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Table of Contents

Title	Page no.
The Impact of IoT on the Higher Education *Huda A l-Qozani , Arwa Aleryani* Internet of Things (IoT) is changing everything through its ability to connect several devices (smart watches, smart appliances, cars, light bulbs, buildings and an array of other devices that collect and transfer data, often without any human involvement) to a digital network, at any time, from any device. In addition to providing people with the greater flexibility to consume content and knowledge whenever and wherever they wish.	38-48
Effect Of Accent On Improving Speech Recognition Systems *Amer A. Sallam1, Nashwan A. Al-Khulaidi, Mogeeb A. Saeed* Speech is the output of a time varying excitation excited by a time varying system. It generates pulses with fundamental frequencies F0. This time varying impulse is trained as one of the features, and characterized by fundamental frequency F0 and its formant frequencies. These features vary from one speaker to another and from a gender to another one as well. In this paper the accent issues in continuous speech recognition system are considered.	49- 55
Radial Basis Function Neural Network In The Analysis Of Segmented Electrocardiosignals *Nashwan A. Al-khulaidi, Mushtaq A . Saleh. , AbdulQuddos, Saad Ahmad.* Artificial neural networks (ANN) are used to model the information processing capabilities of nervous systems. Research in the field of analysis and interpretation of the cardiovascular diseases with ANN has been attracting more attention in recent years. This paper proposes the use of segmentation of electrocardiograms in time relative to R-wave.	56-62

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Article

The Impact of IoT on the Higher Education

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Abstract

Internet of Things (IoT) is changing everything through its ability to connect several devices (smart watches, smart appliances, cars, light bulbs, buildings and an array of other devices that collect and transfer data, often without any human involvement) to a digital network, at any time, from any device. In addition to providing people with the greater flexibility to consume content and knowledge whenever and wherever they wish. The IoT confirms its important position in the context of Information and Communication Technologies and the development of society. In higher education, more devices are connected; campus leaders will be able to extract much more value from the continuous stream of data and information, helping them move from a transactional relationship with students, faculty, administrators, and providers to an iterative process. The purpose of this study is to find out the impact of the IoT on higher education on the future where new development, smart devices and advancement in technology advance every day. In addition, this paper presents a review of the traditional education (previous classroom education) and online education. In conclusion, IoT has overcome the disadvantages of online education; moreover, IoT removes the traditional barriers of teaching and learning. On a different note, understanding IoT with its advantages and disadvantages will help reach its aimed vision, and here we can benefit from it greatly.

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1.Introduction

The term "Internet of Things" (IoT) was first used in 1999 by the British technology pioneer Kevin Ashton to describe a system in which objects in the physical world could be connected to the internet by sensors. Ashton invented the term to illustrate the power of connecting Radio-Frequency Identification (RFID) tags used in corporate supply chains to the internet in order to count and track goods without the need for human intervention [1]. Today, the Internet of Things has become a popular term for describing scenarios in which internet connectivity and computing capability extend to a variety of objects, devices, sensors, and everyday items [2]. The Internet of Things (IoT) was sometimes referred to as the Internet of Objects; that means it will change everything— including ourselves. This may seem like an abnormal statement, but the internet has already had an impact on education, communication, business, science, government, and humanity. Clearly, the internet is one of the most important and powerful creations in all of human history [3]. The educational environment has also registered major changes, towards a new orientation of teenagers' education, reflected through online documentation, implementation of projects in virtual teams, online tutorials and much more [4]. In this paper, we are going to investigate the previous studies to find out the impact of the IoT on the higher education. The aim of this paper is to discuss the changes in higher education in IoT environment.

2.Previous Studies

2.1 The Traditional Education pre-IoT

Classroom Education

Traditional classroom education has been around for more than a 100 years for almost all members of society, and for many centuries before that, to the upwardly mobile and upper classes. Classroom education continues to be an important way of learning, and there are many benefits that accompany this method of education. In a traditional classroom, students are able to interact with their teachers and peers face-to-face. Traditional classroom education often has a greater availability of advanced study programs with hands-on training, such as medicine or engineering. Physical group projects are also more widely available through traditional classroom education, especially in the fields of construction, engineering, and medicine. Moreover, from Pros and Cons of Traditional Education System [5], the advantages of traditional education are total participation, face-to-face interaction, students can enjoy free daily and weekend events, establish responsibility among the students, and learn through real examples, wide knowledge, teacher-cantered learning, and increased student achievement. However, there are some disadvantages like the high costs of commuting or relocating to the physical campus [6]. Moreover, the disadvantages are the cost of commuting, no flexible study hours, less time in pursuing other tasks, loans, lack of motivation, lack of career direction, students become passive listeners as a result of use of authoritarian approach [5].

Online Education

Participating in online educational opportunities affords students many benefits. These benefits include flexibility, affordability, and convenience. In addition, online education is easy in scheduling, has lower costs, and simplifies connecting with instructors and peers. However, the Disadvantages are the fewer chances to join clubs and extracurricular opportunities that are organized by the educational institution. Students who are seeking a vibrant campus social life may miss out on the socializing that goes on at student unions and recreational centres. For programs that require complex, hands-on training such as surgical specialties in a medical school, online education is not an option [6]. When we come to the tools in teaching, it is obvious that technological advances have brought us some notable improvements in the teaching process [7]. The teacher has experienced substantial changes and now has some means of support in the classroom that provides him/her safety and reliability. However, sometimes, the use of such media has been in detriment of the communication between the teacher and the student; as some teachers are limited to "read" and rely too much on the projected material, forgetting one of the major functions of teaching: motivation. Moreover, the teacher is very reliant and at the mercy of the electronic resources, as a result, in the event of failure, he/she can hardly teach the class [7].

Uygarer and Uzunboylu [8] aimed to investigate the efficiency level of digital teaching materials for higher education programs. They presented a mixed research methodology to gather in-depth and rich context. They have chosen twenty participants from a distance education program of the Pedagogical Formation (2014-2015) at Near East University in Nicosia in North Cyprus. Half of the participants, who took the instructional technology and material design course, used electronic sources. And the other half used traditional sources during the distance education. The participants' answers were categorized into; those taking distance education with digital materials and others taking distance education with non-digital materials. The results of this study indicated that the participants were aware of the facilities of using e-books and they were content with the facilities of usage. In addition, the main resource of alternatives and multiplicity in education is the teachers; therefore, the teachers should build a relationship with technology and should use it in a sufficient level in their current and future classes. Moreover, each teacher should follow technology and apply it in their course materials. Therefore, the design of the digital electronic book is prepared to be adaptive for this generation of students because in general, they are digital readers.

2.2 Internet of Things (IoT)

IoT transforms the process into numerous aspects of our daily life. The various definitions of IoT do not necessarily disagree – rather, they emphasize different aspects of the IoT phenomenon from different focal points and use cases [2]. The Internet Architecture Board (IAB) [9] defined IoT with this description:

'The term "Internet of Things" (IoT) denotes a trend where a large number of embedded devices employ communication services offered by the Internet protocols. Many of these devices, often called "smart objects,'' are not directly operated by humans, but exist as components in buildings or vehicles, or are spread out in the environment'.

