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A Vision on Intelligent Medical Service for Emergency on 5G and 6G Communication Era

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Abstract

Emergency service is the most important research field for welfare of human kind. Some examples are ambulances and fire control truck. However, these conventional emergency services are not equipped with appropriate equipment to provide high QoS. For instance, conventional medical emergency services include ambulances with drivers and oxygen supplies only. Another example is the conventional fire control systems that only include fire control truck, which is not suitable for current scenario due to various challenges, for instance, road traffic. In addition, accidental services are unsatisfactory in current and future emergency services. Emergency service is required by anyone at anytime and anywhere. Therefore, it is the time to redefine and restructure the conventional emergency service for saving more lives. Due to the advent of wireless communication technology, it is possible to provide the emergency service on the spot in nearly real-time to save lives. Moreover, integration of Artificial Intelligence with smart devices can change the definition of emergency services. In this chapter, we envision the various emergency services to advance the healthcare services. Besides, we envision the impact of emergency services on healthcare with the help of Artificial Intelligence, 5G and 6G communication technology.

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1. Introduction

Emergency Services are the utmost important services to save human lives. Emergency services are required in fire, personal health, accident and natural disasters. Each year approximately 1.35 million people die due to road traffic crashes [25]. Road accident is the prime cause of death in children and young people age ranging from 5-29 [25]. Similarly, approximately 180000 death causes due to fire is reported worldwide [26]. Current state-of-the-art emergency services are ambulance service, natural disaster response team and fire brigade. These services are truly unsatisfactory because they are unable to provide emergency services on time. On time emergency service can save many lives. Therefore, this is the peak time to redefine and restructure the emergency services. An intelligent emergency service can provide medical services on time with the help of communication technology, sensors, vehicular technology, and Artificial Intelligence (AI) as demonstrated in Figure 1. Technologies are advancing day by day, therefore emergency services are required to be re-engineered using advanced technology.

Smart devices will be integrated with AI to make the devices intelligent [22]. Integrating various machine learning algorithms in smart devices help in making more intelligent predictions. Also, federated learning [32] is emerging in Edge computing for performing learning collaboratively using small devices. These devices are connected with a wireless network to perform various heavy computational tasks. However, the support required for intelligent devices is only possible by 5G, 6G and beyond communication technology. These technologies are not only used by smart phone, but also used by diverse devices (eg. smart watch, healthcare monitoring device). 5G

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Figure 1. Landscape of Emergency Services using 5G and 6G communication technology. The figure demonstrates the requirements of emergency services in fire, accidents and personal healthcare.

communication technology is currently serving many countries efficiently and effectively. However, it has limitation in providing coverage and mobility [6]. Therefore, it is expected that the limitations of 5G communication technology will be overcome in the 6G communication technology. 5G communication satisfy many criteria of emergency services, but 6G communication will fully satisfy all criteria of emergency services. Therefore, many research works are already initiated on 6G Communication including Finland, USA, Japan, China and South Korea [4, 5, 12]. 6G communication technology promises ubiquitous services which will be backed by satellite communications [31]. Moreover, the 6G communication will be able to enable Internet of Everything (IoE), i.e., Internet of Things (IoT) will be replaced by IoE. Also, there will be a transition from smart to intelligent devices [24].

Conventional emergency services are unsatisfactory, including ambulance services, fire brigade, and personal health services. Most of the people dies on the spot or in the ambulance while travelling toward the hospital. These emergency services are required to be restructured and redefined to provide medical support on-spot. In an emergency, an ambulance may reach very late due to various reasons, for instance, road traffic. In addition, natural disaster recovery and response (NDRR) team also does not have enough technology to save many lives. Therefore, in this article, we envision emergency services using AI, Internet of Everything, 5G and 6G communications, and Vehicular Technology. The emergency service can be improved drastically by introducing Hospital-to-Home (H2H) services which includes mobile hospitals. We categorize the mobile hospital into three major categories, patient aid medical service (PAMS), accident aid medical service (FAMS) and fire aid medical service (FAMS). These services require uninterrupted wireless communication service such that emergency can be detected in real-time and emergency service can be provided on time to save lives. Also, intelligent drones and intelligent vehicles can be used for emergency services. Intelligent drones can provide various services, including mob controlling, terrorist monitoring and tracking, thief chasing, fire control, video streaming and network service support. These services require robust wireless communication service.

