted in the society where people who are affected with this type of cardiac diseases are monitored regularly through an application where the abnormal variations are being intimated to the caregiver/Patient as well as the Cardiologist where necessary action is taken. The paper mainly focuses on prevention/nearing of critical conditions in turn it can be a Life saving process.

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