

# Survey on Perception of People Regarding Utilization of Computer Science in Manipulation of Big Data, Disease Detection & Drug Discovery

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**Abstract:** This research explores the manipulation of biomedical big data and diseases detection using automated computing mechanisms. As efficient and cost effective way to discover disease and drug is important for a society so computer aided automated system is a must. This paper aims to understand the importance of computer aided automated system among the people. The analysis result from collected data contributes to finding an effective result that people have enough understanding and much better knowledge about big data and computer aided automated system. Finally suggestions have been developed for further research related to computer technology in manipulation of big data, disease detection and drug discovery.

**Keywords:** big data, disease detection, drug discovery, computer aided automated system.

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## I. INTRODUCTION

Since present era is the era of computing and so computer science as well as information technology interprets a complete and comprehensive chapter of technological evolution on every aspects of human life including day to day activities, business maintenance, medical science, professional activities etc. [11]. This trends generate petabytes of data everyday which is one kind of big threat for human being and negotiating with that nowadays medical science is also incorporating with advanced computing technologies for immediate decision making and drug discovery. Moreover, heterogeneous data generated from various sources make it worsen for medical science.

Additionally, one of the major problems of the society is the efficient and cost effective way to discover disease and drug computationally. For this task to complete how various computer aided automated system can be implemented and is being implemented is mandatory to be analyzed and explored. Thousands of cognitive diseases seemed to be compacted with DNA discontinuity including Tuberos Sclerosis, Tuberculosis, Cancer and this DNA sequence interpret perfect example of Big data. Thus, to deal with that disease computer aided automated system need to be employed. So it is mandatory to make a clearer vision about how computer science is being used for disease detection and discovering drug by dealing with big data. Already lots of interesting works have been conducted and discovered by the researchers in biomedical science. For example, invention of electronic



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aspirin, needle free diabetes care, robotic check-ups are some of the remarkable invention of computer aided technology in medical science.

Nowadays, with the fast development of information technology the exponential growth of technological activities produces huge amount of data [12]. In a word we are now within the ocean of data and every day we are producing this data intentionally or unintentionally using technological substances. In this world of technological superhighway thousands of computer aided systems are now maintaining medical science. Now a computer can detect lots of disease on its own by collecting data from patients and these sort of work produces large amount of data per year. With the advent of big data, medical science and information technology have become more connected to deal with large volume of data for quick and accurate decision making [13]. Computer science can contribute to the medical science by developing intelligence system to deal with big data for identifying various sorts of disease. Moreover recent IOT technology have taken the medical care system more advance by supervising a patient 24/7. This technology also needs more efficient and accurate mechanism for instant decision making and making aware to its user. So computer science and information system is also mandatory to be present with those IOT devices to work efficiently [14, 15].

In section 1, we have discussed about the impact of big data and IOT based technology in the medical care system. Moreover, the objectives of the research, main questions, sub questions and the limitations of the study is also discussed. In section 2, of this work we have reviewed some paper related to our topic and previewed how they worked in their paper. Meanwhile, in section 3 we have described the methodology of data collection, sampling, analysis and research ethics. Moreover, we also described the strategy of data collection with questionnaires, sampling, close-ended questions and open-ended questions. In section 4, the results of the questionnaires are analyzed and represented in graphical pie chart. We also discussed about the future research and come to a conclusion about the topic of the paper.

#### Research Objectives

**Aim:** Basically this particular research is going to explore how computer science as well as information technology is being used to

manipulate biomedical big data and diseases are detected using automated computing mechanisms.

#### Objective:

-To clarify the perspective of majority towards computer aided system for disease detection and drug design over traditional approach

-To identify how existing computer aided approaches are being used in medical science and what is their impact on human being.

#### Main Question:

What are the key steps to interpret ongoing contributions of advanced automated technologies over traditional and manual procedures in medical science?

#### Sub Question

1. How recent advancement of computer aided automated technologies can be revealed over medical disease detection as well as drug discovery?

2. How to know the key impact of computer science over biomedical science?

There are some limitations in our research. The research is conducted with only students from the computer science and engineering students of East West University and few application developers. This is shortage of our time.