Intelligent emergency services require the support of communication technology, Section 2 precisely describe the wireless communication technology along with a brief discussion on issues and challenges of 6G communication network. Section 3 elaborates the support of AI to intelligent services to perform computing and

analysis in network nodes. The chapter briefs on emergency services in Section 4. Section 5 precisely discuss the technologies required for providing emergency services. Furthermore, Section 6 explores intelligent vehicular technology. Intelligent vehicles are important for emergency services, and therefore, Section 6 discusses various research possibilities of intelligent vehicles. We envision real-time detection of emergency services using intelligent devices which are equipped with diverse sensors. After detection of emergency services, medical support is required, and hence, Section 7 envision Hospital-to-Home (H2H) concepts [21]. H2H is implemented on mobile hospital which requires intelligent vehicles. The mobile hospitals are equipped with Intelligent Internet of Medical Things (IIoMT), medical staffs, intelligent devices, medicine and wireless communications. The mobile hospital is categorized into three categories, particularly, patient aid medical service (PAMS), accident aid medical service (AAMS), and fire aid medical service (FAMS). Section 8 highlights and discusses the key challenges in implementing the medical emergency services. Finally, the article is concluded in Section 9.

2. Wireless Communication Technology

Currently, 5G communication is deployed in many countries and it's gaining popularity. 5G communication technology is able to impact on the Global economy. Thus, 5G communication technology is maturing, and it demands next generation communication technology, called 6G communication technology. In the future, high Quality of Services (QoS) will require the support of 5G and 6G communication technology. The 5G communication technology operates at 300 MHz frequency to gain 1 Gbps data rate. However, the 1 Gbps data rate is not sufficient for many applications, for instance, continuous high definition video streaming from Drones. Also, 5G communication technology is unable to support holographic communications. Therefore, the next generation communication technology will provide higher data rate. 6G communication technology will enhance our daily life, lifestyle and society [21]. It will be one of the most prominent technology for the well-being of human kinds. 6G communication technology is a radical technology to revolutionize human kinds. It will enable Internet of Everything (IoE) [34]. IoE will further enable tremendous new technologies and applications [22]. Moreover, 6G will be able to provide space-air, sea, and terrestrial network [34].

6G communication technology promises to provide high QoS [12]. The QoS includes mobile broad bandwidth and low latency (MBBLL), massive broad bandwidth machine type (mBBMT) and massive low latency machine type (mLLMT) [7]. Moreover, it also includes further-enhanced mobile broadband (FeMBB), extremely reliable and low-latency communications (ERLLC), ultra-massive machine-type communications (umMTC), long-distance and high-mobility communications (LDHMC) and extremely low-power communications (ELPC) [33]. This QoS parameters will enable the communication in real-time. In addition, 6G communication technology will operate at more than 1 THz frequency to achieve 1 Tbps. However, it is not sufficient to fully support holographic communication. Therefore, it is expected that it will increase the operating frequency and the wavelength will be $300\mu m$ to $100\mu m$. The end-to-end delay is $\leq 1ms$ which will enable real-time communications [2, 29] and it is vital for healthcare. Also, 6G communication technology will provide truly AI-driven communication that will run on intelligent space. Moreover, it will provide utmost secure communication which will be jamming proof and attack proof [33]. Furthermore, 6G communication technology ensures physical layer security.