However, The International Telecommunication Union (ITU) [10] discusses the concept of interconnectivity:

" A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies.

The Oxford Dictionaries [11] offers a concise definition that invokes the Internet as an element of the IoT:

'The interconnection via the Internet of computing devices embedded in everyday objects, enabling them to send and receive data'.

The Maggie Johnson said [12]:

"At Google, we define the IoT as a network of everyday items with embedded computers that can connect directly or indirectly to the Internet. The number of devices connecting to the Internet is likely to grow exponentially over the next ten years"

Internet of Things (IoT) is a paradigm that considers pervasive presence in the environment of a variety of things/objects that through wireless and wired connections and unique addressing schemes are able to interact with each other and cooperate with other things/objects to create new applications/services and reach common goals [13]. Global sensors and the ability to bridge the gap between the physical world and the machine world were perceived as the conceptual framework for the new learning model. The thinking behind this great paradigm shift is the ability to embed sensors into an object and use Machine-to-Machine (M2M) communication to connect billions of objects/devices to the current Internet infrastructure. The entirety of the physical world is coming online rapidly [14].

3 IoT in Higher Education

The IoT is already presented on most college and university campuses in the form of security cameras, temperature control, access to buildings, lights, power, etc. the potential benefits of increased connectivity that enhance teaching and learning or providing new modes of operation. For example, ubiquitous access to computing power, high-quality online content, and social media and connections can be used to enhance the educational experience. Students can increase their coursework with relevant video, activities, assessments, and conversations with students and faculty around the world. In addition, opportunities to do academic research on various aspects of the IoT are already on-going in many higher education institutions [15], [16].

The IoT opens a range of possibilities and benefits for faculty, staff, and students. With the IoT, students are able to attend any class, at any time, from any device—providing them with greater flexibility to consume content and knowledge whenever and wherever they wish. The IoT lifts the traditional barriers of teaching and learning, providing faculty with the same flexibility to offer better learning experiences for students allowing them to connect with experts from around the world and create robust, hybrid learning environments [17]. The IoT also assists administrators by helping connect everything on campus, everywhere through one secure, unified network to manage campus lighting, parking, and cameras, and to provide valuable data and analytics on traffic patterns, usage, and areas of resource optimization. A second aid that the IoT brings to higher education is the ability to optimize the classroom-learning environment. With the well level of control and extensive sensor data available through the IoT, instructors can continuously regulate classroom conditions, which may be changed depending on the subject and the time of day. Both artificial and natural lighting intensity can be controlled. Air quality can be optimized, as can noise level. By monitoring the ambient sound level at the back of the room, instructors can be alerted whenever their voice becomes difficult to understand [12]. Applications for the IoT are already being leveraged in sectors like healthcare and customer service. The universities and schools are joining the world of IoT. Some of the ways the IoT can benefit education may be obvious, while others are still not as obvious [14]. Tan and his co-authors [18] studied the teaching management system with applications of Radio Frequency Identifications (RFID) and IoT technology. They stated that as the developing field of information technology, IoT technology is applied to the management of higher education classrooms, which is the expected trend of information technology used in education application. Tan and his co-authors have gone to construction of the teaching management systems based on the IoT technology and applying it to the actual classroom teaching experience. They showed that this technology could support students' active interest in learning, improve the teaching efficiency of teachers, and provide technical support for the effective management of education and teaching in colleges and universities.

Bagheri and his co-author [19] have investigated and analyzed how IoT has changed the Education Business Model and added new value proposals in these organizations. They have listed four applications of IoT in the higher education: (1) Campus Energy Management and Eco-System Monitoring: IoT has been applied in energy management and Eco-system monitoring to provide energy efficiency for much more sustainable future. (2) Secure Campus and Classroom access control: create a safe and secure place in universities and managing students' access to classrooms, laboratories and other places in the universities can be achieved by bringing new technologies into education. There are two main technologies that can be used such as RFID (Radio Frequency Identifications) and NFC (Near Field Communication). (3) Student's health monitoring: the IoT plays a major role in a wide range of healthcare application, from monitoring patients to preventing disease. (4) Improving Teaching and learning: IoT can help universities to improve the quality of teaching and learning by providing a richer learning experience and real-time actionable insight into the students' performance. The results of this study showed that IoT has a big impact on value proposals. These include reducing cost, personalized learning, time-saving, enhanced safety, improved comfort, and collaboration.

Elsaadany and Soliman emphasized [17] in their study that with the help of IoT, more information can be collected in order to allow teachers and administrators to turn data into actions by providing the university stakeholders with a real-time view of the students, faculty members, and other staff members. This data intelligence enables universities to improve decisions on student learning experiences, operational efficiency, campus security, and many other aspects of the educational environment promoting more creativity.

McRae and his co-authors [20] studied the relationship between education and technology for students with disabilities. For this potential to be realized, consideration of the wider significance of the relationships between technology and society, education and disability, access and literacy, is needed. They have indicated that concerns about privacy and security and interoperability associated with the technology will need to be overcome, and careful consideration of how the technology can best be adapted to a learning-teaching environment will be needed. However, interviews from this study with students with the disability indicate a willingness to overcome these limitations and embrace the potential of these new technologies as they develop over time.

Gul and his co-authors [21] studied the use of technology and especially IoT in the field of education. They said that IoT has opened the doors for new and innovative ideas to bring ease and improvement in the lives of both students and teachers. They have clarified that research is being conducted on designing IoT-based teaching platforms including smart classrooms, smart labs and entire smart campuses. Studies have also been made to investigate the usefulness of IoT-based smart learning applications and still, much more is left to study regarding IoT in education. Though there are various advantages of IoT in education, a major problem still exists regarding privacy and security. In the future new techniques may be introduced in order to resolve all these issues.

Aldowah and her co-authors [14] introduced an overview of IoT in higher education institutions, especially in universities and took a look at several emerging trends that help evolve higher education, and explore the potential impact of IoT and the future of the IoT on higher education. In addition to further explore some of IoT challenges regarding the higher education sector.

The challenges and opportunities of IoT

IoT brings tremendous challenges and opportunities to higher education. The unique growth of universal computing, developing IoT technologies such as cloud computing, and big data and analytics are helpful not only in improving the core values of teaching and quality of research but also in developing an IoT society and encouraging a new digital culture. Some of the IoT challenges in the higher education sector include Cloud Computing, Instructional Technologies, Mobility Applications, Security and Privacy, Research Computing, Quality and Ethics, and Financing [14]. The IoT can help solve challenges across a wide array of topics, from logistics to administration to student life. So when designing an experience, institutional leaders should approach it first by discovering the biggest pain points. Streamlining and optimizing the utilization of facilities can help achieve financial savings (e.g., responding to weather events, automating operations). Smart devices can alert staff and providers about when to service equipment before a problem even presents itself. Smart doors, locks, and cameras can be used to monitor and control movement in different facilities. As more devices become connected, campus leaders will be able to extract much more value from the continuous stream of data and information, helping them move from a transactional relationship with students, faculty, administrators, and providers to an iterative process in which micro-decisions can be made on an on-going basis [22]. The success of the IoT depends on the availabil-ity of the internet and its spread everywhere [23]. In addition, the internet should be available at a reasonable cost; and this problem may not be very easy to solve in some countries. New devices and the spread of smartphones and apps are generating huge amounts of data, which will continue to increase. It is no longer possible to have that data processed in a central location. This will expand the complexity of the network and the potential for security holes.