## II. MOTIVATION

Drug discovery and development is considered to be a slow process, often consuming a huge amount of time and resources. On an average, it costs USD 2.5 billion to bring a new drug to the market. For big pharmaceutical companies, this average is around USD 4 billion and has been shown to go as high as USD 11 billion. Designing a new drug that binds to any specific target requires a large amount of time, as well as computing power. In many ways, deep machine learning algorithms are being developed to accelerate this process. It is anticipated that digital solutions for drug discovery may save significant time and capital. Machine learning is widely predicted to make drug discovery and disease detection cheaper, faster and effectively in the future. In the last decade the availability of large data sets and the development of advanced algorithms have driven major improvements in machine learning. Applications of machine learning in

pharmaceutical research have emerged in recent years and its utility has gone beyond bioactivity predictions and has shown promise in addressing diverse problems in drug discovery. It is possible to analyze bigger, more complex data and more accurate results even on a very large scale by using machine learning so disease detection will be more accurate if we use automated disease detection model. Currently, automated drug discovery and disease detection models are still in the proof-of-concept stage with not many companies having been able to successfully apply these models for cost savings in drug discovery. If such models become usable, many companies may adopt them to minimize the costs incurred during the drug discovery process.

### III. LITERATURE REVIEW

Thousands of research have already been conducted by lots of researcher and academicians worldwide. Some of the works

We are about to demonstrate in this part of our paper for better clarification. In the paper titled Automated Medical diagnosis from Clinical Data [7] the authors have been concerned on in spite of being advance in medical science, major portion of the world population is still out of proper healthcare because of expensive diagnosis. However, it's mandatory to be ensured healthcare for each and every people to make world livable. Realizing the worth of this situation this paper negotiates with reducing cost, increasing coverage and improving quality of life by using text mining techniques on vector space model. Initially two months' worth of discharge sheets from remote location of India have been collected and using text mining techniques implemented in R language possible symptoms have been searched and depending on the symptoms diagnosis suggestions have been provided. Moreover, vector space model for medical information gathering is feasible. Therefore this paper has explored the same way an expertise suggests a patient what to be done. However, text mining mechanism basically demands for big data but the authors of this paper have failed to ensure that. Moreover, for the context of the contribution [8] it has come to our realization that recent evolution in computer aided technology in medical science reveals

the term big data. The increasing availability and rate of growth of information in medical science demands for computing technologies for further decision making regarding immediate treatment and diagnosis. This contribution focuses on future of information technology and big data manipulation to ensure healthcare easily. Moreover, this study also incorporates with current specific challenges associated with medical science for improving patient healthcare. This paper also reveals a wide vision towards major breakthroughs that have been achieved from clinical health data. Since, medical data is increasing in such an exponential manner that it is now a matter of headache for computer scientists and so obstacles as well as challenges linked to big data in biomedicine has been demonstrated in this work. Meanwhile contribution [9] illustrates about biomedical imaging, different techniques are used to capture an image with high definition and large sizes. MapReduce in Hadoop and Spark, these two are main big data architectures are proposed to be compared here. Some techniques are well established to acquire an image which generally give an internal image of human body parts. However, if a patient suffers from a disease that affects the skin, the technician can use a camera or smartphone to take the picture of the skin and port it into the system. Extraction refers to a technique that enables to obtain useful biomedical images from the raw data and refines them so that they can be used in the analytic steps. The implementation of the Spark architecture are beyond the scope of this kind of work and will be addressed for future works. However in this paper a workflow is proposed for the management and analysis of biomedical image data based on the tools of big data technology and work [10] is up to Application of Big Data Analytics for Automated Estimation of CT Image Quality which demonstrates that In spite of the increasing applications of Big Data analytics in medical image processing systems, there has been a growing need for quantitative medical image quality assessment especially for CT images. Three different data models have been used for this study. The main goal of this study is to identify the optimal method for predictive modeling of CT image quality. The first two models depends on spatial segmentation of region of interest and the third model depends on the convolutional neural

network. Multi-class-classifications algorithm have been used for this study. The observational necessity for CT radiation dosages uses As Low As Reasonably Achievable (ALARA) while ensuring diagnostic image quality. Minimizing the number of CT image acquisitions, optimizing CT image acquisition protocols, and improving low-dose CT image processing algorithms are some approaches for ALARA principles. Medical image data can be accessed from multiple devices through cloud computing. But it has some limitations like it shows over fitted CNN models in subjective data. When processing patient CT images, is indicative of structural dissimilarity factors that affect the classification performances. Also, the lack of subjective scores on patient CT image scans impact the CTIQ predictability. The CNN data model performs consistently on the phantom CT images and but it suffers from inconsistencies for the patient CT images. Still enormous contributions are on the way to make the utilization of computer science in the field of biomedical science and big data manipulation.