2.1. Issues and Challenges of 6G

6G promises to support many new applications such as holographic communication, augmented reality and virtual reality. In future these technologies will be essential for providing advanced healthcare such as telesurgery [21]. 5G has many issues and challenges which will be incapable to support advanced technologies, for instance, the limited Internet coverage will make 5G incapable to support telesurgery. Similarly, 6G has many challenges and issues [23]. 6G will explore the TeraHertz (THz) frequency band where the wavelength is 300 μm for transmission. The continuous THz signal is required for transmission, but due to more strict requirements for size and complex design of antenna/transmitter makes its generation difficult. Also, the THz signal gets attenuated to zero after covering a short distance in air. Furthermore, 6G will also provide Internet services underwater. Nevertheless, the underwater environment is complex and unpredictable. It has a high signal attenuation due to salt water. Network deployment will also be complicated. And, there is a high chance of fouling and corrosion. Hence, sensors and network nodes require extra protection which increases the overall expense of the underwater network deployment. 6G has to provide very low latency to provide high QoS. Flat network architectures and transmission of smaller frame or data packets need to be implemented. AI will also help 6G in reducing latency by deploying AI algorithms to increase efficiency of transmission in physical and networking layers. AI will predict any modification in the channel state and user requests to decrease latency. Another important issue is capacity. 6G will replace the Internet of Things (IoT) with the Internet of Everything (IoE). All the devices will be

connected to the Internet and those devices will be intelligent. Each device will produce Big data and huge traffic. Hence, for high QoS 6G requires high capacity. High capacity also requires high density to provide global coverage. 6G will deploy a large number of network nodes to provide high QoS. As a consequence, the communication cost will increase. The congestion control, synchronization, scheduling, failure detection, etc. tasks will contribute to the communication cost. Moreover, 6G will deploy non-terrestrial nodes, which are costly. Heterogeneity is another big issue which 6G has to handle. Heterogeneity is present in devices, network, protocols, nodes, etc. Billions of different devices will be connected to IoE. To provide global coverage the network will be divided into sub-networks and its integration has to be performed efficiently. 6G will provide services in space-air-water, hence, it will integrate two very diverse communication networks i.e non-terrestrial and terrestrial. These diverse communication networks require different protocols. The TCP/IP protocols are suitable for terrestrial communication networks, which is contrary to non-terrestrial communication networks. The interoperability of protocols will also be an important issue for 6G [2]. Therefore, 6G has to solve a big challenge of integrating various heterogeneous components. 6G also promises a high level of security, secrecy and privacy. Billions of devices producing Big data, requesting processing of private data and requires high QoS. These requirements will stress 6G for providing advanced security, secrecy and privacy.

3. Artificial Intelligence and Future communication Network

6G will be a truly AI-driven communication network [20, 23]. The key features of 6G is to integrate AI and security in Physical layer [8]. It will enhance the security of the communication. 6G wants to make every aspect of network communication intelligent, i.e. the system is self-aware, self-compute and self-decide in any situation. 6G aims to provide global coverage, including space-air-water. 6G wants to achieve this by making the different aspects of communication "intelligent". And, as we know intelligence means AI. Many AI algorithms are showing high accuracy and performance in communication networks. Deep learning (DL) does not require data preprocessing. It takes original data and performs the computation, thus, real-time data can be given as input. Moreover, it shows high accuracy while computing a large number of network parameters [18]. For example, the parameters are collision rates/link access success, packet loss rate, routing delay, bit error rate, and link signal-to-noise ratios (SNRs). DL computes on these parameters to analyze the patterns such as the interference alignment effect, congestion degree, or hotspot distributions. This information is used for protocol controls in different network layers. DL also has high accuracy in case of complex network parameters such as channel variation, channel interference, and node mobility. Similarly, another AI algorithm that is currently exploring for communication is Deep Reinforcement Learning (DRL). In reinforcement learning, the system first develops some decisions, then observes the results. Based on the observation the decision is again computed to obtain an optimal decision. DRL combines both reinforcement learning and deep neural networks algorithms and combines the advantages of both [16]. Thus, DRL gives high performance within small computation time. DRL provides sophisticated network optimization solutions. It solves non-convex and complex problems such as transmission schedule, joint user association, and computation. Moreover, obtaining optimal solutions does not require accurate and complete network data. DRL also obtains optimal solutions without the help of other nodes. Thus, reducing communication overhead and increasing security.

