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Internet of Things: An Insight into Emerging Applications and Architectures

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ABSTRACT

The recent advancements and intensive integration of various fields such as electronics, communication, information technology etc. has led to evolution of Internet of Things (IoT). In this paper, to begin with, a brief overview of IoT and its characteristics is presented. Further, various emerging application areas such as in health monitoring, industrial, intelligent and smart transport system, smart homes and smart grids are investigated in detail along with their respective architectures. Finally the possible research areas are presented in the future scope.

Keywords: IoT, Smart Home, Health Monitoring, Intelligent Transport System, Smart Grids

I. INTRODUCTION

Internet of Things also being stated as "Fourth Industrial Revolution," has enabled connecting electronic devices to human life as depicted in Fig. 1. IoT has been defined in many ways by different organizations and researchers. For e.g. International Telecommunication Union (ITU) in recommendation ITU-T Y.2060 (06/2012), has defined IoT as "a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies." Whereas, as per Cisco, "The Internet of Things (IoT) is the intelligent connectivity of smart devices, expected to drive massive gains in efficiency, business growth and quality of life. In other words, when objects can sense each other and communicate, it changes how and where and who makes decisions about our physical world." As per IBM, "Internet of Things, or IoT, refers to the growing range of Internet-connected devices that capture or generate an enormous amount of information every day. For consumers, these devices include mobile phones, sports wearables, home heating and air conditioning systems, and more. In an industrial setting, these devices and sensors can be found in manufacturing equipment, the supply chain, and in-vehicle components." The key components of IoT from a high-end perspective are:

- The endpoint environment
- Connectivity with endpoint environment where data from sensors and actuators are transmitted
- Connections with cloud, applications and IoT platform
- The actual outcomes in the form of the end customer application and/or process integration/automation and/or services.

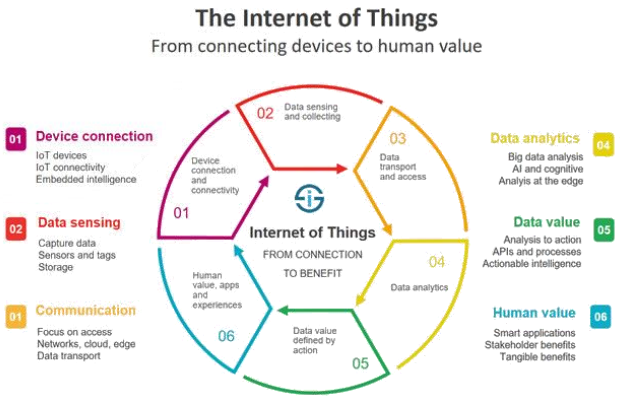

Figure 1. Internet of Things Phenomenon Illustration

Some of the crucial characteristics of IoT are:

- **Connectivity:** Devices, sensors, they need to be connected to an item, to each other, actuators, a process and to 'the Internet' or another network.
- **Things**: Anything that can be tagged or connected as such as it's designed to be connected. From sensors and household appliances to tagged livestock. Devices can contain sensors or sensing materials can be attached to devices and items.
- **Data**: Data is the glue of the Internet of Things, the first step towards action and intelligence.
- **Communication**: Devices get connected so they can communicate data and this data can be analyzed.
- **Intelligence**: The aspect of intelligence as in the sensing capabilities in IoT devices and the intelligence gathered from data analytics (also artificial intelligence).
- **Action**: The consequence of intelligence. This can be manual action, action based upon debates regarding phenomena (for instance in climate change decisions) and automation, often the most important piece.
- **Ecosystem**: The place of the Internet of Things from a perspective of other technologies, communities, goals and the picture in which the Internet of Things fits. The Internet of Everything dimension, the platform dimension and the need for solid partnerships.

II. IOT APPLICATIONS

The Internet of Things enables a smarter bridging of digital, physical and human spheres by adding data capture and communication capacities to objects in a secure way to a networked environment. With the recent technological advancements, IoT is being used in various applications such as medical, industrial, home automation, agriculture, transport etc. as shown in Fig. 2. The various emerging applications are discussed next.

