Human Computer Interaction Applications in Healthcare: An Integrative Review

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Abstract

INTRODUCTION: Human computer interaction (HCI) interprets the design model and the uses of computer technology which focuses on the interface between the user and the computer. HCI is a very important factor in the design of software-oriented decision-making ideas in health-care organizations and also it assists in accurate detection of image, disease including safety of the patients.

OBJECTIVES: There are some pitfalls arises over some previous works on cloud based HCI applications. For that reason, to masafety, patient's safety we wanted to work on explainable artificial intelligence (x-AI) and human intelligence in conjunction with HCI in various fields and algorithms to pro-vide transparency to the user. This may also use some web-based technologies and digital platforms with HCI for development of quality, safety and usability of the patients.

METHODS: The purpose of this study about the communication between the HCI design and healthcare system through client and apply that method to the information system of Healthcare department to analyse the functions, effects and outcomes.

RESULTS: The integration of explainable artificial intelligence (x-AI) and human intelligence with Human-Computer Interaction (HCI) demonstrated promising potential in enhancing patient safety and optimizing healthcare processes.

CONCLUSION: By leveraging web-based technologies and digital platforms, this study established a framework for improving the quality, safety, and usability of healthcare services through effective communication between HCI design and healthcare systems.

1. Introduction

The basic concept of machine-human interaction has been around for decades, and this term also known as Human-Computer-Interaction. This definition mainly involves machine as well as human being. This conceptualization is the combination of artificial intelligence as well as human intelligence. In this study I wanted to apply this theory on health communities with some enhanced applications of Human-Computer-Interaction [HCI] for better communication for decision making ideas in medical teaching system and treatment as well. Online healthcare as well as learning approaches are the present day most appreciated social platform to learn and share health related information's among users globally. There are various difficulties faced in treatment process and that's why we need to introduce some environment appropriate, user - friendly, smart and flexible IT system to smoothen the communication between users and the IT system. Healthcare Decision-making processes, its professional and consultative services and its expertizing panellists are implements various programs in different regions at country level. These procedures fell replacing under such comprehensive classification as contaminating diseases interference, chronic

diseases, organizational personnel and public healthcare management, child-mother healthcare, hygiene and nourishment. National level web-based planning in health was repeatedly susceptible, along with the administrative capability of post- emigrant levels often weak. [Gorsky and Manton, 2022]

[Rundo et al. 2020] introduced latest Machine Learning [ML] technologies to achieve exceptional execution and a key influence in medical research as well as developing healthcare teaching work models. This article included modern AI based tools and also HCI plays an important role in modelling of software-oriented decision-making approaches regarding medicine. [Solari et al. 2018] introduces novel HCI modalities on the recent prevalence of new technology and devices for multimedia contents for exploring the digital information. Cognitive Science and Neuroscience has to be considered during the design of HCI systems in order to decrease visual fatigue.

Intercommunication aspects also having some important consequences in the scientific viewpoints for being used very smoothly and managed easily by the user using it [Zeng et al. 2020]. Human Computer Interaction is the research area that is primarily focused on creating and executing technical communication easy for both the user and the computer [Yun et al. 2020]. In other words, Artificial intelligence methodologies are used here for making the interactions inventive [Bryndin et al. 2020].
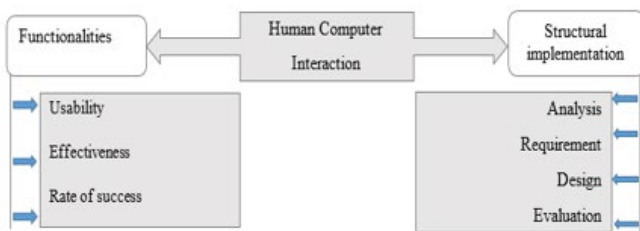

Figure 1. Workflow model of HCI

Under the description of a basic workflow model of the HCI application that are included different tasks and their effective outcomes. To measure the effectiveness of the model we need to observe the task completed within a specific time interval that is considered as task completion time and to measure the ratio of success to failure or vice versa we have to focus upon learning time-span of the user. After the completion of task there have to consider the users satisfaction by taking the reviews of the users and by measuring the success-rate of the work done. In this part of usability, it had measured from the task assigned to the rate of completion how easily over the user interface. In the design interface this needs an analysis to identify the stakeholders. Hence also we need to specify the functional and non-functional domain requirements along with some design interface solutions need to be evaluated.