6G wireless network will rely on AI at every level [11]. At the physical layer of the network, AI will help in the channel state estimation and prediction, automatic modulation classification, adaptive encoding and decoding, and intelligent beamforming. These techniques will implement deep learning. Deep reinforcement learning is implemented in data link layer for network resource allocation. Similarly, at the transport layer, route computing and intelligent traffic prediction algorithms will be deployed [7]. 6G will explore dynamic spectrum access. However, achieving this requires complete network state information. In addition, it is a complex problem. It is proposed to utilize deep reinforcement learning algorithms for the discovery of hidden patterns in the network. Therefore, development of new efficient deep reinforcement learning algorithms which consume less energy is required for dynamic spectrum access [2]. Thus, 6G will depend on AI for taking the heavy computation responsibility to provide next generation services.

AI algorithms have shown high performance. However, it has many issues. Such as high dimensionality due to complexity of physical communication networks and increase in the training phase of DL with increase in the number of codewords. AI algorithms require expensive infrastructure. The AI is also preferred for proactive caching. For Big Data, parallelism in training should be explored. All AI algorithms have high computation. The high computation task takes a long time and consumes more power. Whereas, 6G is unable to provide such relaxation. The AI algorithms that will be implemented in 6G will have their own issues. For example, large numbers of layers in Neural Networks. Their issues will degrade the performance of 6G.

Another issue is the dynamic nature of the network. Once inferences are obtained by AI algorithms, it is used to predict future incoming data. However, communication networks are very dynamic, therefore, the inferences will become obsolete quickly. Training the AI module after a short interval will be very costly for 6G.

AI is the prominent player for intelligent services. It enhances the performances of smart devices, and as a consequence, the smart devices become intelligent to make decision, learn and predict. These devices require an advanced communication technology to connect to the network seamlessly to control center. The control center monitors any kind of emergency situations. Personnel are employed in control centers with automated systems, for instance, mobile hospital. AI has already proved as a game changer technology in many fields. Many new AI techniques are evolving to cope with the growing challenges. Federated AI is a prominent example of future AI. Federated learning [3] can be performed using diverse kinds of devices, for example, federated forest. Therefore, devices can talk with each other, share their knowledge with each other and learn from their neighbors. However, there are grand challenges in federated AI due to privacy and security issues. Therefore, General Data Protection Regulation (GDPR) is enforced by the European Union to protect the data in May 25, 2018.

4. Emergency Medical Services

An emergency is an urgency for help from being damaged or lost. World Health Organization classifies the emergency services in various categories, however, we focus on only saving human lives using AI, communication technology, IoT and medical services. Moreover, we emphasize on medical emergencies outside hospital scenarios. Therefore, this chapter classifies intelligent emergency services into three categories, namely, Patient Aid Medical Service (PAMS), Accident Aids Medical Service (AAMS) and Fire Aid Medical Service (FAMS). Moreover, vehicular technology plays an important role in emergencies, for instance, drones can reach at the destination before other vehicles and medical staffs. Also, intelligent vehicles can determine the traffic and shortest route. These vehicles can also make a decision on emergency service requirements in a particular event using intelligent devices. On the contrary, most of the countries have designated teams to provide emergency services during natural calamities, called natural disaster recovery and response (NDRR). NDRR team serves actively to provide services to natural disaster, particularly, any catastrophe. However, NDRR is not equipped with intelligent emergency services which could save many lives. Moreover, drones play important role in natural disaster site in providing various services, including network, medical aid, and video streaming. Future NDRR will enhance the conventional NDRR by equipping with Hospital-to-Home services along with intelligent vehicular technology.