These challenges are not unique to higher education institutions, but given the budget cuts and aging infrastructure in academia, the challenges may be more profound in that space [12]. They believe there are three areas that require significant investment and collaboration before an ecosystem can emerge to interconnect people, spaces, and institutions:

•Strong data management and identity controls must be built into the ecosystem (a complex network or interconnected system) from the start.

•The current IoT landscape is made up of individual solutions, or “walled gardens,” that offer benefits for customers who buy from a particular product family.

•Increasing the number of connected objects should not increase the screens or keyboards that are needed for configuration or use. Technology should “fade into the background” via objects and services that provide real user benefit from connectivity and can be controlled through voice, gesture, or other relevant means of input. [12].

To secure the information exchange in the IoT, existing encryption technology needs to be care¬fully reviewed [24]. The encryption algorithms need to be faster and less energy consuming.

Security at both the device and network is critical to the operation of IoT.

The author [25] presents some important points to achieve successful implementation of IoT in education. The article reports that IoT in education has huge potential for the higher education institutions. However, there are three key areas should be addressed to ensure widespread and successful adoption:

•Security: the pervasive development of IoT will not take place across educational institutions. The information should be available, yet confidential, when needed, and the information owner should decide who is allowed to access the information; whether people or organizations. The security approach to embed devices must take into account the complex network of people and objects in both the public and private sectors. Such devices will likely create new relationships between people and computers. The discussion about adopting IoT must maintain a balance between the positive impacts and generating awareness about the risks to both privacy and security. Both educators and learners will need to have a better understanding of ethical issues and the risks of IoT, as well as ways to eliminate those risks. Personal and public data will need to be treated differently, and the individual’s privacy will have to be respected and taken into perspective.

•Data integrity: the integrity of data must also be assured, as well as its accuracy, authenticity, timeliness, and completeness. Success will be predicated on an open platform that will allow collaborates working together to use the same baseline technologies. Educators will need to work closely with governments to ensure the development of IoT in education. At the same time, the government must preserve the safety and security of its citizens.

•Education policies: the policies that encourage adoption of technology in the classroom and its effective integration into programs are critical. Such policies must include sound change-management practices among educational institutions to reduce the barriers of technology adoption and increase its scale. Professional development programs for educators should incorporate IoT tools to encourage early adoption and help educators develop innovative methodologies and appropriate pedagogies for the learning environment.

Marhoob and his co-author [15] studied the challenges facing IoT in education in the developing country (Yemen); they stated that the main challenges are the availability of internet at reasonable costs, shortage of IPv4 addresses and transition to IPv6, power supply for sensors, acceptability among the society, and finally security and privacy protection. They suggested that some solutions to these challenges were devised. The transition from IPv4 to IPv6 is the very important step in the development of the IoT in Yemen now. Security and privacy protection are very important topics for research in the field as well.

Banafa [26] studied the challenges facing IoT. He listed three major challenges:

•Technology: this includes covering all technologies needed to make IoT systems function smoothly as a standalone solution or part of existing systems and that's not an easy mission. There are many technological challenges, including Security, Connectivity, Compatibility & Longevity, Standards and Intelligent Analysis and Actions.

•Business: the bottom line is a big motivation for starting, investing in, and operating any business, without a sound and solid business model for IoT it will have another challenge.

•Society: Understanding IoT from the customers' and regulators' perspective is not an easy task for the following reasons:

Customer demands and requirements change regularly.

New uses for devices as well as new devices develop and grow at breakneck speeds. Inventing and reintegrating must-have features and capabilities are expensive and take time and resources.

The uses for the IoT technology are expanding and changing.

Consumer Confidence.

Lack of understanding or education by consumers of best practices for IoT devices security to help in improving privacy, for example, change default passwords of IoT devices.

The Importance of the IoT to Higher Education

Since students arrive on campus with so many devices, higher education institutions can benefit from this as an opportunity to enhance the students' experience in several ways. For instance, they can use students' smartphones and smart watches as a communications' mechanism. Johnson and his co-authors identify seven categories of technologies that drive innovation in education: Consumer Technologies, Digital Strategies, Enabling Technologies, Internet Technologies, Learning Technologies, Social Media and Visualisation Technologies [27]. The IoT needs discovery and development, which researchers, educators, and students in higher education can lead. Higher education researchers, educators, and students are in a unique place to lead the discovery and development of IoT devices, applications, systems, and services.

Xie and his co-authors presented their opinion [28], Internet-of-Things that offers the following ways to improve learning and teaching:

•The access of students to the learning materials from any computer or other devices connected to the Internet.

•The use of intelligent devices (equipped with hardware and software applications) in so-called smart classrooms.

•The collection and analysis of an important volume of data from sensors and wearable devices more easily and monitoring students' capabilities and achievement.

•The development of educational social software within a context of IoT, referring to the Social Networking Services (SNS), Wikis, Weblogs as support for collaborative activities [4].

Higher education needs to build the leaders of the future IoT economy. The sophisticated talent within higher education systems will imagine, develop, and lead the new business model and technology innovations. The future of the IoT economy can be shaped by experts and leaders in higher education and as well as the students themselves.

3.Discussion

It is not logical nor will it be fair to compare traditional education with education in the Internet of things environment, since education has not moved from classrooms education to the IoT education directly. The education has developed alongside the technology's development gradually. One of the most important online education advantages is the access to the education venue from anywhere in addition to the lack of cost. On the other hand, online education is perceived to result in depriving students' from social life in the university and missing direct orientation (face to face) as well as not being a preference for applied studies. With the development of IoT, the education tried to extract benefits from this development. Now, the education environment has been able to take advantage of all social media to compensate for the lack of social life. Students can get to know each other better, share their interests and build a social life on these social media as well as in real life.

The great benefit that has been the main reason behind the development of education in the IoT's environment is the possibility of making use of this technology to develop applied education online.

4.Conclusion

In our investigation, we can conclude that IoT was of great use to the higher education. It has overcome the disadvantages of online education; moreover, it strength the advantages. The future will bring every day new development, which can be useful for education; however, the most important point to conclude here is we have to make use of it in a proper way. Understanding IoT with its advantages and disadvantages will bring the real vision of it, and here we can benefit from it in great well. The IOT and the advancement in technology can reduce the barriers to technology adoption and increase its scale on higher education. The IoT removes the traditional barriers to teaching and learning, and create robust, hybrid learning environments using Smart devices, also allowing the students to connect with experts from around the world, also The development of educational social software within a context of IoT in the future work.

