

Domotics in inclusion and health: Descriptive Study

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Abstract

The present research is a bibliographic, exploratory, descriptive, and documentary study of the main contributions of the home automation area for people with disabilities, including mental, physical, or temporary therapy. The study selects 30 journal articles or review articles from the Scopus database of the main quartiles Q1, Q2, Q3, that meet the purpose of the study and respond to the research question, from a total of 228 articles (208 articles, 20 reviews) of the last 10 years and that have English language. Among the main results, 3 specific areas of interest of the scientific community are identified: Telemedicine, home automation, Artificial Intelligence, in studies of remote monitoring for medical assistance of the elderly, disabled people, medical centers, additionally for intelligent energy management, portable sensors, IT Smart House, stress management, emergency calls, alternative communication with brain-computer interfaces, education and innovation of algorithms. The purpose of this research is to provide a first approach to the scientific, academic and business community that initiates learning in this area, in order to provide a review of the most relevant contributions in this line of knowledge.

Keywords: Home Automation, Telecommunications, Ambient Assisted Living (AAL), Quality of Life, Assistive technologies, Accessibility

Resumen. La presente investigación es un estudio de tipo documental, exploratorio y descriptivo acerca de las principales aportaciones en el área de la domótica para personas con discapacidad. De un total de 228 artículos (208 artículos, 20 revisiones) publicados en inglés en los últimos 10 años, este estudio selecciona 30 artículos científicos y de revisión de la base de datos Scopus, ubicados en cuartiles Q1, Q2 y Q3, dentro de la temática de estudio. Entre los principales resultados, se identifican 3 áreas de interés en la comunidad científica: (i) Telemedicina, (ii) domótica, (iii) Inteligencia Artificial. Adicionalmente existe estudios de interés en monitorización remota para asistencia médica de personas mayores, discapacitados, centros médicos, así como, investigaciones de gestión inteligente de la energía, sensores portátiles, IT Smart House, gestión del estrés, llamadas de emergencia, comunicación alternativa con interfaces cerebro-ordenador, educación e innovación de algoritmos. El propósito de esta investigación es proporcionar una primera aproximación a la comunidad científica, académica y empresarial que se inicia en el aprendizaje en esta área, con el fin de proporcionar una revisión de las contribuciones más relevantes en esta línea de conocimiento.

Palabras clave: Domótica, Telecomunicaciones, Vida Cotidiana Asistida por el Entorno (AAL), Calidad de Vida, Tecnologías de Apoyo, Accesibilidad

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Introducción

The term telemedicine is relatively new. However, this kind of service has proven to continue evolving in line with demands from different contexts in search of efficiency and systems acceptance. [8,17]; It is crucial to mention that one of the central obstacles found throughout the years when using wireless networks is information management security and safety resulting in a non-exponential growth of this industry and that experts seek opportunities helping get over such hurdle. [17].

The main focus of scientific publications in the area of home automation is on improving the quality of life of people with special needs, especially through advances in telemedicine and telecommunications. These investigations seek to provide creative solutions that promote greater independence, safety, and comfort in the daily lives of these people. In addition, the importance of inclusion is highlighted, since, using technologies such as home automation and telecommunications, tools are developed that facilitate the participation and active integration of people with special abilities in various areas of society. Specific solution models are proposed that are viable and effective to address cases of people with special abilities, where the integration of these technologies is considered necessary.

In the second section of this paper denominated Materials and Methods was written after analyzing the connection between a bibliography and information gathering instrument. Similarly, section 3 is comprised by a complete synthesis of every document studied organized in a narrative form. Section 4 conclusions drawn from the study of articles. Lastly, section 5 gives an opening to possible new subject matters or circumstances to do research on.

Materials and methods

This Project has been performed based on mixed, documental, and exploratory investigation describing qualitative and quantitative data primarily focused on Home Automation and handicaps explained as follows. Previously consulted articles had as a common objective to facilitate the realization of day-to-day tasks to those suffering from mental or physical handicaps or even experiencing a kind of therapy to help them perform activities through the use of technology such as Home Automation including Artificial Intelligence which has had an unquestionable success in recent years. Hopefully safety, health, and the optimum development of patients with special needs is likely to be assured.

Information survey

There isn't a great deal of information about the chosen subject in diverse bibliographical databases, for this reason Table 1 highlights search equation related information. It should be noted that those articles complying with requirements were exclusively considered such as articles publishing relevant information in the last 10 years, articles categorized in quartiles Q1 and Q2 dismissing articles not written in English. In this context, the offered range was minimized to obtain articles containing the most relevant information..