Lakkis and Elshakankiri [13] proposed a system for emergency and operational services in healthcare. The system consists of many technologies, namely, ZigBee Wireless IEEE 802.15.4, sensors, 6LowPan and Hadoop Framework. ZigBee provides the communication among the devices in the IoT. It consumes less power and supports good communication distance. Variety of sensors are used for different purposes such as vehicular crash detection, blood pressure measuring, heart rate monitoring, GPS etc. 6LowPan is an IPv6 architecture that consumes less power, hence, used in small devices. It implements TCP/IP similar protocol and supports mesh network topology. Hadoop Framework is the brain of the system. It stores data, runs applications and executes processes. The system supports three emergency services i.e, ambulance, vehicular accidents and patient emergency monitoring. In an ambulance, equipment such as blood pressure, ECG and EPCR are embedded with multiple wireless sensors. It constantly transmits data to the hospital to inform the doctor(s) of the current state of the patient(s). The ambulance uses GPS of the patient(s) smartphones for accurate location. Similarly, GPS is used to provide a shortest route with less traffic. The ambulance also has a sensor that sends signals to the traffic control unit for smooth and speedy movement. For detection of vehicular accidents, crash sensors are embedded into the vehicle on the front-end, sides, and rear-end. Upon damage due to a big accident, these sensors send signal for emergency services. Another important application is the system also monitors patients. The patient wears various body sensors to detect various parameters of the body such as body temperature, blood pressure, heartbeat and sugar pressure. All the data are transmitted and stored in a sink node. When there is an emergency situation, the data is transmitted from sink node to the central medical control system. Then, they dispatch the emergency services to the patient. This proposal has many serious concerns. The ambulance will continuously transmit the data to the hospital. However, 4G is not capable of providing a smooth Internet. Hence, it requires the support of advanced communication networks such as 5G and 6G. GPS of the patient's smartphone is used to determine the location, however, it may not be always possible that the victim will be able to inform or the identity of the victim is known beforehand. Therefore, satellite or drone communication will help in finding the accurate location of the victim. Again, for smooth communication with the traffic control room, an advanced communication network is necessary. In the future IoT will be incapable to handle the billion smart devices

connected to the IoT. Thus, IoE is required. In section 7 we have envisioned hospital- to-home service which is an advanced emergency medical service.

5. Enabler of Emergency Medical Services

5.1. Internet of Everything

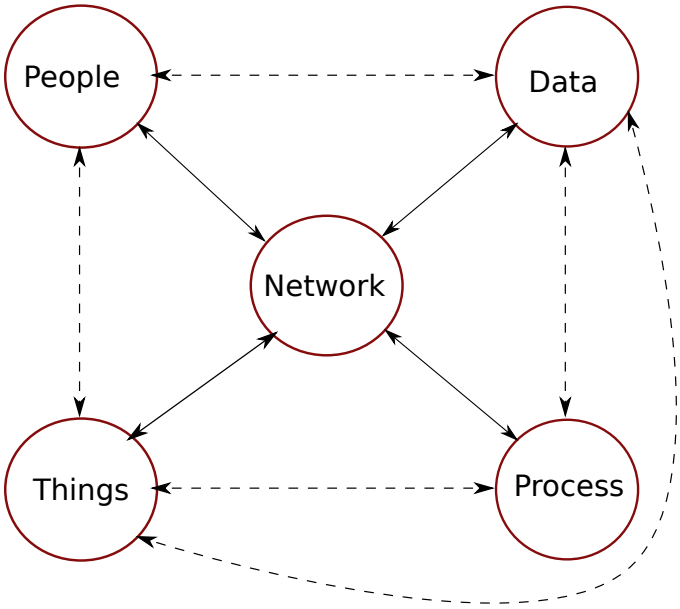

Figure 2. The architecture of IoE. A network is added to existing IoE. Solid lines depict network connection and dashed line depicts direct relations.