1.1 Research Hypothesis

In this study we go through several research papers related to HCI, its applications and uses in different sectors of Healthcare industries. We investigate a contemporary methodology used widely in every area of research i.e. X-AI using Machine Learning Algorithms.

From which act of this study, we also identify some research questions that are given below:

H1: What are the challenges and drawbacks in HCI applications?

H2: what does Explainability mean in X-AI?

H3: What is the significance of X-AIML techniques in Healthcare?

H4: What are user's expectations from this X-AIML methodology in present and in future as well?

By look forward to several research studies, some relatable information's got collected which may include HCI, X-AI, and ML algorithms. Responses of the above said questions are given below:

H1: Basically, HCI is a design process. Form different studies we found that, HCI is further divisible into two subcategories. One is system usability and other one is user centric design process. As described in [Raduntz et al. 2019], a problem raised initially in system usability is due to user interface for the suitable interaction. It requires better product and services for the better result. The user centric design process is having some problems which described in [P. Forbrig 2016], that includes user requirements and interface designs are neither proper nor transparent to the user.

H2: here the word explainable means to summarize, analyse, extend and apply current psychological theories to develop a computational theory. An explainable AI means there are having explainable models and explainable interface, i.e. the system gives an explanation to the user that justifies its action.

H3: System plans for implementation of X-AI algorithms which include ML, DL and some other subfields of this, which may help in improving the organizational challenges and pitfalls of X-AI on healthcare industries. By the conjunction of Machine learning techniques with X-AI many challenges may resolved by improving the explainability, classification and abstraction of X-AIML models.

H4: This X-AI field is an emerging and integrating field to various ML algorithms and models. Expectations and primary requirements of the users may be manipulated by a description of X-AI system. But it can be resolved by using ML algorithms into X-AI, which may be eligible to fulfil all user's requirement now-a-days.

1.2 Objectives of this Study

The primary goal of this research is to study the existing HCI techniques used in healthcare systems and review the recent works and investigate the possibility of designing an efficient approach for collecting appropriate information to make a scalable methodology to maximize patient safety.

We have set the following broad objectives from our research:

- We plan to study recent works on different HCI techniques and methodologies along with AI tools.
- We plan to propose an efficient approach for collecting accurate information and focuses on Accuracy for running the methodology.
- We plan to identify different challenges involved in different HCI techniques and future research directions in this area.

2. Reviewed Method

"IEEE Explorer", "PubMed", "science Direct", "SCI", "Google Scholar" and "Scopus" were searched by the healthcare professionals and health informaticists for an assistance to increasing their searching scheme and developing a technology. The semantic keywords used were sensors, robotics, machine-human interface, command-line interface, graphical user interface, and healthcare to determine the net volume of the articles published about HCI along with x-AI tools and machine learning techniques in the healthcare sectors in common. [S.Dino et al. 2022].

At the time of the data collection, evaluation, and analysis the worked papers were evaluated using "C3" protocol i.e., Command, Control, and Consequence along with accurateness, analysis, equitability, time checklist [Tyndall, 2010] for analytical research, and 0-100% scoring analytical approach assessment Tool or "A3" [Pluye et al., 2009] for research works. The below figure [Fig 2.] [Liberati et al., 2009] shows the diagrammatic representation for the working model for information execution [S.Dino et al. 2022].

Figure 2. Prisma Model

In such scenario, there are some major aspects that aims to give emphasis on the functional and accessible standards which may involves that the model is: how much efficient, how effective, and does that model able to satisfy the users' basic needs [Siavvas et al. 2017].

Accuracy of the working model can be analysed based on the performance of the user which are available with the system and the approximate interval of time taken by the user to perform the function with a satisfactory result as its outcome. [Nazar et al. 2021]

$$Accuracy = \frac{no.\ of\ tasks\ executed \times \frac{Rxy}{Txy}}{total\ no.\ goals \times total\ no.user} \times 100 \qquad \cdots\cdots\cdots \{1\}$$

$$Total\ no.\ of\ task\ executed = \sum_{y=1}^{U} \times \sum_{x=1}^{G} \square \qquad \cdots\cdots\cdots \{2\}$$

$$\Rightarrow \quad \frac{\sum_{y=1}^{U} \times \sum_{x=1}^{G} \times \frac{Rxy}{Txy}}{GU} \qquad \cdots\cdots\cdots \{3\}$$

Where, G = set of Objectives
U = total Users aggregation
Rxy = outcome of the model 'x' done by the user 'y'
Txy = approximate duration to end the task x by user y [per seconds]

Rate of success of the proposed model can be defined by the satisfaction rate of the users' according to their requirements and as the duration of the completion of the task to which user needs are satisfied by utilizing the methodology for a specific model [Li et al. 2022]. It characterizes the average percentage of the success rate of the proposed architecture.