5.Future Study

The authors are planning to investigate the existence of IoT in the higher education field in Yemen; to be able to find ways through which it can be of great benefit to further develop the higher education in Yemen.

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Article

EFFECT OF ACCENT ON IMPROVING SPEECH RECOGNITION SYSTEMS

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Abstract

Speech is the output of a time varying excitation excited by a time varying system. It generates pulses with fundamental frequencies F0. This time varying impulse is trained as one of the features, and characterized by fundamental frequency F0 and its formant frequencies. These features vary from one speaker to another and from a gender to another one as well. In this paper the accent issues in continuous speech recognition system are considered. Variations in F0 and formant frequencies are the main features that characterize variation in a speaker. The variation becomes considerably less within a speaker, medium within the same accent and very high among a different accent. This variation in information can be exploited to recognize gender type and to improve performance of speech recognition systems through customizing separate models based on gender type information.

Five sentences are selected for training. Each of the sentences are spoken and recorded by 5 female speakers and 5 male speakers. The speech corpus will be preprocessed to identify the voiced and unvoiced region. The voiced region is the only region which carries information about F0. From each voiced segment, F0 is computed. Each forms the feature space labeled with the speaker identification: i.e., male or female. This information is used to parameterize the model for male and female. The K-means algorithm is used during training as well as testing. Testing is conducted in two ways: speaker dependent testing and speaker independent testing. SPHINX-III software by Carnegie Mellon University has been used to measure the accuracy of speech recognition of data taking in to account the case of gender separation which has been used in this research.

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1-Introduction:

As speech recognition is a complex task it is still difficult to find the complete solution, because every human being has his/her own different characteristics of voice and accent, this in itself has become one of the main problems in the field of speech recognition [1], [2]. It is worth pointing out the fact that this research investigates an approach for identifying genders from spoken data and builds separate models for accent that can enhance the performance of speech recognition by reducing the search space in lexicon[3], [4],[5], [6].

Studies in gender classification using voice shall give insights to how humans process voice information[7], [8]. What may be important is that gender information is conveyed by the F0, type of sound, and the size of vocal tract. It can be assumed that modeling the vocal tract using Linear Prediction Coding (LPC) and Spectrum information[9],[10]. Furthermore, small errors in gender classification can be allowed; as sometimes it is even hard for a person to identify the gender of a speaker. This study has showed that a feature-based system with a trained decision tree can successfully classify male and female voices automatically. However, their studies have been most concentrated on age separation. In the context of speech recognition, accent and gender separation can improve the performance of speech recognition by limiting the search space to speakers from the same accent and gender.

In the gender classification accuracy[11], [12], it has been noticed that perhaps the most important variability across speakers besides gender is a role played by the accents. Therefore, it is probable that any recognition system attempting to be robust to a wide variety of speakers and languages should make some effort to account for different accents that the system might encounter.

In this paper, one approach is to use gender dependent features, such as the pitch and formants. The pitch information was used in [13], [14]for the problem of gender separation. However, fundamental frequency and formant frequencies estimation both rely considerably on the speech quality and accent. Although the quality of speech used in this study was not free from noise, we tried to improve the gender model by using K-means algorithm to get high accuracy[15]–[18].

2. Implementation

Gender separation is the process of separating the speaker's gender type directly from the acoustic information. This is possible using gender invariant feature separation and learning from variations within gender and accent. Furthermore, Speech is produced as a result of convolution of excitations of the vocal cord with the vocal tract system all coupled with the nasal tract.

It is decided to make a practical study of accent issues in continuous speech recognition systems, trying to find out the most correct results by implementing autocorrelation techniques. This practical study was carried out though several stages that will be described as follows.

Stage 1: Data Collection

Training Data:

5 female and 5 male speaker subjects are selected to record 5 properly selected sets of sentences. The selected recorded sentences for the training purpose are: welcome, where is Mike? I believe you are fine! Have fun with him. Thanks to God.

Testing Data:

For the testing purpose, 5 females and 5 males have been selected to speak one sentence and each has been recorded. In fact, every speaker has been given a sentence different from other speakers. It has to be accounted that the group of testing is actually independent from that of the training data.

Stage 2: Feature Extraction

This stage illustrates the processes of features extraction that can identify the gender type on the basis of individual information included in speech waves through extracting the features, viz, fundamental frequency F0 from the collected training data; making separate models depending on the type of features and optimal parameters for each gender. The fundamental frequency shows high variations from one speaker to another. The variation becomes higher when the comparison is among speakers of different gender.

This process is represented in Figure 1. below. Technically, when the voice characteristics of utterance are checked, there will be a wide range of probabilities that exist for parametrically representing the speech signal for the gender separation task.

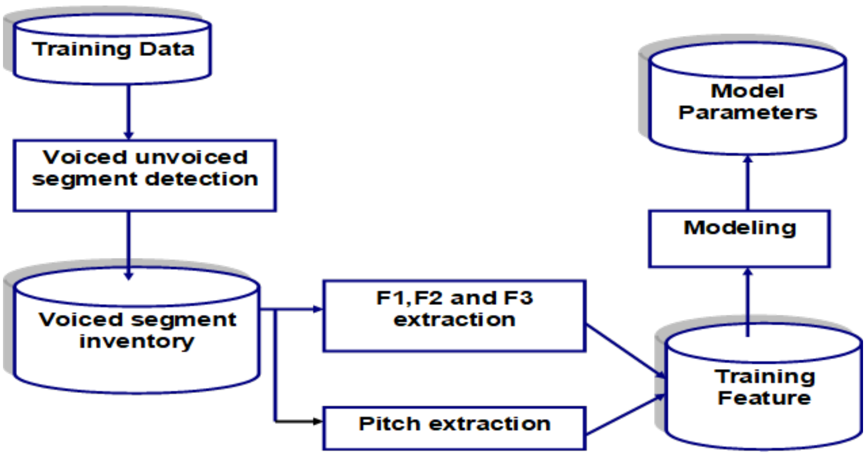

Fig1. Extraction of Features

Stage 3: Feature Matching and Decision Making

In this stage, we extracted the same feature type for testing data as done during the training stage. Then we applied the concept of pattern recognition to classify objects of interest into one of the desired gender types. The objects of interest are called sequences of vectors that are extracted from an input speech. Since the classification procedure in our case is applied on extracted features, it can be also referred to as feature matching as shown in Figure 2

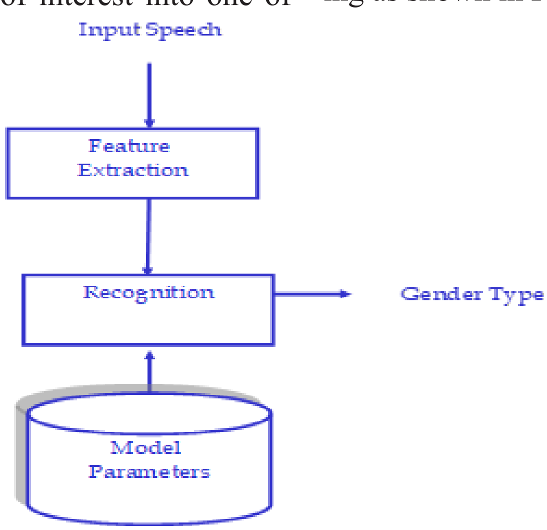

Fig2. Matching of Features

The K-means approach is used because of its flexibility and ability to give high recognition accuracy. K-means can be simply defined as a process of mapping vectors from a large vector space to a finite number of regions in that space. Each region is called a cluster and can be represented by its center; called a code word. The collection of all code words is called a codebook. The gender separation System will compare the codebooks of the tested speaker with the codebooks of the trained speaker. In other words, during recognition, among the models, the best model that maximizes the joint probability of the given observation will be selected as a recognized model. The best matching result will be the desired gender type and this can be verified as the decision making logic.