Internet of Things (IoT) will be replaced by Internet of Everything (IoE). CISCO defines as "IoE is built on four pillars, namely, data, process, people and things" [19]. However, network is the most important in IoE as shown in Figure 2. The 'Things' can have people, process and data. 'People' requires data and things. 'Process' requires 'Things' and 'Data' to process. These are strongly connected through networking. For instance, data and process can be in remote places where things required to access these data. Therefore, IoE enable connection among device-to-device, person-to-person, person-to-device, person-to-process and person-to-data, etc., through communication technology.

Emergency Medical Dispatcher (EMD) [27] has a prominent role during emergencies. EMD handles all the important aspects regarding emergencies such as receiving basic caller information, determining emergency location, classifying the type of level of emergency and other related tasks. Based on the type of emergency, EMD determines what are the services that should be sent to the location such as ambulance, police or fire services. EMD is responsible for sending important details regarding the emergency to the response unit for efficient execution of the rescue operation. Moreover, EMD has to handle multiple cases simultaneously. EMD has to constantly monitor these cases and provide as much support as possible, for example, in case the emergency requires helicopters or some special rescue equipment. Suppose a hospital is unable to accept such patients due to lack of medical services. Then, this information has to be sent to the rescue unit to send the victim to another hospital. EMD also has to store all these information with security for legal and quality assurance. In some situations these documents serve as evidence. IoE will be a huge help to EMD. As EMD handle the whole emergency situation. It has to maintain constant connection to effective instruct and update the situation to different personals such as ambulance, fire station or hospital. Hence, IoE will efficiently connect those personals.

5.2. Sensor Technology

Sensor technology is essential in modern intelligent devices. Intelligent devices will be fully loaded with sensors to make the devices intelligent. And, these devices will be connected to the Internet to access the services. Vehicles will also be installed with various sensors. Furthermore, healthcare devices will be installed with sensors with blood pressure sensor, heartbeat sensor and body temperature sensors, etc., to monitor the health of a person. Blood Sample Reader (BSR) sensor is required to read all blood parameters [21], for examples, white blood count (WBC), red blood count (RBC), and blood group etc., to ensure needle-free and hassle-free healthcare. Moreover, a vehicle or building can be installed such sensors for detecting accidents and fire. However, accident or fire will also be measured from Intelligent wearable devices (IWD). Such devices are integrated with AI to send a signal for accident, fire or any other emergency signals. Moreover, IWD shares their information among each other in case of emergency situation. Vehicles and network nodes will have cameras which will be able to analyze the live images/video and predict whether an accident has occurred or not. This whole process is referred as the accident sensor in the article. However, IWD will be installed with different accident sensors.

Lima and Faria [15] proposed a system, combination of Hospital Emergency Smart Band (HESB) and a Smart Priority Recommendation and Patient Control System (SPRPC) to prioritize the patient for providing medical services. HESB is a smart band which is a triage method and also contains additional features. In a particular triage system [17] the patients are classified into groups based on their urgency. Based on the group there is a fixed waiting time within which the medical services will be provided. HESB has sensors that monitor some parameters of the human body such as heart rate,

body temperature, blood oxygenation level and blood pressure. HESB has a LED to indicate the group using a color light. It vibrates to indicate the patient's turn. Also, the location of the patient is determined using HESB. HESB constantly communicates with the SPRPC server. SPRPC monitors the patient in real time. Upon changes in parameters the group of the patient is changed. Then, SPRPC sends an alert to the doctors for immediate medical attention.

6. Vehicular Technology

6G communication technology will provide high mobility and coverage, which is an issue in 5G communication technology. It is expected that 6G communication will be fully backed by satellite communication to provide wide coverage and high mobility. Moreover, the rural communication is a huge challenge for 5G communication technology [30]. However, 6G will be able to overcome the issue. Also, vehicles are becoming more intelligent due to the advent of AI, where a vehicle can make decision, learn and predict. Therefore, intelligent vehicle will be independent from drivers. Also, unmanned aerial vehicles (UAV) will become intelligent with the integration of AI. Therefore, it is expected that vehicular technology will plays important role in healthcare services.