Rate of success of the given model =
$(A+ (U_t \times 0.5))/ (P_t) \times 100$

Where, A = total no. of successful execution
U_t = no. of User for one try
P_t = no. of try to execute the methodology.

[Stal et al., 2020] describes a comprehensive survey on UI-UX design process of man-machine interaction along with providing various frameworks and diagrammatic explanations from different research studies. This study basically focuses on Searching, Screening, and Synthesizing methods to review the articles. Basic judgment of the study classified as:

- Analysis of the Research
- User satisfaction from the work
- Efficiency of the review
- Validity and Enhancement of the methodology

3. Research gap analysis

By going through several research articles related to HCI applications in Healthcare we found approximately 3 to 4 years of research gap regarding "Electronic Health Record" [EHR], which requires to be more focused in today's virtual world. We have analysed the gap about processing of Electronic Health Record according to its key objective, ongoing services, framework used along with its challenges. Here we found some issues regarding privacy of the patients' information and accessibility of the system. We need to focus on it using AI-ML methodology.
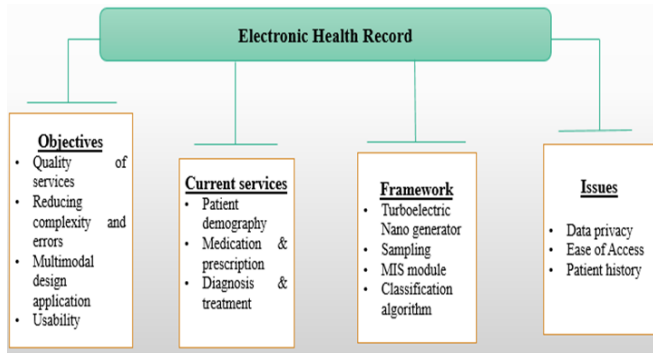
Figure 3. Gap Analysis

system which is accomplished by determining effectiveness of x-AI [Xu. W 2019].

Figure 4. Human cantered x-AI

4. Problem Statement

As HCI techniques are resource intensive, it is very essential that we have some enhanced applications of HCI by using AI-based tools as well as human intelligence. The popularity of HCI approaches is increasing day by day and accelerated according to their priorities. HCI technologies cooperates to boost the computational power as well as the decision-making ideas by creating a user-friendly communication between the system and the user and focused on how the work together in an efficient manner. The objective of this research is to study the existing HCI applications and investigating the possibilities of designing an efficient approach for running HCI applications in health-care community.

4.1 x-AI [Explainable Artificial Intelligence]

Initially the word "explainable" means humans can understand the predictions and conclusions made by the intelligence of the computing devices. It means that x-AI is the conjunction of human intelligence and artificial intelligence as well. Explainable is also called as interpretable artificial intelligence.

x-AI is functioning in different areas, like information system, HCI, cyber security, and industrial processes. Functions of x-AI are used to explore many fields, its primary objective to take an initiative for the expansion and enhancement in many technologies in different area. The prime aspects that have to do with x-AI are effectiveness of decision-making ideas and faith of natural human being.

There was a program based on x-AI introduced in 2017 named as "DARPA". The key objective of this coined program was to propose a unique and developed x-AI algorithm for the better interaction between human and computer. This methodology is also looking forward to user interfaces with modified and developed HCI technologies i.e. "UI visualization" and "Conversational UI" [Topak et al. 2020]. Aim of x-AI is to represent the user's expectations of the predetermined and considered clients from the overall
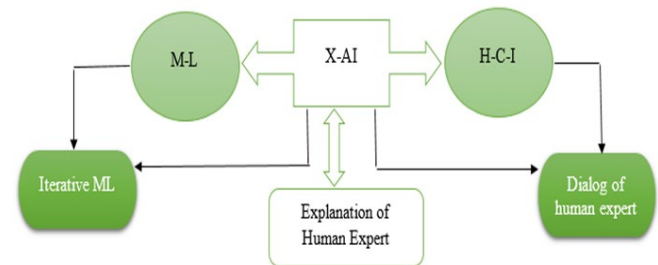
4.2 RNN [Recurrent Neural Network]

Recurrent Neural Network is an efficient algorithm which is one subfield of Machine Learning that may use for the better classification of different training and testing datasets. But in this study, we basically focus on Healthcare industries and that is why we are taking the data's from different healthcare sectors which are stored, accessed and analysed over the electronic health record. We supposed to apply RNN algorithm focusing on privacy concern of the EHR from unauthorized access.