## IV. METHODOLOGY

### 1. Data collection methods

Data collection is basically a process of gathering and measuring information in a systematic fashion. Hence for discovering the answers of the research questions, for testing the presumption and then evaluating the outcomes, this is a process of piling up information from all the pertinent sources.. There are many kinds of data collecting methods that can be used in this research like doing an interview, questionnaires, observations, documents, and records etc.

The questionnaires can be an effective research method, to a low cost for the study. (Denscombe, 2010, p. 169) Questionnaires provides benefits in comparing with other types of survey like verbal or telephone surveys in case of low costs and less efforts and also provide simplicity sometimes through containing ascertained answers which simplify data interpretation. However, such standardized answers may frustrate users. Questionnaires are also sharply limited by the fact that respondents must be able to read the questions and respond to them.

In This research, it has been explored how

computer science is being used to manipulate biomedical big data and diseases are detected using automated computing mechanisms. . Questionnaires were highly effective method for this research as our perspective because we can directly understand the perspective of common people towards use of information technology to adopt medical science to work better than before and moreover efficiently. Their perspective also can be manipulated by incorporating with the participants.

The reason for choosing questionnaires was to measure some predefined scenarios, and make some questions related to this scenario. This method give clear and measurable answers to do analyses on. The questionnaires were sent to the students and 2 of the faculty members of east West University. Moreover, the questionnaires' also has been sent to two of the experts in the field of biomedical and bioinformatics researchers for more clarification. Overall comments from the people we meet has been demonstrated graphically in the result analysis section.

### 2. Participants/sampling

The participants of this research were 3 experts in big data and more than 50 students from the department of Computer Science and Engineering East West University. We provided right information about our research aim to this participant. (Denscombe, 2010)

An individual of a sample has to select randomly to clarify that preference would not occur for influencing the sample. (Denscombe, 2010, p. 41)

### 3. Data analysis

The data was stored in a Microsoft excel sheet as a gathered information which was answered by all the participants. After which various there are two key features of survey research charts associated with the data has been executed. All those graph charts have been demonstrated in the result section.

### 4. Research Ethics

We provided all the participants a consent form which contains the purpose of our study and the privacy policy criteria for the participants. We have mentioned all the necessary concerns that might occur from the participant sides. We

demonstrated everything to them so that they can be co-operate minded with us. After they agreed with our terms and conditions, they answered our questions. Those who denied our privacy policy and our terms and conditions didn't participate in the survey.

### 5. Data collection strategy

Survey research is a commonly used method of collecting information about a population of interest. There are many different types of surveys, several ways to administer them, and many methods of sampling. Two leading prominence of survey research:

Questionnaires -- a string of questions which has to be established in advance for piling up information from individuals. The questions will be set initially. Then going to every participant all the questions are asked.

Sampling--a procedure for choosing a subgroup from an entire population to response the survey questions, the accumulating information can be generalized for the entire population of interest. This will forecast the aspects of all the population theoretically. However, sometimes findings using this technique can predict less accuracy.

. Surveys are used to best effect when the researcher wants factual information relating to groups of people: what they do, what they think, who they are. (Denscombe, 2010, p.12) Surveys can prove to be an efficient and relatively inexpensive means of collecting data (Denscombe, 2010, p.49). Also, questionnaires can supply a considerable amount of research data for a relatively low cost in terms of materials, money and time (Denscombe, 2010, p.169).

We selected questionnaires because it is less expensive and less time consuming. Moreover, the participants also feel comfortable and secure while using this technique. We wanted to select sample survey for our case study since our time frame is short to optimize this strategy as convenience sampling. Within this short period of time we think this approach is feasible for us.

### 6. Closed-Ended Questions

The respondents are given a list of predetermined responses from which to choose their answer and mark so that we can collect that data easily from there.

The list of responses should include every

possible responses and the meaning of the responses should not overlap with each other. Therefore, for our data collection process we have already mentioned all the possible responses that can be the answer of the questions we defined earlier.

Following example illustrate a close-ended questions: "Rate the following statement according to your opinion: 'I am satisfied in my current post of this job'. Are you strongly agree, somewhat agree, neither agree nor disagree, somewhat disagree, or strongly disagree?"