6.1. Intelligent Drones

Due to the advent of UAV, drones will play vital role in future business and emergency services. The challenges of drones are to deploy in fire control, transporter, security and surveillance, and network provider. Therefore, drones require seamless connectivity with Drone-to-Drone (D2D), Drone-to-Infrastructure (D2I) and Drone-to-Everything (D2X). The drones are vital in providing networking services, emergency services, fire control services, security and surveillance services, accident detection, transporting medical kits and streaming videos for health conditions of injured people as shown in Figure 1.

Fire Control. Fire incidents are very common. Conventional fire truck is unable to reach at the destination timely due to road traffic and distance from the fire control officer. Moreover, the fire control office may also receive the information very late. Therefore, many lives may be lost due to sudden outbursts of fire and unable to provide medical aid on time. Thus, it is necessary to redefine the old architecture of fire control. For drones, there are no traffic disturbances. Therefore, drones can reach the desired distance in time to control fire. Moreover, the aerial distance of the destination is shorter than terrestrial distance. Thus, the fire control truck always reaches late in the destination. Also, medical assistance cannot be provided on time. Drones can reach the destination and medical aids can be provided on time. Drones can stream videos of the number of fatalities and casualties to a medical center for early preparedness. It demands intelligent drones that can optimize their path to travel and reach the destination faster. Also, intelligent fire control can predict the event even before occurring. Due to AI, it is also expected that intelligent drones will require less human interaction and will operate automatically. Intelligent drones can communicate with each other and share their knowledge and experience among them. Therefore, number of drones will fly to the destination to control fire as per the requirements.

Accidental Services. The another key challenge is to detect accident in real-time. Drones will be very helpful in emergency service not only in the fire control, but also other emergency services. 5G and 6G network nodes with the help of AI will be able to detect an accident. Accident sensors sense the accident and broadcast the emergency signal. Eventually, drone receives the signal and locate the destination with precision. The accident can be minor or major. However, accident rescue service must be provided on time. Therefore, drones will reach the destination on time and provide medical aids. Also, drones will stream the video to medical centers and control center.

Security and surveillance. Another prominent challenge for Drone is security and surveillance. Drones are vital in security and surveillance not only in border of a country, but also in the city. Intelligent drones will keep an eye on the activities of the citizens in the public gathering, traffic points, roads and inhabitant areas. The intelligent drones focuses on abnormality in the activities and predict possible future events. For instance, terrorist plans a bomb. It can be detected easily by the drones and this intelligent drones (bomb diffuser drone) can diffuse the bomb even before blasting. These kinds of drones are equipped with robotic arms. It's a great challenge to design and develop such kind of drones. Moreover, intelligent drones also play a critical role in after blasting a bomb. It can stream the videos continuously to the medical center and control center. Also, drones can provide medical assistance, and also, transports the medical equipment and medicine to the spot. Most importantly, drones can identify the terrorists and chase them to locate precisely their hidden location. The terrorist may be equipped with guns and bomb. Therefore, it is very dangerous to catch a terrorist by defense personnel. The knowledge of accurate location is required to arrest the terrorist or shot the terrorist. A drone can continuously monitor the terrorist activities and locations from a far distance. Therefore, the intelligent drones enhance the defense personal task in arresting or chasing the

terrorist. In addition, there may by diverse crimes in a city. These crimes can be monitored, tracked and predict by the intelligent drones. Also, the mob can be controlled by intelligent drones by spraying tear gases. There may be many casualties and drone can provide medical facilities to the casualties. The various activities of a mob can also be monitored and tracked by intelligent drones.

Network provider. Drones play vital role as a network service provider in emergency area, for instance, natural disaster. In a natural disaster, there is no electricity, hence no power supply for network nodes. In such situation, drones can provide a network for communications. The communication system will deploy intelligent drones based on the service requirement of the people.