This will work on three layers i.e. first one is Input layer, then middle is hidden layer and third and final layer gives the calculated result as output. The major benefit of this Methodology is that this may easy to access by a layer, and it can be implemented smoothly followed by primary training in real time operating system. [V. Rajesh, 2009]
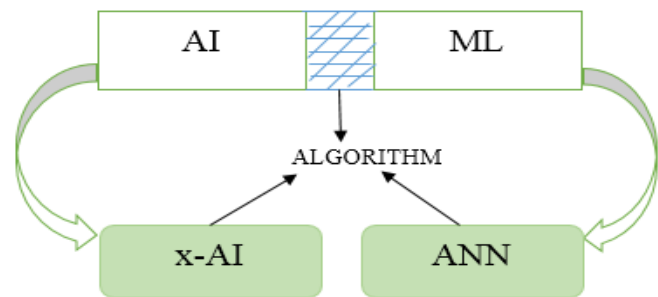

Figure 5. Paradigm for x-AI with ANN

5. Related Work done

This section of the paperwork represents some of related research works including HCI, its methodologies, uses, AI techniques and ML algorithms in different healthcare and clinical sectors. Objectives and goal of some reviewed research papers are described below along with its parameters

and services used for the results and future research directions derived from these studies.

[jin and wei 2022] was detected some low accuracy and high consumption of time for image and edge detection. Here a machine vision technology is proposed to calculate the weight of an image edge. In this study, the detection time is acknowledged 0.2s and average time for quickest detection is 0.1s. [S Mishra et al, 2022] described about a general phenomenon regarding AI based learning algorithms for resolving critical problems in our day-to-day lifestyle. This study shows an integral survey of advanced AI technologies used in various sections of healthcare sectors focusing on clinical care, bio-medical environment, and pharmaceutical industries and so on. [Xue and Lai, 2023] proposed a civilized MMI system for electromyography electrode based dynamic force reconstruction scheme. This networking model was out-performed the 2-DCNN methodology and feature based linear regression based on features and this may meet the basic human requirement of virtual communication over the cloud. This study shows the general estimation performance of online and offline tests are 0.83 and 0.99 respectively and the approximate speed of the assumption has reached 1115.5μs per sample. An AI paradigm was being described in [R. Agrawal, 2021] which may provide many solutions to solve day to day problems of human life. Two significant methodologies namely pattern recognition using 'ML' and

'NLP' in different medical industries has introduced by this chapter. The review [B. Gebru et al, 2022] shows different technologies for the calculation of trust between human and the computer system from the system's point of view. This combines different studies about the relationship between operations which brings a conceptual method of dynamic trust evaluation process that may related to human-robot environment. [B. Zhou et al., 2022] presents a review on different NLP approaches and emerging AI applications used for smart healthcare scenarios that involves healthcare management, clinical care, medicines and treatment which focuses on covid-19 pandemic. [A.A. Alzubi et al. 2021] gives a brief introduction about cyber physical system and their uses in cyber-attack detection over confidential information of healthcare industries. This study also introduces an immense attack surface along with the cognitive machine learning framework for the detection of attacks and keep the healthcare information more secure.

In this section of the study, we surveyed some of the research works related to our research area including Man Machine Interaction, AIML Technologies in Healthcare industries along with different tools and techniques used that have been reported in the literature. This Table-1 presents an overview of some related work done in the related research topic.