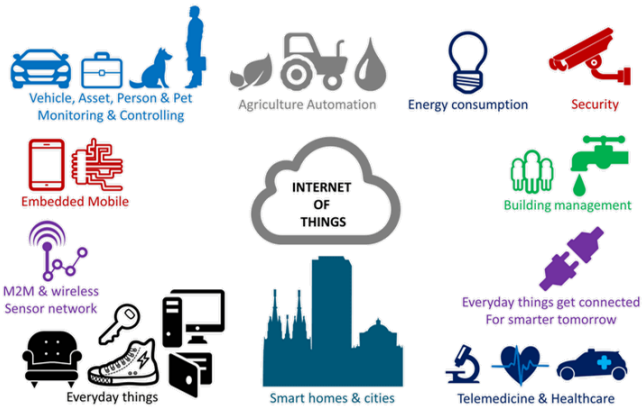

Figure 2. Illustrations of various applications of Internet of Things

A. Medical Care

With advancement in technology, IoT will be the realistic start point of industry and other information industry. Though the IOT is not mature, there are many applications of IoT used in medical system, which can changes our lives.

1. Clinical Care: The IoT in medical information management has broadened the application prospects. The main needs of the information management in hospitals are identification (of patients and doctors), sample identification (medicines, medical equipment's and testing products), and medical record identification. The IoT can meet the needs of the hospital [1]. The Fig. 3 is a model of IoT used in hospital clinical care.

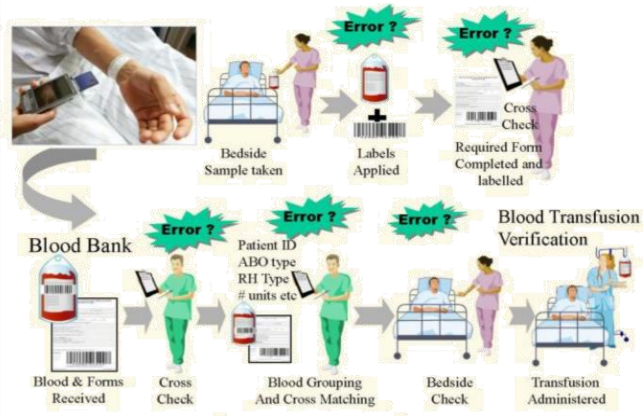

Figure 3. RFID used in bedside [1]

Using the RFID technology, the doctor can take the bedside sample easily. They can identify the patient's identification; if there are some errors the alert will call the doctor automatically. The RFID technology applied in blood management, can effectively avoid the shortcomings of small capacity bar codes, achieve non-contact identification, reduce blood contamination and improve data collection efficiency [2]. Beside the RFID, there are many sensors in the sickroom, which can capture the information of the patient's and transfer the data to the doctors or servers in the hospital.

2. Remote Real-Time ECG Monitoring: Holter monitoring is an important component of telemedicine. At present time there are some ways of ECG holter transferring the data to hospital or doctors as follow:

- Connect ECG signal to the local PC directly, and then the signal will be diagnosed by professional medical staff from the hospital [3].
- Save the ECG signal to the local memory storage. The patients or their family take the memory storage to the hospital to be diagnosed by a doctor.
- Through the internet transfer the ECG data to the remote monitoring centre.
- Through wireless networks transfer the data to the monitoring centre [4].

B. Smart Transport System

Urban transportation problems are becoming increasingly prominent. Traffic jams lead to economic loss and exacerbating the energy crisis; quality of urban life is involved with urban transportation. Therefore, sustainable transportation is quite significant for modern society. Intelligent Transport System (ITS) is a sweeping trend, countries like America, Japan and many European countries all have relevant researches and offered new approaches to solving traffic problems. However, ITS is not popular enough all over the world and there still exists many problems it cannot address. With advancement in technology, the appearance of IOT offers new approaches to a better transportation system.

1. Intelligent Transport System: ITS is a kind of Transportation Management System based on relatively perfect road infrastructure, using a series of advanced area, information, sensor and system engineering which is up-to-minute, accurate, efficient and large-scale and all-round [5]. ITS consists of a range of important parts as follows: Traffic Detection (induction loop, infrared, microwave, CCTV cameras, GPS technology) ; Traffic Control (traffic signal system, signal control technology); Communication Technology (high density wavelength division multiplexing technology, optical transmission and access control, wireless transmission technology, etc.); Data Processing (traffic data charging , control information data); Information Providing (traffic status and best trip route). To sum up, ITS is an intelligent system aiming at creating an integration made up of individuals, vehicles and roads, pursuing and comfortable traffic environment [6].