Finally, the gender type which is modeled by the recognized model will be given as an output of our system.

3. Data Analysis and Observation

In this section, the data analysis of the work is discussed. Figure 3. shows feature extraction (F0) in which the utterance welcome of both genders is analyzed showing that female on the right and male on the left. It shows that female speakers have higher pitch than male. Regarding the technique of feature extraction, each subfigure has its description as below in Figure 3.

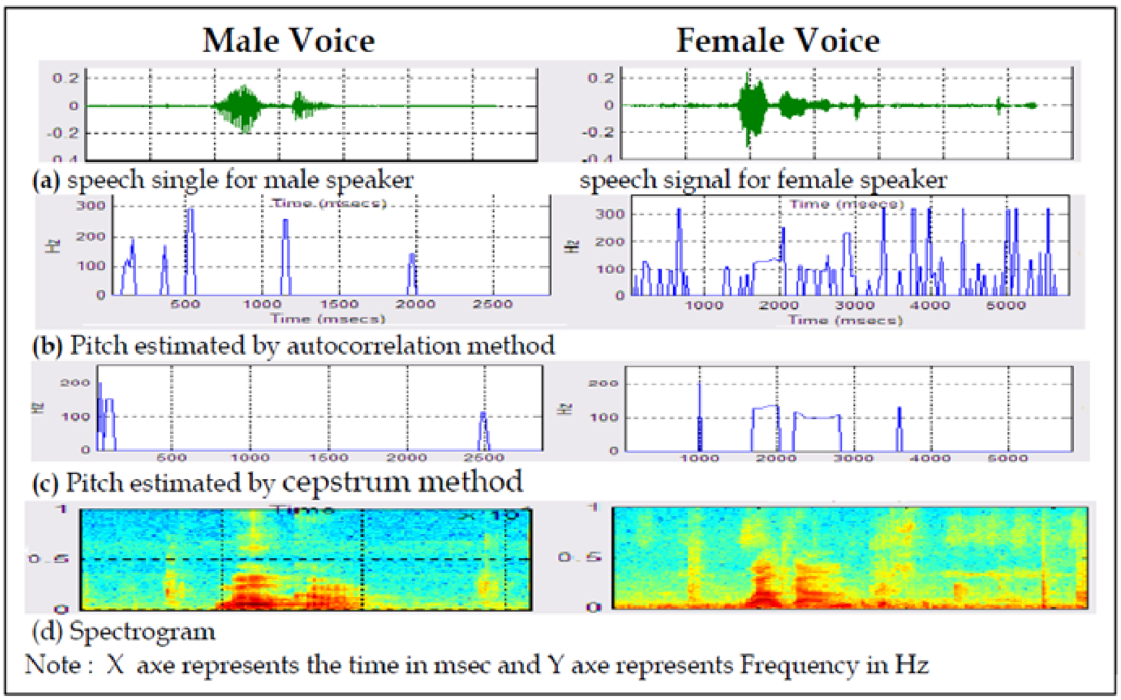

Fig3. Feature Extraction & Experiment Results

Speech Recognition Accuracy Results:

Speech recognition accuracy has been measured under Sphinx System and the results are as follows (see Table 1):

When the data is mixed from both genders, the accuracy resulted in 58%, and we consider this as a low result of accuracy. But when we separate the gender type, an increase of accuracy is obtained. This appears obviously through the results achieved by the same gender (females) which is 84%, while the accuracy results of the same gender (males) is 78%. In the step followed, we test the accuracy within the same gender and same speaker and the accuracy resulted is 100%.

In addition, for the training data of males and testing data of females, the accuracy of speech recognition resulted in 45%, while training data of females and testing data of males resulted in 34%.

Moreover, the results of same accents (Indian Accent) appear to be somewhat different for both genders. Their accuracy is 70 %. And when they are separated the accuracy of males is 72 % whereas the females is 90 %.

To sum up, we conclude that the gender separation and accent plays an important role in increasing the rate of accuracy of the results of speech recognition.

Accuracy	Testing Data		Training Data	
%	Female	Male	Female	Male
Different accent				
58 %	□	□	□	□
84 %	□		□	
78 %		□		□
34 %	□			□
45 %		□	□	
Same accent				
70 %	□	□	□	□
90 %	□		□	
72 %		□		□
Same speaker				
100 %		□		□
100 %	□		□	□

Table 1: Speech Recognition Accuracy of Different Accent, Same Accent and Same Speaker

4.Conclusions

Speech is considered as the essential form of communication between humans. It plays a central role in the interaction between human and machine, and between machine and machine. The automatic speech recognition is aimed to extract the sequence of spoken words from a recorded speech signal and so it does not include the task of speech understanding, which can be seen as an even more elaborate problem. Because of the fact that the goal of speech recognition is still far away from the optimal solution for higher accuracy, the accent and the gender separation system has been proposed to enhance the performance of speech recognition through building separate gender accent models; by limiting search from whole space of acoustic models that can further lead to improve the accuracy of speech recognition. Although the speech data used in this study are collected from different nationalities with different accents (Arabs, Russians, Americans and Indians), it is recorded in different sampling rate and channels. High accuracy of gender recognition is obtained by using the technique which has been mentioned so far. However, when applying K-means algorithm as pattern recognition for the extraction of features, the results of the experiments for estimated pitch value through Autocorrelation and spectrum, have shown 100 % accuracy. Consequently, we conclude that pitch features are more suitable and strongly advised to distinguish the gender type. Moreover, we have noticed that the accent variability among speakers plays a crucial role in speech recognition accuracy besides gender feature. Therefore, it seems that any recognition system attempting to be robust to a wide variety of speakers and languages should make some effort to account for different accents that the system might encounter.

In future work, we are planning to expand the range of evaluation set. We are also planning to investigate the performance of the system to make it applicable, usable as well as useful for the study purpose in speaker-separation and speaker-verification.

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Article

RADIAL BASIS FUNCTION NEURAL NETWORK IN THE ANALYSIS OF SEGMENTED ELECTROCARDIOSIGNALS

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Abstract

Artificial neural networks (ANN) are used to model the information processing capabilities of nervous systems. Research in the field of analysis and interpretation of the cardiovascular diseases with ANN has been attracting more attention in recent years. This paper proposes the use of segmentation of electrocardiograms in time relative to R-wave. The ECG parameter is chosen as an approach based on ECG segmentation on 3 key areas that are responsible for the atria, ventricles depolarization and repolarization of the ventricles. Radial basis function neural network (RBFNN) is chosen for the recognition of abnormality in each segment.