Table 1. Search equations

Search string	Filters	Articles	Review	Total
1 (TITLE-ABS-KEY (home AND automation) OR TITLE-ABS-KEY (domotics) AND TITLE-ABS-KEY (telecommunications)) AND (LIMIT-TO (PUBYEAR , 2022) OR LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013)) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "re"))	Article OR Review	204	15	219
2 (TITLE-ABS-KEY ("artificial intelligence") AND TITLE-ABS-KEY ("therapy") AND TITLE-ABS-KEY ("telecommunications")) AND (LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2012)) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "re"))	Article OR Review	4	5	9

Results

The articles selected for this study identify the following information in Figure 1.

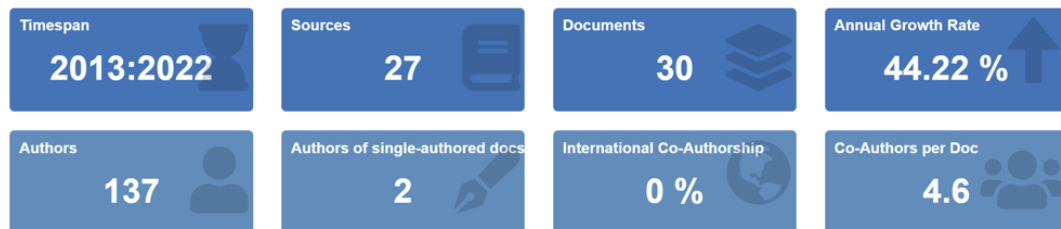


Fig. 1. Articles selected. Bibliometrix tool [31]

After an extensive analysis regarding the information inquired, three fundamental points were found which the article was based on, governed by different topics. For this reason, the field of telemedicine, home automation and artificial intelligence were categorized in different areas; all references described in Table 2.

Table 2. Summary

Area	Reference
Telemedicine	[4, 8, 11, 17, 28, 30]
Home automation	[1, 2, 3, 7, 12, 15, 16, 18, 19, 21, 23, 27, 29]
Artificial Intelligence	[5, 6, 9, 10, 13, 14, 20, 22, 24, 25, 26]

In addition, there is a growing interest in the research topics of this study in Figure 2.

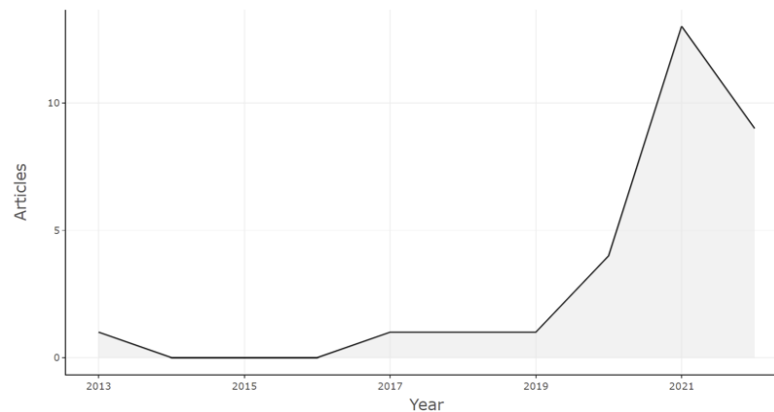


Fig. 2. Bibliometrix tool [31]

Telemedicine

The morphology of the term 'telemedicine' makes its concept evident; [17] assures that telemedicine is a research task and multidisciplinary application that uses advanced technology regarding data processing, telecommunication, bio detection and artificial intelligence. By extension, this expression is used to name environments in which remote monitorization (medical assistance) is realized by technology. The application of this new medical care technique emerged as a solution to difficulties faced distinctively by the elderly and individuals with special needs namely to commute to health centers in rural areas to either preventative care or to seek medical treatment.

In [8] cardiovascular disease prevention is the objective, therefore a monitoring system by means of an electrocardiogram (ECG) implemented with Zigbee technology to facilitate the evaluation of hear electrical-activity is suggested. The monitoring system can be implemented to provide a contrasting approach.