2. Smart Transportation System: The interaction of IoT and ITS brings about a new kind of transportation system: Smart Transportation System (STS) of which the concept comes from Smart China of IBM. STS is an environmental-friendly, safe, efficient, visual and predictable transportation

developing model. By reducing carbon emissions, STS makes transportation system more environmental friendly; Mobile Communication in STS provides best trip routines and one-time payment services for different traffic fees, thus leading to a convenient trip; Dangers are much easier to detect; Cross-network analysis and prediction is efficient by avoiding undue waste of time and funds, thus makes the transportation system much more efficient and improve the traffic capacity as well as infrastructure planning [7]. The Fig. 4 gives the basic idea of smart transportation system [8].

Figure 4. Smart Transportation System Illustration [8]

C. Home Automation

Among many applications of IoT, smart homes play an important role in realizing smart cities. Smart homes can be used for remotely monitoring and controlling electrical appliances fitted inside the home using smart and intelligent physical infrastructure. According to Cisco, it is estimated that 50 billion devices would be connected to the internet by 2020 [9]. Recent advancement in cloud computing and data analytics allows intelligent systems to process and analyze the data in a more efficient manner. The concept of mobile based Home Automation System is shown in Fig. 5 [10].

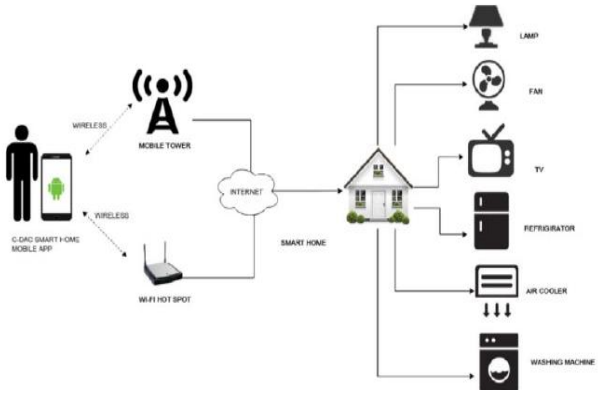

Figure 5. Concept of Smart Home [10]

In "SMART HOME", the word "SMART" means context aware which can be realized using Information and Communication Technology (ICT) and IoT. Though the concept of IoT is new in the developing countries, considerable amount of work has been carried out in other countries, where smart homes are already in place.

1. Home Automation using Bluetooth: Wireless technologies are becoming more popular around the world and the consumers appreciate this wireless lifestyle which gives them relieve of the well known "cable chaos" that tends to grow under their desk. Now with the form a network in which the appliances and devices can communicate with each other. Today, home automation is one of the major application of Bluetooth embedded Bluetooth technology, digital devices technology. The concept of home automation using IoT is realised using low cost micro-controller Arduino board and an Android mobile phone.

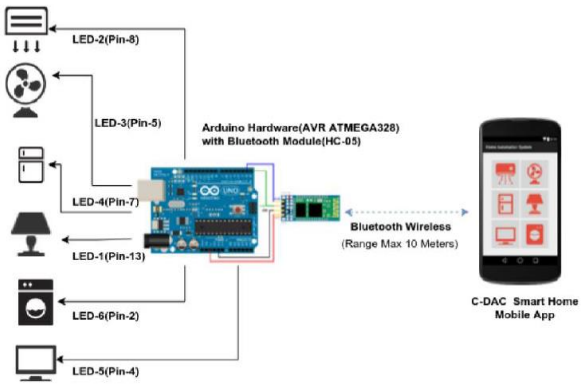

Fig. 6: Home Automation Using Bluetooth [10].

Arduino is an open source platform that can be used for prototyping any hardware and software. Arduino can be programmed to receive keyboard input or sensor data and control various electrical appliances connected to output peripherals. Since mobile phone is a wireless communication device, connectivity between Arduino and smart phone is established using Bluetooth, one of the short range wireless communication in an indoor environment. Once home appliances are connected to Arduino board, they can be easily controlled using any Bluetooth enabled smart phone inside a smart home [11]. The Home Automation using Bluetooth technology is shown in the Fig. 6. The application of Bluetooth is limited up to 10-20 metres only and cannot be used from a distant location. This application can only be used by a person to control and manage appliances in an indoor environment.