Table 1. Below given Table shows Related Survey Report

Author name & year	Aim and Objective	Parameters	Tools & Services	Future Research Directions
[26]	To get together IoT with BCI for creating an emerging healthcare system.	• Classification Model • Regression Algorithm	• P300 Signal	Focus need to be developed up to further population apart from healthcare system.
[40]	To introduce a MMI system that leverages electromyography electrodes for dynamic force reconstruction.	• Liner Regression	• 2-DCNN	Real time performance and user experience need to be considered.
[5]	To provide AI based HCI approach to develop the safety and detection of disease.	• HCI • AI	• Phenotyping tools • Web based techniques	Quality, safety and usability may be considered by adding human intelligence into the model.
[19]	To consider the design of HCI in the field of research and to improve the healthcare system.	• Inertial measurement unit (IMU) • CNN • NN	• short-term auto correlation (STAC) • IMCMR-UWSN technology	Reduction of the fault tolerance rate need to be considered.
[29]	To improve usability of robotics technologies and usefulness for taking care of older persons	• Robotics • HCI	• Tactile sensor • TRIC • iRo	Quality care services need to be considered.
[17]	Integrate and discuss on two experiments to implement the placebo effect on user interface.	• NASA-TLX • ANOVA-TAM	• Likert Scale • Wilcoxon rank test	Source code and primary data for the placebo need to be enhanced.
[14]	Introduce a textile based electrical hardware which can be applied for human robot interaction.	• Sandwich structured framework	• GO/CNTS/BSA composites • LBL self-assembly technique	Flexibility of the proposed architecture need to be improved.
[2]	To introduce a patient-centric design model for safety of patient information.	• Cyber Physical System	• CML-ADF model • MATLAB	Smart CPS need to be established to deal with CML-ADF better communication.
[5]	To describe the intercommunication between the client-server to build a dependable and believable atmosphere.	• XAI	• Prism model • Digital mental health tools	Accurate detection and safety need to be considered.

[6]	To focus on design aspects to improving healthcare workflow by using advanced ML techniques.	• HCI • HER • TEXT MINING	• AI enabled devices • CDSS	To support physicians in their decision-making activities by synergy between HCI & AI techniques.
[3]	To understand B-C-I from H.C.I point of view	• Visual simulation • Visual contrasts • Acoustic feedback	• SSVEP system • A/D converter • MATLAB	Increase the mobility of BCI to make it real for all users.
[8]	To improve HCI to obtain natural and ecological ways to interact with digital content in VR & AR algorithm.	• Brain computer interface • ML approaches	• VR techniques	To improve HCI applications to identify some pitfalls.
[9]	To differentiate between the approximate time interval during scanning process of patients with different health problems.	• Iterative Method • Statistical Algorithm	• CT scan • ASIR	Data privacy need to improve by socio-technical system model.
[7]	To develop complex CDSS to modify the design related to HCI for the sake of decrease the count of mistakes in HER	• Medical data analysis • HER	• UI • Classification algorithm	To improve usability of the system

[Balcombe et al. 2022] introduced a usable HCL model, which may support in idea and improvement of some technical representations and to analyse and summarize accurately and to acknowledge some disproportionateness of patients with mentally unstable and for prevention of suicidal attempts and also helps in the digital diagnostic alliances.

[Li et al. 2022] introduces the harmonious interaction between users and products and the interaction between humans and computers. In this research work it may show to consider the design of HCI in the analysis and development of healthcare related gadgets for better communication.

[S. Dino et al. 2022] introduced a "Prisma model" to evaluate healthcare services, clinical data, and characteristic regarding intercommunication between user and computer in the robotic system for clinical care of older adult population from the recent experimental and analytical research works. This is an integrative review work which emphasize the improving robotics system usability and utility for the care of older adults.

[Nazar et al 2021] introduced a feature by combining AI and HCI over the past several years in order to create an interactive intelligence system for easy user interaction.

They used the tools of AI in association with HCI applications in various fields and algorithm to provide clarity to the user.

[Rundo et al. 2020] introduced latest Machine Learning [ML] technologies to achieve exceptional interpretation and a useful effect in healthcare research along with developing medical and clinical workflows. This article included modern AI based tools and also HCI plays a very important role in modelling of software-oriented decision-making models in health sectors.

[Arruda Leite et al. 2018] introduces a methodical evaluation of a game controlled by Brain Computer Interface [BCI] based on "steady state visually evoked potentials" [SSVEP]. Aim of this study is to understand BCI from HCI point of view and visualizing the feasibleness of the intercommunication between the human brain and the computer system.

[Solari et al. 2018] introduces novel HCI modalities on the recent prevalence of new technology and devices for multimedia contents for exploring the digital information. Cognitive Science and Neuroscience has to be considered during the design of HCI systems in order to decrease visual fatigue.

[Bologva et al. 2016] introduces some common challenges of HCI applications at the time of using Electronic Medical Record [EMR]. This study focuses on EMR instead of PMR (Paper Medical Records) and make an assumption by enhancing the HCI we can, thereby increase the satisfaction of the work of physicians.