On the other hand [4] the operation of mHealth is detailed and the way aggregate information is transmitted in the form of mobile phone signals pertaining to an individual to other digital personal assistant acting as edge device. This type of wireless communication was possible using technologies like Bluetooth, Zigbee, RFID and so on. The edge device was used to perform a local layout effect over measured vital signs. Then, if an anomaly was evident, a notification was sent to appropriate healthcare authorities. This process would optimize the monitoring, analysis and illness symptomatology detection.

In [11] Long-Acting Therapies are revealed, particularly those therapies that require less visits to clinics in order to administer treatment and that is when Telemedicine and Artificial Intelligence come in since they may be adapted to the treatment efficacy for illnesses such as chronic eye disease mitigating the burden of treatment.

In [28] indicates a cellular model that describes tumor immune dynamics incorporating the function of estrogens. Telemedicine comes into this aspect since it will be able to analyze and explain the complex structures of the mathematical models that will be used for the interaction that the cells will have.

Home Automation

In research [2] raises a new energy management technique in smart homes. (SHEM) Smart Homes Energy Management—for its acronym in English comprised by a 3kWp photovoltaic generation system, a 10kWh lithium-ion battery bank and a 3,6kW hybrid inverter developed with Dynamic-proactive mathematics in addition to using a whole linear and mixed linear programming model, with rugged adjustable programming (ADJ-ROBUST-MILP). At the same time, in [23] several suggested articles are grouped aiming to provide wireless sensor networks (WSN) energy optimization alternatives taking different routes to maximize the use of energy and cost-reduction processes.

The Internet of things (IoT) describes the network of physical objects. It is a technology based on wireless networks for the purpose of connecting devices simultaneously to Internet that said, [15] introduces a new model called “An enhanced ON/OFF traffic modelling technique for modelling the IoT smart city” aiming to simplify the complexity in burst of data occurring in IoT data exchange.

Although technological advancements not only improve and optimize processes, they become more vulnerable in regards to data management, privacy and security, that said [16] an efficient data security system unfolds through an authentication mechanism that, with user help is able to authenticate interactions performed by each device with a web server. Document [1] determines real-time threats and protective actions required for the implementation of a Smart House IT device module.

It is worth mentioning that [29] is an article written according to a previous inquiry exploration from which a bibliography analysis in the field of Internet of Things is performed.

“The IoT paradigm is not considered a new technology, but a combination of approaches that makes use of semiconductors, networks and data processing advancements research”. [21] Exemplifies many technological applications that use a machine-to-machine wireless communication.

Item [7] explains the design of an application that accepts interventions for the training of stress management founded on the cognitive-behavioral theory. Such application is key since artificial intelligence would be a useful instrument to be included in a psychotherapy model.

Likewise in [19] support measures of technical basis are increasingly valuable to an aging society, then such support measures may provide a self-determined life in a familiar environment despite the vital need for attention. For instance, a support measure is an at home emergency calls smart system (iHNR), which automatically detects critical emergency situations such as falls so it transmits this information to an emergency call center hence, the call for assistance and response becomes faster. Now, [18] talks about and contrasts smart home information providing a set of software and hardware independently and remotely controlled connected to a network providing a smarter living conditions.

Part of what was mentioned in [19] is explained in [3] stating that individuals having motor and cognitive impairments face hardship in every day life because of limited accessibility and inclusion in spaces limiting their autonomy and independence thus the mention of DOMHO project which addresses these issues seizing an innovative solution: a smart apartment or co-housing—semi-communal housing. Moreover, the aim of the project is to

explore well-known effects of co-housing in terms of health benefits and the well-being of its residents as assisted-living technology is combined with the environment.

In [27] it is said that Technology has a presence and increasingly plays a major role in Parkinson's disease whether is embraced or rejected by patients and doctors, it certainly is a growing field without doubt. Portable sensors have had the utmost attention by far. With [12] in recent years there has been an explosion in home-automation systems making every-day life easier, but it is true that there aren't enough tools specifically aimed to this population sector.

Artificial Intelligence

Formulates a feasible solution consisting of exploiting the flexibility and adaptability Software Defined Networks provide (SDN) together with Network Function Virtualization (NFV) focused on improving quality service and residential networks.

In [22] it is indicated that brain-computer interfaces are capable of detecting specific patterns and translate them into control signals for external devices by providing users suffering from serious motor-disabilities an alternative solution to communicate and interact with the world.