2. Home Automation using Ethernet: The main drawback of Bluetooth based home automation can be overcome using Ethernet technology. Ethernet module is used for connecting Arduino board from any part of the world. Arduino's Ethernet module IP address and Port number can be used to locate remote device connected to the Internet in a smart home environment. Android mobile app can also be used to control electrical appliances from a remote location. The basic idea of home automation using Ethernet is shown in the Fig. 7 [10].

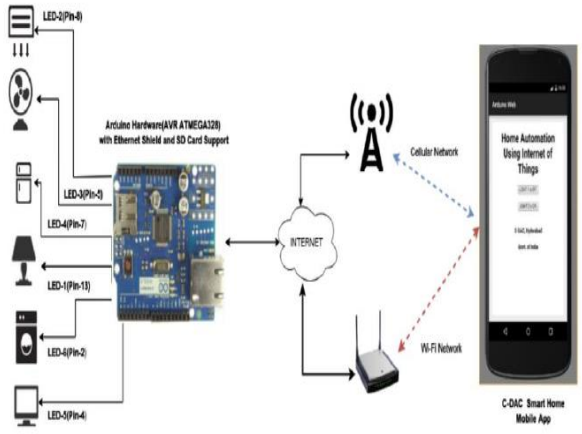

Figure 7. Home Automation Using Ethernet [10]

D. Industrial Applications

The application of IoT in industries is still in its early stage. However, the use of IoT is rapidly evolving and growing. Quite a few IoT applications are being developed and/or deployed in various industries including environmental monitoring, healthcare services, food supply chain (FSC), transportation, workplace and home support, security and surveillance. Some of the IoT applications in various industries are:

1. Healthcare Industries: IoT provides new opportunities to improve healthcare. Powered by IoT's ubiquitous identification, sensing, and communication capacities, all objects in the healthcare systems (people, equipments, medicines, etc.) can be tracked and monitored constantly. For example, a patient's heart rate can be collected by sensors from time to time and then sent to the doctor's office. By using the personal computing devices (laptop, mobile phones, etc.) and the mobile internet access (WiFi, 3G, LTE, etc.), the IoT based healthcare services can be mobile and personalized [12]. The wide spread of mobile internet service has expedited the development of the IoT in home and healthcare services [13].

2. Food Supply Chain (FSC): Today's FSC is extremely distributed and complex. It has large geographical scale, complex operation processes, and large number of stakeholders. The complexity has caused many issues in the quality management, operational efficiency, and public food safety. IoT technologies offer promising potentials to address the challenges faced by FSC. It can cover the FSC in the so called farm-to-plate manner, from precise agriculture, to food production, processing, storage, distribution, and consuming. Safer, more efficient, and sustainable FSC's are expectable in future [14].

3. Safer Mining Production: Mine safety is a big concern for many countries due to the working condition in the underground mines. To prevent and

reduce accidents in the mining, there is a need to use IoT technologies to sense mine disaster signals in order to make early warning, disaster forecasting, and safety improvement of underground production [15]. By using RFID, WiFi, and other wireless communications technology and devices to enable effective communication between surface and underground, mining companies can track the location of underground miners and analyze critical safety data collected from sensors to enhance safety measures.

4. Transportation and Logistics: IoT will play an important role in transportation and logistics industries. As more and more physical objects are equipped with bar codes, RFID tags or sensors, transportation and logistics companies can conduct real time monitoring of the move of physical objects from an origin to a destination across the entire supply chain including manufacturing, shipping, distribution and so on [16]. Furthermore, IOT is expected to offer promising solutions to transform transportation systems and automobile services.