Results show that in the analysis of atria, ventricles depolarization and repolarization of the ventricles segments, the best spread values for each RBFNN are 1, 2.5 and 1.5 respectively. By selecting the optimal spread values for each segment the average sensitivity for all segments is 82.4 and the average specificity is 93.7.

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Introduction:

In the latest years, diseases and death associated with cardiovascular diseases increased significantly in most countries of the world. Therefore, cardiovascular diseases may become the biggest cause of death in all continents [1].

One of the methods that are mostly noted by specialists, for assessing the heart activity, is electrocardiogram (ECG). ECG is the measure of how the electrical activity of the heart changes over time as action potentials propagate throughout the heart, during each cardiac cycle [2].

The electrocardiogram is used to measure the electrical activity of the heart rhythm. It provides information about chamber size and is the main test used to assess myocardial ischemia and infarction. The basis of a single ECG recording is that the electrical depolarization of myocardial tissue produces a small dipole current which can be detected by electrode pairs on the body surface. To produce an ECG, these signals are amplified and either printed or displayed on a monitor [1].

The normal ECG waveform (Fig. 1) has similarities in shape regardless of its orientation. The first deflection 'known as a P wave' is caused by atrial depolarization and it is a slow deflection with a low-amplitude. A shaper that is larger than the P wave; which reflects ventricular activation is known as QRS complex. Initial downward and upward deflections are called the Q wave and R wave respectively. The S wave is the last part of ventricular activation. The T wave is another slow and low-amplitude deflection that results from ventricular repolarization [3].

Today, it is more common to use automated methods for analyzing and interpreting ECGs. As a recognition system, a core neural network method was chosen. The use of neural network analysis in clinical practice improves the accuracy of the cardiovascular diseases diagnosis. ANNs are connections of simple artificial neurons operating in a parallel manner. These artificial neurons are inspired by biological nervous systems. As in nature, the network function is determined largely by the connections between neurons. Neural networks are trained to perform a particular function by modifying the values of the connections between neurons [4].

ANNs have been trained to perform complex functions in various fields of application including pattern recognition, identification, classification and control systems [4].

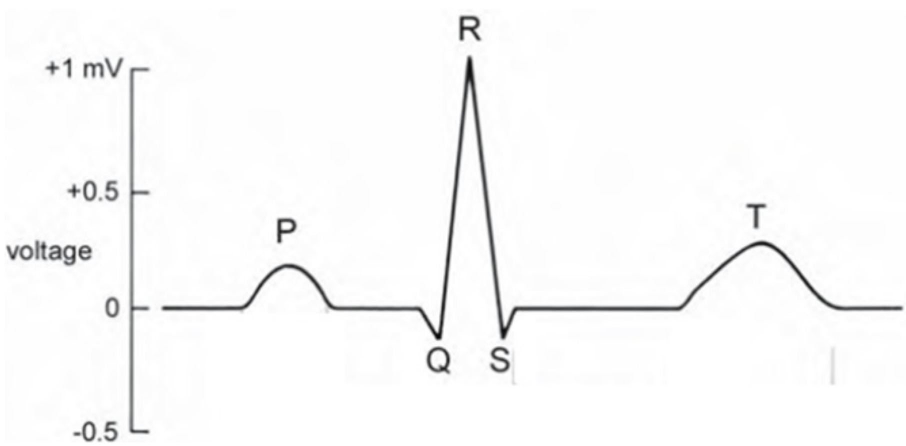


Fig 1. A Typical ECG Waveform for One Cardiac Cycle

Artificial Neural Networks (ANNs), increasingly, in the field of medicine, especially, in the analysis of heart by using ECG waveform are used [5,6,7,8,9].

Classification of heartbeats is one of the most developed applications to the ECG waveform [10,11].

Other studies emphasize on classification, based on the overall behavior of the ECG [12,13].

In this paper, the ECG is chosen as an approach based on ECG segmentation on 3 key areas that are responsible for the atria, ventricles depolarization and repolarization of the ventricles.

The principle of the separation of ECG waveform into segments is to refine the localization of pathological changes in the ECG signal.

Abnormalities in the ECG in each segment are determined by using a RBFNN.

The construction of a RBFNN, consist of three layers. The input layer: and it consists of the normalized segments of the ECG waveform. The second layer: a hidden layer that applies a nonlinear activation function. The output layer: it applies a linear activation function. It consists of one neuron and indicates the presence or absence of abnormality in ECG waveform segments.

Determining a spread parameter is the most important part in training RBFNNs. In this work, the way that the optimum number of this parameter was found by investigating different RBFNNs with various values of spread parameter.

2. Material and Methods

2.1 Database and Processing Data

In this work, the ECG archive published in www.PhysioNet.org was used to train and test the RBFNN.

From selected data we created a database, which is divided into training and testing database. Radial basis function neural networks are trained by the normalized segments of the ECG. It learns to recognize the presence or absence of abnormality in these segments with a sufficiently low error rate. Testing the neural networks is used to test the performance of the RBFNNs.

Algorithm pre-processing signal in creating experimental database segmented ECG is shown in Figure 2.