Moreover, in [13] it is said that product, project and service development current trends are focused on having greater consideration when it comes to User Experience. Therefore, traditional training and educational methodologies are to be modified for student learning yet so that they are able to develop conflict-resolution techniques vital for their professional career, similarly [6] contrasts far more complex information indicating that data processing generated in a bulk at high-speed from the Internet of things, Smart cities, home-automation, smart surveillance and electronic medical care systems require efficient services in data processing and data analysis within the surrounding perimeters to reduce latency and response time.

Having said that, the issue in [14] which refers to performance and usability related to user interface, technology reliability, privacy and attitude towards home automation. A series of demotivators'-systems guidelines proved a high reliability level these advanced tools. From the machine learning view, article [24] denotes that in recent years, technological paradigms like the Internet of Things (IoT) to include machine learning have become crucial because of the benefits its application represents to several specialized fields, thus the implementation of those 2 technologies promotes the formulation of more and better automatic control systems that better adjust to each user's specific preferences in the field of Home Automation. Finally, an experimental case study is presented validating the effectivity on the platform, where smart homes residents' behavioral patterns were established.

That said, [10] innovative algorithms raised related to image reconstruction based on DL which correct analyzing artifacts, the loss of signal and noise amplification with a kind of effectivity never before seen. This is just an example of what DL algorithms provide promised value proposals in musculoskeletal radiology. In [20] a technology convergence is based including major synergy with life-science technology capturing the value of massive multi-modal data in the form of predictive models supporting decision-making processes. Both articles have the same objective establishing a reduced error rate and increased productivity in connection with artificial intelligence illness detection.

One of the purposes of artificial intelligence [25] explains is that it is a superior tool predicting IUU success with a satisfactory predictive value (over 70% in the mentioned study) since it uses masculine and feminine reference factors. Hence, this process allows for the success probability prediction of the treatment and consequently, recipients of such treatments and their families have an opportunity to improve their quality of life.

Let us now consider [26] ML whose objective is to develop models capturing connections and essential patterns between input variables and data output. As long as high-quality data is available, we will be able to build models accurately predicting critical variables in each step of the planning process to automatize and enhance results. This process aims to reduce or completely eliminate the trial-and-error process resulting in high-quality planning.

Finally, [30] reveals aptamer-pharmakon (ApDC) able to significantly improve therapeutic efficacy and reduce toxicity in medication systems; using artificial intelligence advancements a protein and ARN prediction structure could be achieved; combining ApDC and IA concepts to mark a major breakthrough, since biopharmaceutical production would be faster and accurate for the treatment of several types of cancer.

Conclusions

It is safe to say that today, home automation is a primary system aimed to comfort those individuals with special needs by controlling several rooms at home, office even buildings depending on the need required. In this study a few predominant domotics applications have been numbered, nevertheless there are other applications equally important; allowing countries to greater save power, which is way domotics applied to light is an outstanding present-day option. Domotics and artificial intelligence go hand-in hand although the cost of home automation is high at the moment, enormous savings will be achieved on the long run as well as better efficacy in energy consumption. It is worth mentioning that domotics and AI combined can optimize several areas of telemedicine as medical treatments and medical care simplify. This article highlights the long-term positive impact of home automation on energy consumption as well as the optimization of medical care and treatments in the field of telemedicine.

The increasing processing of high-volume, high-speed data of different types (structured, unstructured, semi-structured) from various sources such as the Internet of Things, M2M, smart cities, home automation, smart surveillance systems and e-health care, raises the need for efficient data processing and analysis services.

In the area of machine learning has become crucial in the context of the Internet of Things (IoT) and Ambient Assisted Living (AAL). Its application in home automation and other specialized fields allows the development of more efficient automatic control systems, adapted to the individual preferences of each user, allowing to contribute in areas such as health, quality of life, accessibility and inclusion mainly, additionally it focuses on the validation of the effectiveness of this platform, pattern analysis, sensor behavior, applications for Smart Homes.

The assistive technologies provide a home environment adapted to the individual, facilitating communication and access to remote medical services, and fostering independence, social inclusion, and better quality of life for people with these types of special abilities.

Additional areas of interest have been identified in this study, such as performance, user interface usability, user-centered design, user experience, and privacy. Furthermore, it has been confirmed that a series of guidelines established in home automation systems demonstrate a high level of reliability.

To conclude, it must be emphasized that telemedicine, home automation and artificial intelligence are of great help, since they facilitate and allow to lead a life without so much complexity; the three areas have a common goal which is to seek health and improvement of people who have catastrophic diseases or any special ability, all this is possible thanks to the technology that offers them the opportunity for a great change in their lives.