E. Smart Grids

Smart grid is one of the major applications of IoT. Smart grid can apply IoT technologies for creating various intelligent services. Since information perception, transmission and processing widely exist in smart grid, IoT technology would play a significant role in power grid construction, safety control, security monitoring, data collection and interaction, etc. The various applications of IoT in smart grid are:

1. Online Monitoring For Power Transmission Line: Power transmission line monitoring is one of the most important applications of IoT in smart grid, particularly, disaster prevention and mitigation of power transmission lines. In recent years, natural disasters bring about many challenges to high-voltage power transmission, including security, stability and reliability. The power transmission line monitoring system is composed of two parts as shown in Fig. 8. One part is installed along with the power transmission lines to monitor their states; the other part is installed on the transmission towers to monitor the environment and their states. The communication between the IoT devices on the power transmission lines and the transmission towers is usually based on wireless networks. The master station system could transmit data through the wireless Mesh network together with power optic fiber network or wireless broadband network.

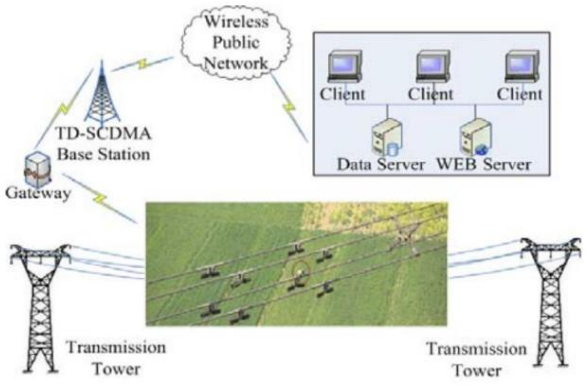

Figure 8. Online Monitoring Of Power Transmission Lines [17]

2. *Smart Home Services*: Smart power utilization service includes hybrid smart AMR system, smart sensor network system, smart home system, security system and energy information collection system, etc. There are three functions for the smart power utilization service system: reliable electricity supply, smart home experience for users and smart management and efficient use of energy. As shown in the Fig. 9, the communication of the hybrid smart AMR system is mostly based on Power Line Carrier (PLC), Fiber to the Home (FTTH), broadband wireless communication and other broadband communication network [17]. Through this system, the capacity of integrated services of power grid can be enhanced. The interactive marketing demands can be met. The quality of service can be improved. The user's energy efficiency can be enhanced significantly by applying the smart interactive terminal in smart home services.

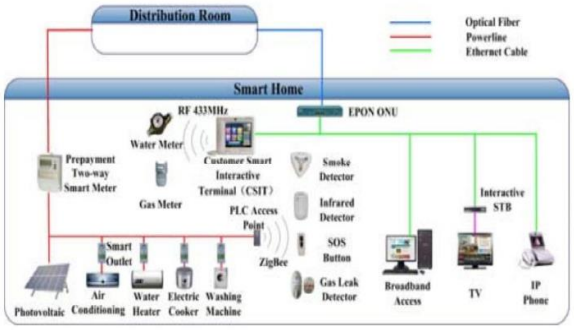

Figure 9. Smart Home System [17]

3. Information Management System [18]: Electric vehicle (EV) offers an interesting smart grid opportunity beyond eco-friendly transportation. It can be used to store energy. EV charging station is composed of four aspects: power supply system, charging equipment, monitoring system and related facilities, which is shown in the Fig. 10. EV can be considered as the mobile power storage device of smart grid, and it would help the power grid to mitigate the effect of peak-valley. This new capability results in better management of resources and is considerably more environmentally friendly. Based on smart sensing and high capacity transmitting device, IoT technology could provide smart sensing and efficient interaction for EVs, batteries and charging stations.

Figure 10. Information Management System for Electric Vehicle [18].

III. FUTURE SCOPE

As technology is becoming more and more state-of-art day by day, and the access of internet in every corner of the world is going to be easily obtainable, so the future of the IoT is undoubtedly bright [19]. Achieving greater connectivity is the requirement for progress in the present world; thus the Internet of Things has become a vital instrument for interconnecting devices. IoT is going to transform our lives beyond imagination. It would make our life faster, easier and more productive. In future nearly everything and every device in daily life will have a connected application. There will be machine to machine interfaces, where devices talk to each other. IoT will lead to increased awareness about environmental and social issues as more population comes online and they have more access to new techniques and solutions for education, human rights, environmental hazards and education [19]. From climate change to disease prevention, from smart parking to traffic management, from water conservation to waste management all answers will lie in the IoT and we will find a better way to deal with it.