6. Challenges and Discussion

HCI undoubtedly contributed the interaction model and developed some efficient solution. But still there were some technical issues found about the safety concern and so on. Some of the identified challenges like safety and security, accessibility, data integrity and ease-of-use are given below:

Usability and User Experience: Designing healthcare applications with good usability and user experience can be challenging due to the complexity of healthcare systems and the diverse needs of different user groups, including patients, healthcare professionals, and administrators.

Privacy and Security: Protecting patient data from unauthorized access or breaches is essential. Designing secure authentication and authorization mechanisms, as well as ensuring data encryption and compliance with privacy regulations, are ongoing challenges in healthcare HCI.

Human Factors and User Needs: Understanding the unique needs, capabilities, and limitations of end-users is crucial in healthcare HCI. Factors such as age, physical abilities, cognitive impairments, and cultural diversity can significantly impact the design and usability of applications.

6.1 Discussion

The phenomena of WBAN [Wireless Body Area Network] is discussed in the paper [Q. Liu et al. 2021] which based on both medical and non-medical applications and the privacy and safety concern of its user's information. Here it requires a little more study about the advanced AI enabled privacy measures. Similarly [A. Scibilia et al. 2022] surveyed a mathematical model regarding calculation of approximate time for manipulation of neuromuscular system tasks. In this study the author takes different variables to identify various factors of the neuromuscular dynamic function.

Now-a-days everything becomes completely online, and privacy alarms are also be-come virtual and more threatened. Therefore, approving their important discrimination and significance among the research committee, this paper involved a greater group of experts' research work in this area of research from various disciplines in HCI. Thus, this study introduces the discussion on the future direction of HCI applications and contribute the enhancement in recent and future research on HCI.

Human daily behaviour is an important factor for the maintenance of health and prevention and cure of disease. This study trying to add some enhanced and efficient technical operations along with human behaviour for some better result. In this paper we have gone through some recent work done on HCI along with AI models in various digital healthcare technologies. We have addressed some challenges of HCI in digital health techniques and to overcome that limitations the researchers had added some AI tools to that for better result.

The systematic literature review pointed out the parameters and tools used with HCI applications in medical care. In today's day-to-day changing lifecycles and several technical advancements creating balance for an extensive expectation on computational healthcare tools and technologies besides the natural ignorance of future challenges and drawbacks' regarding healthcare activities and various diseases, which may need further studies. [Q. liu et al. 2021]

7. Conclusion and Future Research Direction

This paper provides a basic survey of HCI along with AI based tool and different parameters under the section of review of literature. Because all the regulations have basic idea about the literature survey. Under the principle of combined HCI and AI technologies are very much important to integrate with different models, which may base on the conjunction of artificial intelligence and human intelligence as well. The field related to clinical and healthcare system was the prime content of this HCI usability evaluation method. This study gives a brief description of the overall content and introduces the background of some recent work done related to this area of re-search. This paper also introduced the basic origin of HCI based medical learning approaches and system framework.

7.1 Future Research Direction

Here need to focus on more Accuracy, Running Performance of the system, and Privacy & Safety concern of the user. Also need to focus on basics of health care informatics and need to make more interactive interface because however there are still some areas where technical services are not clear. The field of explainable AI i.e. conjunction of artificial intelligence into human intelligence that may create a trust-worthy environment for the user, patients and also for healthcare professionals by

involving several kind of population into the circumference and excluding transparency concern. Some future work should be taken on HCI applications and XAI algorithms to overcome the pitfalls arises in this review.

References

[1]   Agarwal, R. (2022). Predictive Analysis in Health Care System Using AI. Artificial Intelligence in Healthcare, 117-131.

[2]   AlZubi, A. A., Al-Maitah, M., & Alarifi, A. (2021). Cyber-attack detection in healthcare using cyber-physical system and machine learning techniques. Soft Computing, 25(18), 12319-12332.

[3]   Arruda leite. H. M, Carvalho. S.N.C, Sliva costa. T.B, Attux. R, Hornung. H.H, Arantes. D.S, "Analysis of user interaction with a Brain- Computer interface based on a stady state visually evoked potential: case study of a game" (2018).

[4]   B. Zhou, G. Yang, Z. Shi and S. Ma, "Natural Language Processing for Smart Healthcare," in IEEE Reviews in Biomedical Engineering, 2022, doi: 10.1109/RBME.2022.3210270.

[5]   Balacombe. L, Leo. D.D, "Review- Human Computer Interaction in digital mental health informatics", (2022)-9, 14.