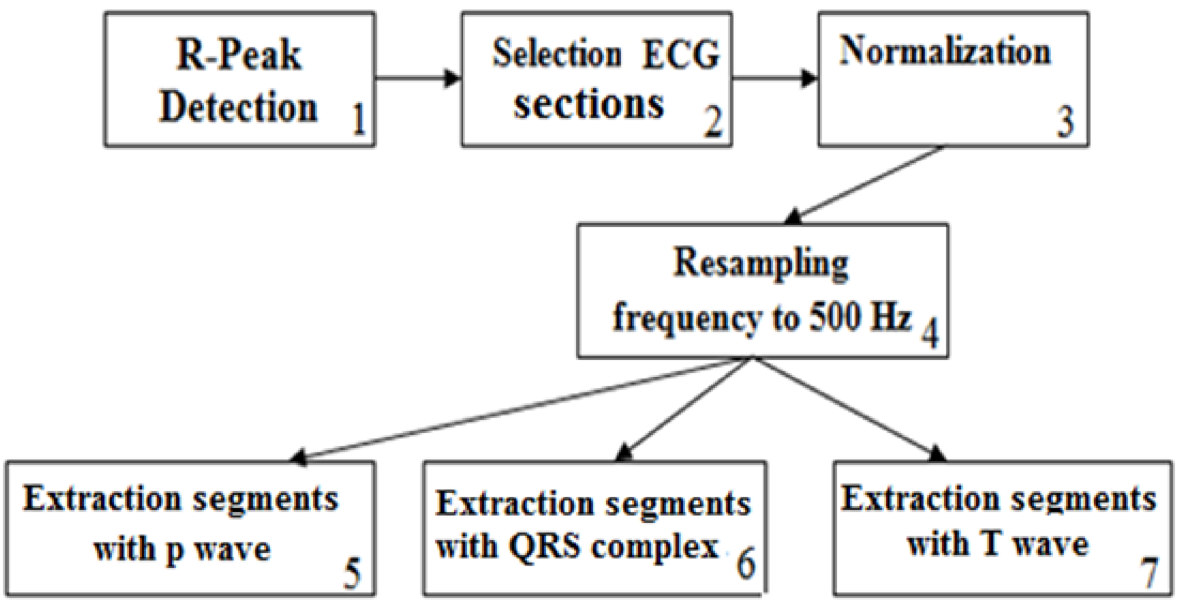


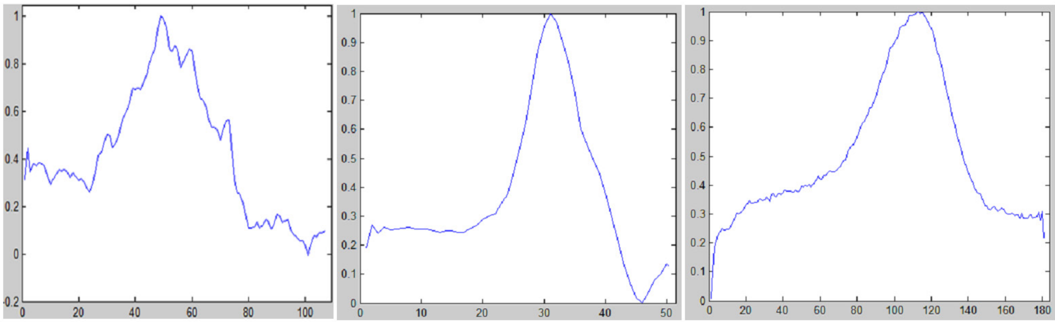
Fig.2 Algorithm Pre-processing Signal in Creating Experimental Database Segmented ECG.

The main stages of processing ECG are the detection of R- peak in the ECG; ECG sections containing P-QRS-T complexes; changing sampling frequency to 500 Hz, and finally normalization and segmentation of ECG.

Normalization is the process of organizing the ECG signals by minimizing its amplitude without losing information.

At the stage of pre-processing, segmentation of ECG on the time zones corresponding to the different departments of the heart is performed (atria, ventricles depolarization and repolarization of the ventricles).

Figure 3 shows examples of normalized ECG segments: the atria segment (Figure 3.a), ventricles depolarization segment (Figure 3.b) and repolarization of the ventricles segment (Figure 3.c).



A B C

Fig.3 Normalized Atria Segment (Fig.3.A), Ventricles Depolarization Segment (Fig.3.B) and Repolarization of the Ventricles Segment (Fig.3.C).

2.2 Radial Basis Function Neural Network (RBFNN)

The type of ANN that was used in this work was the radial basis function neural network; it is one of the most important classes of ANNs. In this neural network, the activation function of the hidden layer is determined by the distance between the input vector and a prototype vector. A significant property of RBFNNs is that they form a unifying link between a number of disparate concepts [14].

As mentioned in the introduction, RBFNN involves three layers with entirely different roles. The input layer is made up of source nodes. The second layer is a single hidden layer that applies a nonlinear transformation (Gaussian Activation Functions) from the input space to the hidden space. The last layer is the output layer which is a set of linear units that can be thought of as computing a weighted sum of evidence from each of the feature template RBF units (Figure 4).

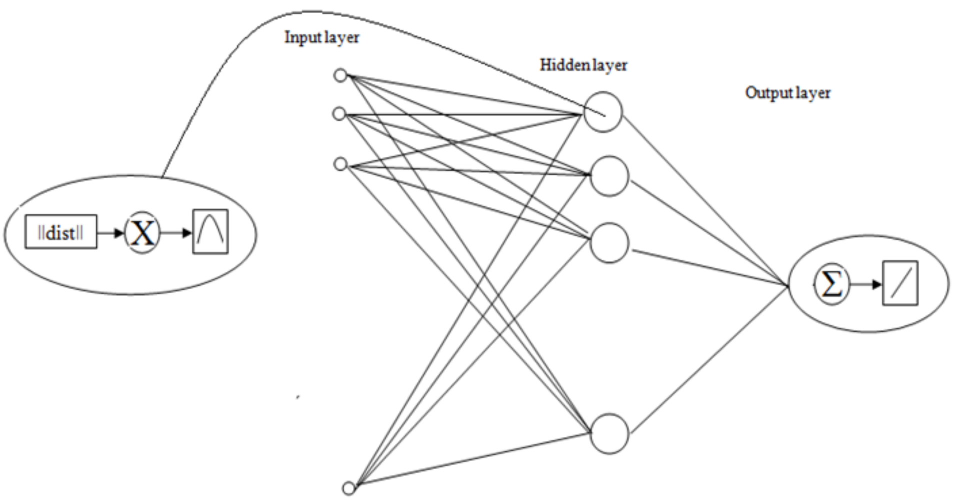


Fig.4 Topic RBFNN Structure.

The radial basis activation function (Gaussian Activation Functions) has two parameters, the center and the spread parameter (Figure 5).

If the spread parameter is inappropriate, too large or too small, values of spread parameter could cause under-fitting or over-fitting problems. The way that the optimum number of this parameter was found was by investigating different RBFNNs with various values of spread parameter. Then we selected the spread parameter value that gave the best sensitivity and specificity.

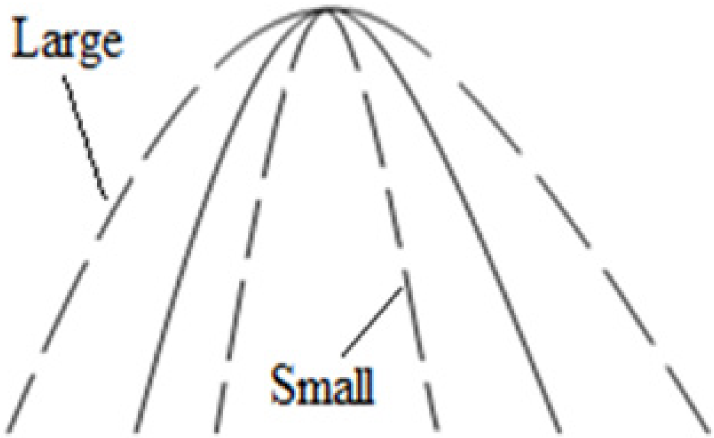


Fig. 5, Gaussian Activation Functions with Varying the Values of Spread Parameter.

3.Results and discussion

The research results presented in this paper are intended to solve the problem of constructing cardiovascular system early in diagnosis complexes. The basis of recognition core is proposed to use radial basis function as neural network (RBFNN).

In this paper, to measure performance of diagnosis, the presence or absence of abnormality for each segment of ECG with artificial neural network; we use the terms of its sensitivity and its specificity.