In case of close-ended questions frequency counting of each question answered is very much easy for which this technique is preferred in survey research.

### 7. Open-Ended Questions

Survey respondents have their independence for answering each question for their own words.

Responses are generally sorted into a tiny list of responses that can be counted by the study team for statistical experiment.

Closed ended questions have been used in our survey. The participant's data were preserved classified and wiped out after the research. They got information about the research aims and objectives, and the research problems.

## V. RESULTS

This section analyzes the results found on surveys conducted for the research.

### 1. Data collection and analysis

We collected our data through google forms. We created two forms for normal users and developers to conduct our surveys. We added consent forms and questions in the google form for the participants. We got 20 responses from normal users and 4 from the developers.

2. Graphical presentation

- Which department are you representing

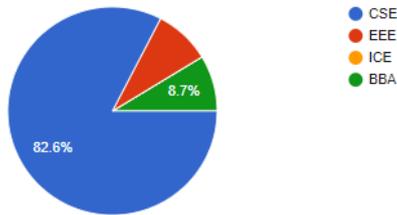


Fig.1 Pie chart of the participant’s department

From fig.1 we can see that majority of the participants were from CSE department. Also there were many participants from EEE and BBA. They gave their opinion through survey.

- Your gender:

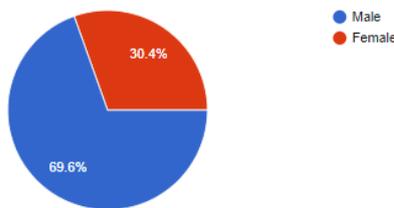


Fig.2 Pie chart of the participant’s gender

Fig.2 shows the gender if the participants. Around 69.6% of male and 30.4% of female attended to the survey.

- Do you know about big data analysis?

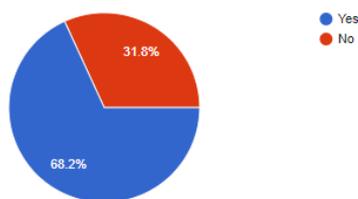


Fig.3 Pie chart of the participant’s knowing about Big Data

From fig.3 we can see that 68.2% of people were aware about big data and understand it. On the other hand 31.8% of people were not familiar with big data. Therefore, number of people know big data is quite higher and it is satisfactory in this era of technological evolution.

- Are you aware of the recent advancement of computer aided technology in biomedical big data analysis and drug design?

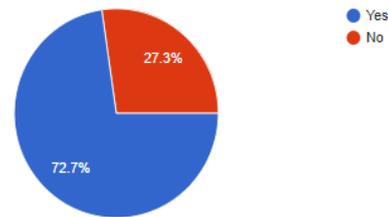


Fig.4 Pie chart of the participant’s awareness recent advancement

From fig.4 we can see that 72.7% of participants were aware of the recent advancement of computer aided technology in biomedical big data analysis and drug design but rest of them did not know about it at all. They should be informed about it.

- Do you agree that computer aided technology does ensure biomedical big data analysis?

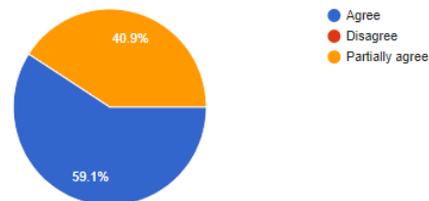
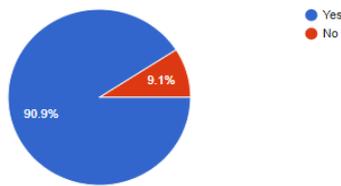


Fig.5 Pie chart of the participant’s opinion about computer aided technology

Fig.5 shows about the opinion of the participants on computer aided technology did ensure biomedical big data analysis. It looks like 59.1% agreed and 40.9% partially agreed. But, it looks promising that none of them gave opinion against computer aided technology.

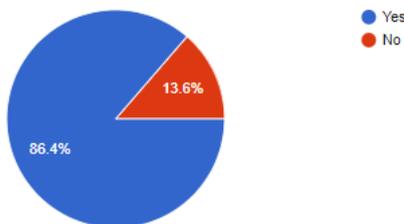
- Do you think technology can be used to reduce clinical errors and expense in disease detection?



**Fig.6 Pie chart of the participant’s on reducing clinical errors by technology**

In fig.6 we can see that, almost 91% of the participants agreed that technology can be used to reduce clinical errors and expense in disease detection.