[6]   Ballesteros. J, Ayala. I, Rafael. J, Romerod. C, Amora. M, Fuentesa. L, "Evolving dy-namic self-adaptation policies of mHealth systems for long-term monitoring" (2020)

[7]   Bologva. E.V, Prokusheva. D.I, Krikunov. A.V, Zvartau. N.E,Sergey V. Kovalchuk. S.V," Human-Computer Interaction in Electronic Medical Records: from the Perspec-tives of Physicians and Data Scientists" (2016), Pp- 915-920.

[8]   Bansal et al., International Journal of Advanced Research in Computer Science and Software Engineering 8(4) ISSN (E): 2277-128X, ISSN (P): 2277-6451, pp. 53-56.

[9]   Cassano, C., Colantuono, A., De Simone, G., Giani, A., Liston, P. M., Marchigiani, E., & Parlangeli, O. (2019). Developments and problems in the man-machine relationship in computed tomography (CT). In Proceedings of the 20th Congress of the International Ergonomics Association (IEA 2018) Volume V: Human Simulation and Virtual Envi-ronments, Work with Computing Systems (WWCS), Process Control 20 (pp. 488-496). Springer International Publishing.

[10]   E. Bryndin, ``Development of artificial intelligence by ensembles of virtual agents with mobile interaction," Autom. Control Intell. Syst., vol. 8, no. 1, p. 1, 2020, doi: 10.11648/j.acis.20200801.11.

[11]   F. Topak, M.K. Pekericli, "towards using Human Computer Interaction research for ad-vancing intelligent build environments: a review", in proc. 6th international projrct con-struction management. Conf. 2020, Pp- 835.

[12]   Gebru, B., Zeleke, L., Blankson, D., Nabil, M., Nateghi, S., Homaifar, A., & Tunstel, E. (2022). A review on human–machine trust evaluation: Human-centric and machine-centric perspectives. IEEE Transactions on Human-Machine Systems, 52(5), 952-962.

[13]   Gonzalez. O.L, "Black-box vs. White-box: understanding their advantages and weak-ness from a practical point of view", (2019), Vol-4, Pp-1-19.

[14]   Guo, X., Hong, W., Zhao, Y., Zhu, T., Li, H., Zheng, G., & Xu, Y. (2022). Bioinspired sandwich-structured pressure sensors based on graphene oxide/hydroxyl functionalized carbon nanotubes/bovine serum albumin nanocomposites for wearable textile electronics. Composites Part A: Applied Science and Manufacturing, 163, 107240.

[15]   Gorsky, M., & Manton, J. (2022). The political economy of 'strengthening health ser-vices': The view from WHO AFRO, 1951-c. 1985. Social Science & Medicine, 115412.

[16]   Jin, Y., & Wei, W. (2022). Image edge enhancement detection method of human-computer interaction interface based on machine vision technology. Mobile Networks and Applications, 27(2), 775-783.

[17]   Kosch, T., Welsch, R., Chuang, L., & Schmidt, A. (2023). The Placebo Effect of Artifi-cial Intelligence in Human–Computer Interaction. ACM Transactions on Computer-Human Interaction, 29(6), 1-32.

[18]   Kumar. R, Jayswal. V, Nishad. V, "Human Computer Interaction" (IJERT) (2021).

[19]   Li. X, Xu. Y, "Role of Human-Computer Interaction Healthcare System in the Teaching of Physiology and Medicine" Apr-2022.

[20]   Liberati, A., Altman, D.G., Tetzlaff, J., Mulrow, C., Gotzsche, P.C., Ioannidis, J.P.A., Clarke, M., Devereaux, P.J., Kleijnen, J., Moher, D., 2009. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare inter-ventions: Explanation and elaboration. BMJ 339 (jul21 1), b2700–b2700. 10.1136/bmj.b2700.

[21]   Liu, Q., Mkongwa, K. G., & Zhang, C. (2021). Performance issues in wireless body ar-ea networks for the healthcare application: A survey and future prospects. SN Applied Sciences, 3, 1-19.

[22]   M. G. Siavvas, K. C. Chatzidimitriou, and A. L. Symeonidis, ``QATCH_An adaptive framework for software product quality assessment,"Expert Syst. Appl., vol. 86, pp.350_366, Nov. 2017, doi: 10.1016/j.eswa.2017.05.060.