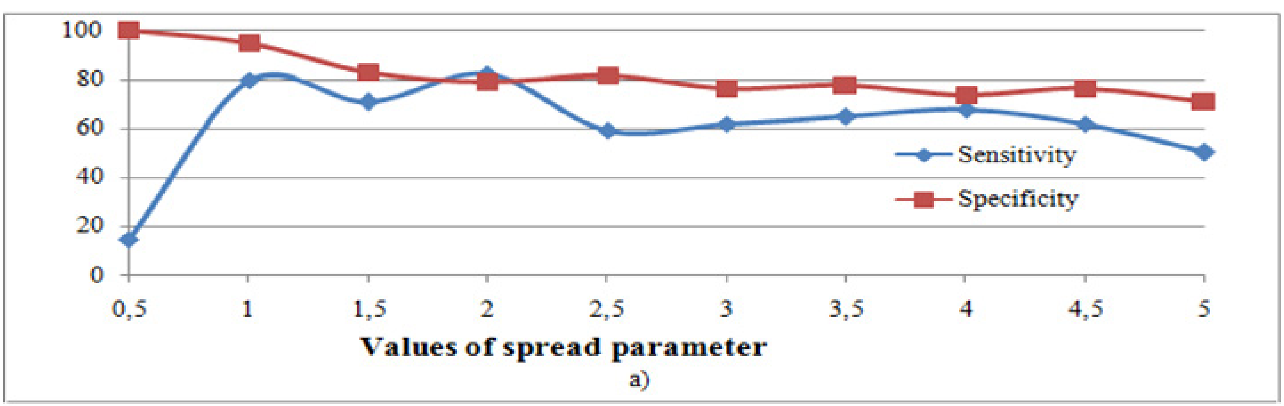
Sensitivity and specificity can be calculated by the formulas shown below;

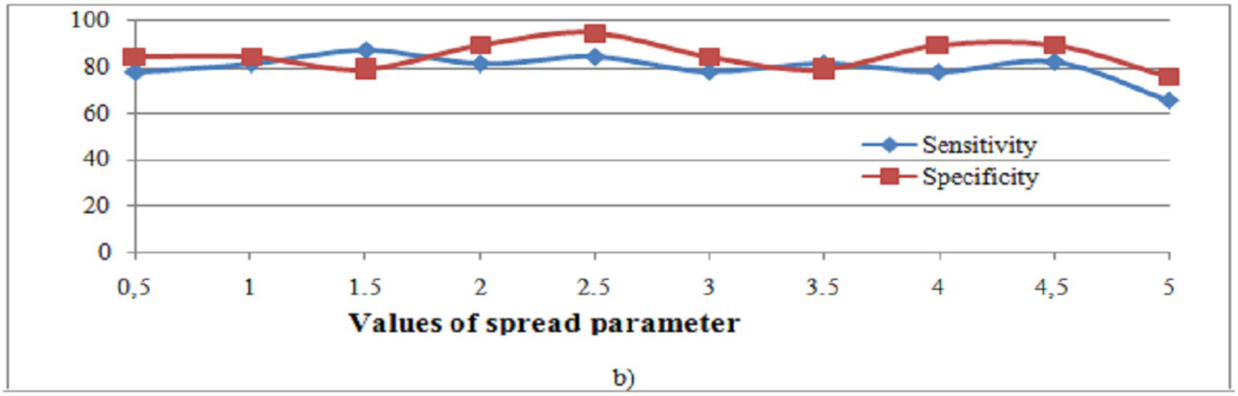
Sensitivity = TP/(TP + FN) % = (Number of true positive assessment)/(Number of all positive assessment).

Specificity = TN/(TN + FP) % = (Number of true negative assessment)/(Number of all negative assessment).

As previously mentioned, determining a spread parameter is the most important part in training RBFNN. The way the optimum number of this parameter was found, was by investigating different RBFNN with various values of spread parameter. Then we did compute the sensitivity and specificity to measure the performances of these RBFNNs for recognizing the presence or absence of abnormality in each segment of ECG (fig 6, tab1).

Next we selected the best spread values by taking the combination of sensitivity and specificity values, for which the increase of one parameter does not cause the fall of another.





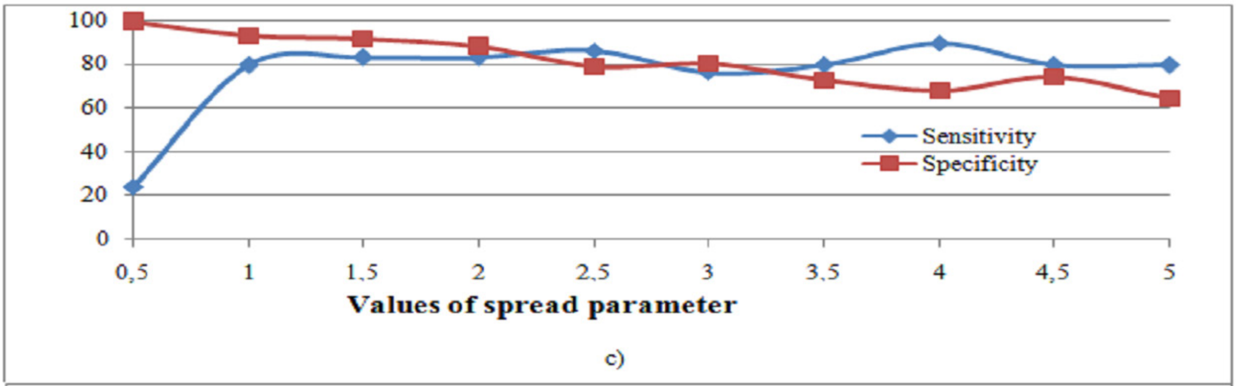


Fig. 6, Rrelationship between Values of Spread Parameter and Sensitivity and Specificity a) Atria Segment b) Ventricles Depolarization Segment c) Repolarization of the Ventricles Segment.

Results show that for analysis of atria, ventricles depolarization and repolarization of the ventricles segments, the best spread values for each RBFNN are 1, 2.5 and 1.5 respectively.

As shown in table 1, by selecting the optimal spread value for each segment, the average sensitivity and specificity for all segments are 82.4 and 93.7 respectively.

Table 1, Results Obtained by Using RBF to Recognizing the Presence or Absence of Abnormality for the Three Segments of ECG.

Segment of ECG	Sensitivity	Specificity	Spread
Atria	80	94.7	1
Ventricles Depolarization	84.3	94.9	2.5
Repolarization of the Ventricles.	82.8	91.4	1.5
Average	82.4	93.7	

4.Conclusion

In this paper, for the ECG parameter, an approach was chosen based on ECG segmentation on 3 key areas that are responsible for depolarization of the atria, ventricles depolarization and repolarization of the ventricles. Abnormalities in the ECG in each segment are determined by using a RBFNN with Gaussian activation functions.

In this work we used three RBFNNs for the recognition of abnormality in each segment.

Results show that for the analysis of atria, ventricles depolarization and repolarization of the ventricles segments; the best spread values for each RBFNN was 1, 2.5 and 1.5 respectively. By selecting the optimal spread values for each segment the average sensitivity and specificity for all segments was 82.4 and 93.7 respectively.

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