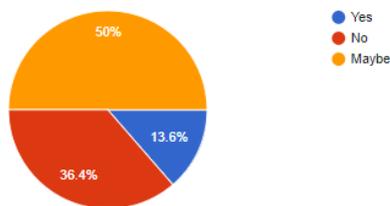
- Do you think there is a bright future of computer aided disease detection on biomedical big data?



**Fig.7 Pie chart of the participant’s about disease detection is a bright future**

Fig.7 also shows, almost 87% of the participants think that there is a bright future of computer aided disease detection on biomedical big data. That is a fruitful result for our research.

- Will you share your medical data through online?

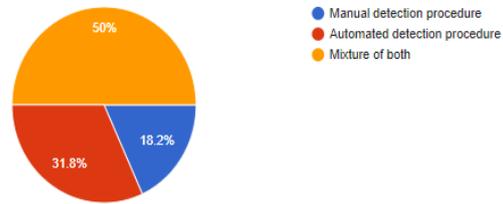


**Fig.8 Pie chart of the participant’s opinion about sharing medical data through online**

From fig.8 we can say that 50% of the participants may share their medical data if we ensure enough security but 36.4% did not want to share their medical data which is still a concern for our research. Only 13.6% of the participants

wanted to share their medical data willingly.

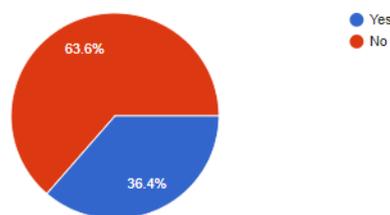
- Between manual detection procedure and automated detection procedure what will you choose?



**Fig.9 Pie chart of the participant’s choice between automation and manual detection**

Fig.9 demonstrate that almost 31.8% of people were interested in only automated detection procedure using computer aided technology. Whereas 18.2% of people believed in manual detection of disease and diagnosis. However, majority of people which is approximately 50% people wanted both the mixture of computer aided detection along with manual detection procedure for better accuracy. Therefore, we can conclude from this fig that new upcoming technology can be more trustworthy in near future because people are familiar with manual system traditionally but with recent technology they are not so much familiar with. Thus the trend is going towards computer aided technology. We can also see that most of the user want to use the mixture of both.

- The recent accuracy level of automated disease detection system is 74.5%. Is that enough to convince you to trust this system?

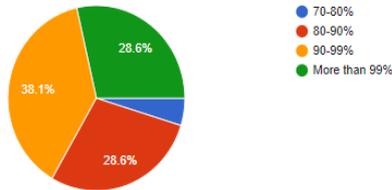


**Fig.10 Pie chart of the participant’s trusts of the automated system**

Additionally, fig.10 demonstrates that most of the users confirmed that 74.5% is not enough to be trusted. Thus to be trustworthy towards people more accuracy level need to be achieved.

New approaches with higher accuracy, specificity, sensitivity, F-measures need to be developed and implemented. New research ideas need to be employed in this regard.

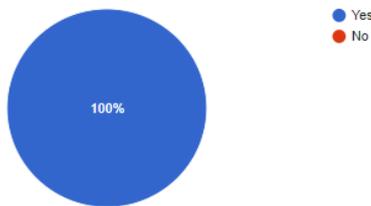
- In your perspective, for automated disease detection accuracy level should be around –



**Fig.11 Pie chart of the participant’s opinion about accuracy level**

In fig.11 we asked the participants about how much they want the accuracy level. It looks like that most of the people are happy if the accuracy level is between 90-99%. But, we just achieved about 75%. So, there will be a long way to gain everyone’s trust for this type of treatment.

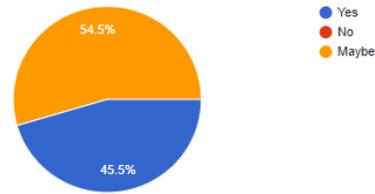
- Does the accuracy level of automated disease detection system need to be improve further?



**Fig.12 Pie chart of the participant’s opinion on accuracy level**

Fig.12 shows the need to improve the accuracy level of automated disease detection system. Otherwise it will affect badly in our life. Because, people will not trust the automation system.