Future work

Artificial intelligence and home automation are suggested to be explored in depth. As research progresses, it becomes clear that there is much information to be explored, including fascinating areas such as low-cost home nanotechnology to automate home maintenance.

It is vital to make society aware of the features and benefits, security, privacy, accessibility and affordability of home automation. By enabling people to effectively manage and automate their properties, they can achieve greater well-being, security and control over their belongings.

A crucial aspect worth highlighting for future studies is the specification of relationship of home automation in a field of telemedicine in everyday life essentially considering related key factors such as network infrastructure, coverage, dimensions, among others.

References

1. Alexandrov VA, Desnitsky VA, Chaly DY (2019) Design and Security Analysis of a Fragment of Internet of Things Telecommunication System. *Autom Control Comput Sci* 53:851–856. doi: 10.3103/S0146411619070241
2. de Azevedo RM, Canha LN, Garcia VJ, Sepúlveda Rangel CA, Silva Santana TA, Nadal ZI (2022) Dynamic and proactive heuristic for AC/DC hybrid smart home energy operation considering load, energy resources and price uncertainties. *Int J Electr Power Energy Syst* 137:107463. doi: 10.1016/j.ijepes.2021.107463
3. Bacchin D, Pluchino P, Grippaldi AZ, Mapelli D, Spagnolli A, Zanella A, Gamberini L (2021) Smart Co-housing for People With Disabilities: A Preliminary Assessment of Caregivers' Interaction With the DOMHO System. *Front Psychol* 12. doi: 10.3389/FPSYG.2021.734180
4. Barot V, Patel DR (2022) A physiological signal compression approach using optimized Spindle Convolutional Auto-encoder in mHealth applications. *Biomed Signal Process Control* 73:103436. doi: 10.1016/J.BSPC.2021.103436
5. Chen J, Li K, Zhang Z, Li K, Yu PS (2022) A Survey on Applications of Artificial Intelligence in Fighting against COVID-19. *ACM Comput Surv* 54. doi: 10.1145/3465398
6. Cumin J, Lefebvre G, Ramparany F, Crowley J (2020) PSINES: Activity and Availability Prediction for Adaptive Ambient Intelligence. *ACM Trans Auton Adapt Syst*. doi: 10.1145/nnnnnnn.nnnnnnn

7. Danieli M, Ciulli T, Mousavi SM, Riccardi G (2021) A Conversational Artificial Intelligence Agent for a Mental Health Care App: Evaluation Study of Its Participatory Design. *JMIR Form Res* 5:e30053. doi: 10.2196/30053
8. Dey N, Ashour AS, Shi F, Fong SJ, Sherratt RS (2017) Developing residential wireless sensor networks for ECG healthcare monitoring. *IEEE Trans Consum Electron* 63:442–449. doi: 10.1109/TCE.2017.015063
9. Flores Moyano R, Fernandez D, Merayo N, Lentisco CM, Cardenas A (2020) NFV and SDN-Based Differentiated Traffic Treatment for Residential Networks. *IEEE Access* 8:34038–34055. doi: 10.1109/ACCESS.2020.2974504
10. Fritz J, Kijowski R, Recht MP (2022) Artificial intelligence in musculoskeletal imaging: a perspective on value propositions, clinical use, and obstacles. *Skeletal Radiol* 51:239–243. doi: 10.1007/S00256-021-03802-Y
11. Ghanchi F, Bourne R, Downes SM, Gale R, Rennie C, Tapply I, Sivaprasad S (2022) An update on long-acting therapies in chronic sight-threatening eye diseases of the posterior segment: AMD, DMO, RVO, uveitis and glaucoma. *Eye*. doi: 10.1038/S41433-021-01766-W
12. Gonzalez D, Patricio MA, Berlanga A, Molina JM (2021) Variational autoencoders for anomaly detection in the behaviour of the elderly using electricity consumption data. *Expert Syst* 1–12. doi: 10.1111/exsy.12744
13. Gutiérrez-Martínez Y, Bustamante-Bello R, Navarro-Tuch SA, López-Aguilar AA, Molina A, Longoria IÁI (2021) A challenge-based learning experience in industrial engineering in the framework of education 4.0. *Sustain* 13. doi: 10.3390/su13179867
14. Gutierrez-Torre A, Bahadori K, Baig S ur R, Iqbal W, Vardanega T, Berral JL, Carrera D (2021) Automatic Distributed Deep Learning Using Resource-constrained Edge Devices. *IEEE Internet Things J*. doi: 10.1109/JIOT.2021.3098973
15. Ibrahim AS, Youssef KY, Kamel H, Abouelatta M (2020) Traffic modelling of smart city internet of things architecture. *IET Commun* 14:1275–1284. doi: 10.1049/IET-COM.2019.1252
16. Khoa TA, Nhu LMB, Son HH, Trong NM, Phuc CH, Phuong NTH, Van Dung N, Nam NH, Chau DST, Duc DNM (2020) Designing Efficient Smart Home Management with IoT Smart Lighting: A Case Study. *Wirel Commun Mob Comput* 2020. doi: 10.1155/2020/8896637
17. Li KF (2013) Smart home technology for telemedicine and emergency management. *J Ambient Intell Humaniz Comput* 4:535–546. doi: 10.1007/S12652-012-0129-8
18. Li W, Yigitcanlar T, Erol I, Liu A (2021) Motivations, barriers and risks of smart home adoption: From systematic literature review to conceptual framework. *Energy Res Soc Sci* 80:102211. doi: 10.1016/j.erss.2021.102211
19. Lukas A, Maucher I, Bugler S, Flemming D, Meyer I (2021) Security and user acceptance of an intelligent home emergency call system for older people living at home with limited daily living skills and receiving home care. *Z Gerontol Geriatr* 54:685–694. doi: 10.1007/s00391-020-01763-w