[23]   Mishra, S., Abbas, M., Jindal, K., Narayan, J., & Dwivedy, S. K. (2022). Artificial in-telligence-based technological advancements in clinical healthcare applications: A sys-tematic review. Revolutions in Product Design for Healthcare: Advances in Product Design and Design Methods for Healthcare, 207-227.

[24]   Nazar. M, Alam. M.M, Yafi. E, Su'ud. M.M, "a systematic review of Human computer Interaction and Explainable Artificial intelligence in healthcare with Artificial intelligence techniques", (2021), Vol-9, Pp-153316-153348.

[25] P. Forbrig, ''Continuous software engineering with special emphasis on continuous business-process modeling and human-centered design,'' in Proc. 8th Int. Conf. Sub-ject-Oriented Bus. Process Manage. Apr. 2016, pp. 1–4, doi: 10.1145/2882879.2882895

[26] Parui, S., Samanta, D., & Chakravorty, N. (2023, January). An Advanced Healthcare System Where Internet of Things meets Brain-Computer Interface using Event-Related Potential. In 24th International Conference on Distributed Computing and Network-ing (pp. 438-443).

[27] Pluye, P., Gagnon, M.-P., Griffiths, F., Johnson-Lafleur, J., 2009. A scoring system for appraising mixed methods research, and concomitantly appraising qualitative, quantita-tive and mixed methods primary studies in Mixed Studies Reviews. International Jour-nal of Nursing Studies 46 (4), 529–546, 10.1016/j.ijnurstu.2009.01.009.

[28] Rundo. L, Pirrone. R, Vitabile. S, Sala. E, Gambino. O, "recent advances of HCI in de-cision-making tasks for optimized clinical workflows and precision medicine" (2020-aug).

[29] S.Dino.M.J, M.Davidson.P, W.Dion.K, L.Szanton.S, L.Ong.I, "Nursing and human-computer interaction in healthcare robots for older people: An integrative review." Mar-2022.

[30] Scibilia, A., Pedrocchi, N., & Fortuna, L. (2022). Human control model estimation in physical human–machine interaction: A survey. Sensors, 22(5), 1732.

[31] Solari. F, Chessa. M, Chinellato. E, Bresciani. J. P, "advances in Human Computer In-teraction: Methods, Algorithms, Applications", (2018).

[32] T. Raduntz, T. Muhlhausen, N. Furstenau, E. Cheladze, and B. Meffert, Application of the Usability Metrics of the ISO 9126 Standard in the E-Commerce Domain: A Case Study, vol. 903. Cham, Switzerland: Springer, 2019.

[33] Ter Stal, S., Kramer, L. L., Tabak, M., op den Akker, H., & Hermens, H. (2020). De-sign features of embodied conversational agents in eHealth: a literature re-view. International Journal of Human-Computer Studies, 138, 102409.

[34] Tyndall, James. (2010). AACODS Checklist. http://dspace.flinders.edu.au/dspace/. United Nations, Department of Economic and Social Affairs, 2017. World Population Prospects: The 2017 Revision. https://www.un.org/development/desa/ publica-tions/world-population-prospects-the-2017-revision.html.

[35] V. Rajesh, P. Rajesh kumar and D. V. R. Koti Reddy, "SEMG based human machine interface for controlling wheel chair by using ANN," 2009 International Conference on Control, Automation, Communication and Energy Conservation, Perundurai, India, 2009, pp. 1-6.

[36] Wang.J, Cheng. R, Liu.M, Liao. P.C, "research trends of HCI studies in construction hazard recognition: A bibliometric review", (Sensors 2021, 21, 6172).

[37] W. Xu, "A perspective from human computer interaction", Tech. Rep. (2019).

[38] X. Li, Y. Xu, "role of human computer interaction healthcare system in the teaching of physiology and medicine" (2022).

[39] Xue, J., & Lai, K. W. C. (2023). Dynamic gripping force estimation and reconstruction in EMG-based human-machine interaction. Biomedical Signal Processing and Con-trol, 80, 104216.

[40] Y. Yun, D. Ma, and M. Yang, ``Human computer interaction based decision support system with applications in data mining," Future Gener.. Comp. Syst., vol. 114, pp. 285_289, Jan. 2021, doi:10.1016/j.future.2020.07.048.

[41] Z. Zeng, P. J. Chen, and A. A. Lew, ``from high-touch to high-tech: COVID-19 drives robotics adoption," Tour. Geogr, vol. 22, no. 3, pp. 724_734, 2020, doi: 10.1080/14616688.2020.1762118.