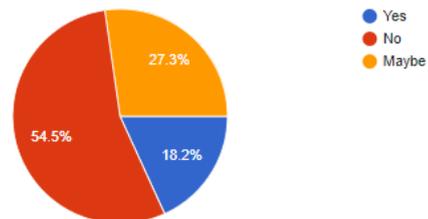
- Do you think computer aided disease detection system will be the future of medical science?



**Fig.13 Pie chart of the participant’s about the future of computer aided disease detection**

From fig.13 we can see, the automated disease detection system is a good sign to all. Because no one was disagreed that it will be the future of medical science and we can see that also.

- 3 billion base pairs (Approximately 6.5GB of Big data) of human DNA can be analyzed to detect crucial diseases using computer aided technology. Do you think it is manually possible to analyze?



**Fig.14 Pie chart of the participant’s on manual analysis of 6.5GB data**

Fig.14 illustrates that, most of the user think that it is not possible to analyze data of 6.5GB manually. It will consume lots of time and even may be impossible to be manipulated without computer used system. Thus, development of computer aided technology in this era of technology has become mandatory. However, 25% people think that manipulation is possible traditionally and also 25% people are not sure about it and they think that maybe it is possible or may not be.

- Recently computational software is being used to identify novel molecules and proteins that will positively interact with the potential to speed up the process of drug discovery. Is it truth worthy?

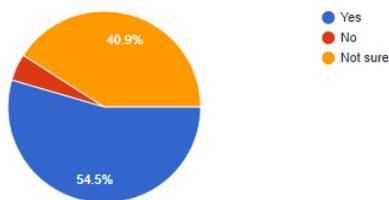


Fig.15 Pie chart of the participant’s on speeding up the process of drug discovery

Fig.15 shows that only 4.5% do not have trust on computational software is being used to identify novel molecules and proteins that will positively interact with the potential to speed up the process of drug discovery. Most of them have trust on it. But, 40.9% are not sure about it whether it is trust worthy or not.

- If we employ computer aided technology for drug design it will ensure drug manufacturing as well as producing cost lower. Your opinion?

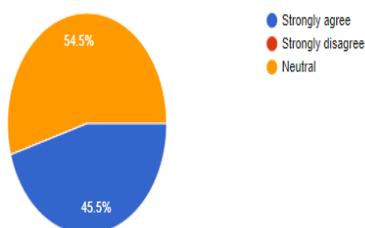


Fig.16 Pie chart of the participant’s opinion about lowering cost

From fig.16 we can say, 54.5% people do not have opinion if we employ computer aided technology for drug design it will ensure drug manufacturing as well as producing cost lower or not. But, 45.5% agree on this.

- Will Bangladeshi people treat this automation system as blessing or they reject it? Give your opinion.

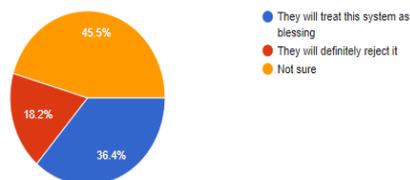


Fig.17 Pie chart of the participant’s about blessing or rejection

Fig.17 shows, 18.2% people are afraid of this automation system and they will definitely reject it. On the other hand 36.4% people will treat this system as blessing. But, 45.5% people are not sure about it.

## VI. FUTURE RESEARCH AND DIRTECTION

From the overall discussion of result section the outcome indicates reactions of people regarding utilization of computer aided technology in biomedical disease and drug discovery. Within shortest period of time this research has been conducted by a small group of people. If more user can be involve within this process to make decision, then it will be better to know more different angles of the views. That will need more time. Moreover, exact perspective should be explored by employing the same on wide number of people. The study can be improved by increasing the sample size, data collection. In near future we will work to improve our research.

## VII. CONCLUSION

This research is aimed to understand the importance of computer aided automated system among East West University students and to identify if they are aware of this. The empirical result shows that they have strong knowledge of big data and computer aided system. This study can be used for making decisions regarding implementing a computer aided automated system which will help us to manipulate big data and help us in disease detection and drug discovery. Moreover, gist outcome of this work will enhance vision of general people towards computer aided technology as well as recent technological evolution which is the most hotly debated topic in this era.