20. Moingeon P, Kuenemann M, Guedj M (2022) Artificial intelligence-enhanced drug design and development: Toward a computational precision medicine. *Drug Discov Today* 27:215–222. doi: 10.1016/J.DRUDIS.2021.09.006
21. Montori F, Bedogni L, Di Felice M, Bononi L (2018) Machine-to-machine wireless communication technologies for the Internet of Things: Taxonomy, comparison and open issues. *Pervasive Mob Comput* 50:56–81. doi: 10.1016/J.PMCJ.2018.08.002
22. Palumbo A, Ielpo N, Calabrese B (2022) An FPGA-Embedded Brain-Computer Interface System to Support Individual Autonomy in Locked-In Individuals. *Sensors* 22:318. doi: 10.3390/S22010318
23. Rathore RS, Sangwan S, Kaiwartya O, Aggarwal G (2021) Green Communication for Next-Generation Wireless Systems: Optimization Strategies, Challenges, Solutions, and Future Aspects. *Wirel Commun Mob Comput* 2021. doi: 10.1155/2021/5528584
24. Reyes-Campos J, Alor-Hernández G, Machorro-Cano I, Olmedo-Aguirre JO, Sánchez-Cervantes JL, Rodríguez-Mazahua L (2021) Discovery of resident behavior patterns using machine learning techniques and IoT paradigm. *Mathematics* 9:1–25. doi: 10.3390/MATH9030219
25. Sene A.A., Zandieh Z., Soflaei M., Torshizi H.M. SK (2021) Using artificial intelligence to predict the intrauterine insemination success rate among infertile couples _ Enhanced Reader.pdf
26. Sheng Y, Zhang J, Ge Y, Li X, Wang W, Stephens H, Yin FF, Wu Q, Wu QJ (2021) Artificial intelligence applications in intensity modulated radiation treatment planning: An overview. *Quant. Imaging Med. Surg.* 11:4859–4880
27. Simonet C, Noyce AJ (2021) Domotics, Smart Homes, and Parkinson’s Disease. *J Parkinsons Dis* 11:S55–S63. doi: 10.3233/JPD-202398
28. Wang F, Idrees M, Sohail A (2022) “AI-MCMC” for the parametric analysis of the hormonal therapy of cancer. *Chaos, Solitons & Fractals* 154:111618. doi: 10.1016/J.CHAOS.2021.111618
29. Wang Y, Zhang F, Wang J, Liu L, Wang B (2021) A Bibliometric Analysis of Edge Computing for Internet of Things. doi: 10.1155/2021/5563868
30. Yang C, Jiang Y, Hao SH, Yan XY, Hong DF, Naranmandura H (2022) Aptamers: an emerging navigation tool of therapeutic agents for targeted cancer therapy. *J Mater Chem B* 10:20–33. doi: 10.1039/D1TB02098F
31. Aria, M., & Cuccurullo, C. (2017). bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of Informetrics* , 11(4), 959-975.