IV. CONCLUSON

It has been estimated that IoT is not yet mature and it is expected to be after 5-10 years, will change our society greatly. The world is going to become a much better place to live. Commute and connectivity would become easier. In the near future, the IoT will bring more and more things into the digital mode every day, which would at some day in future, make IoT a multi-trillion dollar industry. With such a fast growth, the day is not too far that IoT will become realistic and essential in the future, and it is a new choice of sustainable livelihood.

V. REFERENCES

[1] Tao Liu and Dongxin Lu, "The Application of IOT in Medical System", ITME, 2011 International Symposium, 9-11 Dec, 2011, pp. 272-275.

[2] Travis Kriplean, Evan Welbourne, Nodira Khoussainova, Vibhor Rastogi, Magdalena Balazinska, Gaetano Borriello, Tadayoshi Kohno, and Dan Suciu, "Physical Access Control for Captured RFID Data", IEEE Pervasive Computing, vol. 6, no. 4, pp. 48-55, 2007

[3] Wang Fen-Huaa, Nian Xina, Hao Guo-Lianga, Wang Zhi-Lianga, "Application of network of

things technology on system of status detector", Application research of computers, vol. 27, no. 9, pp. 3375-3380, 2010.

[4] Wan Li, Zhang Yue, Zhang Long-Fei, "ECG Data Processing Mechanism of Remote Wireless ECG Monitor," Computer Engineering," vol. 36, no. 15, pp. 291-293, 2010

[5] ZHANG Yinchun, Huang Zhihong, "The Development of ITS" Science and Technology Information, vol. 26, pp. 485-586, 2009

[6] Zhang Daoxin, "Application of electronic intelligent transportation in new era," Highway Transportation Technology, vol. 11, pp. 234-234, 2009

[7] Zhang Min, Yu Tao and Zhai Guofang, Smart Transport System Based on "The Internet of Things", Applied Mechanics and Materials, vols. 48-49, pp. 1073-1076, 2011.

[8] Smart Transportation system [online] Available: https://blog.scriptr.io/implement-smart-cities-applications/

[9] Applications of IOT in smart homes[online] Available; http://www.cisco.com/web/solutions/trends/IoT/overview.html

[10] Kumar Mandula, Ramu Parupalli, CH.A.S.Murty, E.Magesh, Rutul Lunagariya, "Mobile Based Home Automation using IOT", Proc. of International Conference on Control, Instrumentation, Communication and Computational Technologies (ICCICCTT), 2015, pp. 340-343

[11] R. Piyare, M.Tazil, "Bluetooth based home automation system using cell phone", Proc. of IEEE 15th International Symposium on Consumer Electronics, 2011, pp. 192-195.

[12] I. Plaza, L. Martin, S. Martin and C. Medrano, "Mobile applications in aging society: Status and trends," System. Software, vol. 84, no. 11, pp. 1977-1988, 2011.

[13] Z. Pang, Q. Chen, J. Tian, L. Zheng and E. Dubrova, "Ecosystem analysis in the design of open platform-based in home healthcare terminals towards the internet of things," in Proc. of 15th International Conerence. Adance Communication Technoogy, (ICACT), Pyeongchang, Korea, 2013, pp. 529-534.

[14] Q. Wei, S. Zhu, and C. Du, "Study on key technologies of internet of things perceiving mine," Procedia Engineering, vol. 26, pp. 2326–2333, 2011.

[15] B. Karakostas, "A DNS architecture for the internet of things: A case study in transport logistics," Procedia Computer Sciences, vol. 19, pp. 594–601, 2013.

[16] H. Zhou, B. Liu, and D. Wang, "Design and research of urban intelligent transportation system based on the internet of things," Communications in Computer and Information Science, vol. 312, pp. 572–580, 2012.

[17] Jianming Liu, Xiangzhen Li, Xi Chen, Yan Zhen and Lingkang Zeng, "Applications of internet of things on smart grid in China", in Proc. of 13TH International Conference on Advanced communication technology (ICACT), 13-16 Feb, 2011, pp. 13-17

[18] Lu Tingjie, "The Origin and Development of Things of Internet" Information and Communications Technologies, vo. 4, no. 2, 2010,

[19] Faraz Khan, "Future Scope and Possibilities in Internet of Things", International Conference on Advances in Engineering Science and Management, 8 Nov 2015, pp. 310-312.