## REFERENCES

1. Michael Riegler, Konstantin Pogorelov, Jonas Markussen, Mathias Lux, Håkon Kvale Stensland, Thomas de Lange, Carsten Griwodz, Pål Halvorsen, Dag Johansen, Peter T. Schmidt, and Sigrun L. Eskeland. 2016. Computer aided disease detection system for gastrointestinal examinations. In Proceedings of the 7th International Conference on Multimedia Systems (MMSys '16). ACM, New York, NY, USA, Article 29, 4 pages. DOI: <https://doi.org/10.1145/2910017.2910629>
2. John Rooksby, Parvin Asadzadeh, Alistair Morrison, Claire McCallum, Cindy Gray, and Matthew Chalmers. 2016. Implementing ethics for a mobile app deployment. In Proceedings of the 28th Australian Conference on Computer-Human Interaction (OzCHI '16). ACM, New York, NY, USA, 406-415. DOI: <https://doi.org/10.1145/3010915.3010919>
3. S. E. Polykalas, G. N. Prezerakos, F. D. Chrysidou and E. D. Pylarinou, "Mobile apps and data privacy: When the service is free, the product is your data," 2017 8th International Conference on Information, Intelligence, Systems & Applications (IISA), Larnaca, 2017, pp. 1-5.
4. SU MON KYWE; Yingjiu LI; HONG, Jason; and CHENG, Yao. Dissecting developer policy violating apps: Characterization and detection. (2016). Proceedings of the 11th IEEE International Conference on Malicious and Unwanted Software (Malcon): October 18-21, Fajardo, Puerto Rico. Research Collection School Of Information Systems.
5. S. Karthick and S. Binu, "Android security issues and solutions," 2017 International Conference on Innovative Mechanisms for Industry Applications (ICIMIA), Bangalore, 2017, pp. 686-689.
6. "Grounded Theory", The Good Research Guide by Denscombe. Chapter 14 page no. 283.
7. V. S. Pendyala and S. Figueira, "Automated Medical Diagnosis from Clinical Data," 2017 IEEE Third International Conference on Big Data Computing Service and Applications (BigDataService), San Francisco, CA, 2017, pp. 185-190. doi: 10.1109/BigDataService.2017.14
8. Fabricio F. Costa, Big data in biomedicine, Drug Discovery Today, Volume 19, Issue 4, 2014, Pages 433-440, ISSN 1359-6446, <https://doi.org/10.1016/j.drudis.2013.10.012>.
9. Aurelle Tchagna Kouanou, Daniel Tchiotsop, Romanic Kengne, Djoufack Tansaa Zephirin, Ngo Mouelas Adele Armele, René Tchinda, An optimal big data workflow for biomedical image analysis, Informatics in Medicine Unlocked, Volume 11, 2018, Pages 68-74, ISSN 2352-9148, <https://doi.org/10.1016/j.imu.2018.05.001>.
10. M. D. Naeemi, J. Ren, N. Hollcroft, A. M. Alessio and S. Roychowdhury, "Application of big data analytics for automated estimation of CT image quality," 2016 IEEE International Conference on Big Data (Big Data), Washington, DC, 2016, pp. 3422-3431. doi: 10.1109/BigData.2016.7841003.
11. Masouleh, M. F., Kazemi, M. A. A., Alborzi, M., & Eshlaghy, A. T. (2017). Identification of electrocardiogram signals using internet of things based on combinatorial classification. *International Journal of Modeling, Simulation, and Scientific Computing*, 8(03), 1750035.
12. Sarowar MDG (2018) Emergence of Automated Computing Technologies in Biomedical Disease and Drug Discovery. *J Biomed Syst Emerg Technol* 5: 117.
13. Rahman A., Nimmy S.F., Sarowar G. (2019) Developing an Automated Machine Learning Approach to Test Discontinuity in DNA for Detecting Tuberculosis. In: Xu J., Cooke F., Gen M., Ahmed S. (eds) Proceedings of the Twelfth International Conference on Management Science and Engineering Management. ICMSEM 2018. Lecture Notes on Multidisciplinary Industrial Engineering. Springer, Cham
14. Sarowar, M. G., Kamal, M. S., & Dey, N. (2019). Internet of Things and Its Impacts in Computing Intelligence: A Comprehensive Review – IoT Application for Big Data. In N. Dey, & S. Tamane (Eds.), *Big Data Analytics for Smart and Connected Cities* (pp. 103-136). Hershey, PA: IGI Global. doi:10.4018/978-1-5225-6207-8.ch005
15. Hassanién, A. E. (Ed.), Dey, N. (Ed.), Borra, S. (Ed.). (2019). *Medical Big Data and Internet of Medical Things*. Boca Raton: CRC Press.