Hunukumbure and Tsoukaneri [9] proposed a 5G deployment model using drones for emergency services. During an emergency situation, the drone will be deployed to provide high speed Internet for handling the emergency situation efficiently. However, the service will be provided based on demand after analysing the severity of the emergency. Drone will help to provide Internet services in any location. Deployment of more drones increases the QoS, but also increases cost. Moreover, drones also require the support of pre-selected ground small cells. To achieve this, the pre-selected ground small cells require to be upgraded for smooth communication between drones and Base Band Unit (BBU). In addition, the model requires the support of both the fronthaul and backhaul networks.

6.2. Intelligent Vehicles

Nowadays, vehicles are fully loaded with diverse sensors, for instance, heat sensors. However, state-of-the-art vehicles are not intelligent. It is expected that the future cars will be intelligent and driverless [22]. Therefore, it's a great challenge to convert the smart vehicle to intelligent vehicle using smart devices. The intelligent vehicles can predict traffic and optimize the route. Also, intelligent vehicles are more efficient in the works. The future vehicles will be run on electric power, and thus, batteries are required. The batteries are charged automatically by the vehicles as per requirements in mobile state without using any wire. The charging station will provide their services over wireless networks. Intelligent vehicle can avoid accidents by exchanging information among them. However, there are diverse situation where an intelligent vehicle may face accidents. For instance, landslide from hill on the road. In this natural disaster, the intelligent vehicles predict the event and broadcast the emergency signal. This panic signal can be received by drones, control rooms, etc. for rescue operation. Intelligent vehicle will also concentrate on healthcare. The intelligent vehicles will monitor health of all passengers, including, blood pressure, brain wave, heartbeat etc. while travelling. The intelligent vehicles will also be integrated with oxygen supplies to supply oxygen in emergency situations. Mobile hospital also be implemented on the intelligent vehicle platform.

7. Hospital-to-Home

The grand challenge is to design a movable hospital for emergency services where a hospital can move to desired location on an emergency basis. It demands new vision on existing architecture of medical services. Medical things are getting smarter, and as a consequence, these medical things are able to connect to the Internet. Therefore, these medical things become intelligent enough to predict and make a decision. Hospital-to-Home (H2H) [21] is a new concept to enhance conventional ambulance services for emergency services. H2H is an emergency service that moves the entire hospital to the required destination. The hospital is installed in an intelligent vehicle platform, and thus, it can move from one place to other places during an emergency. Therefore, H2H requires seamless network connectivity, mobile platform, Intelligent Internet of Medical Things (IIoMT) and Intelligent Wearable Devices (IWD).

7.1. Mobile Hospital

Most of the patients dies at home, or inside ambulance due to ambulance cannot reach on time at the destination. Therefore, it is required to redefine conventional ambulance services to enhance the life style of human kinds. Moreover, there is no earlier alert systems to detect emergency, for instance, accident. It is a challenge to design a mobile hospital which utilizes modern technologies for healthcare services. Mobile hospital [21] implements H2H on an intelligent vehicle platform to provide emergency services. The mobile hospital requires an exact location to reach at the destination on time. Also, mobile hospital requires seamless network connectivity. The mobile hospital must have the minimum medical staff required to be a hospital. It is installed with IIoMT, set of medical aid, and medicines. Mobile hospital is categorized into three key challenges, namely, Patient Aid Medical Services (PAMS), Accident Aid Medical Services (AAMS) and Fire Aid Medical Services (FAMS)

Patient Aid Medical Services. Patient Aid Medical Services (PAMS) are mobile hospital that aims to provide emergency service to the patients and it is yet achieved. For instance, Heart-attack and elderly services. PAMS is equipped with medical devices that can connect the network of hospitals, medical aids,

medicines with medical staffs (including doctors) and remote doctors such that treatment can be started inside the vehicles. PAMS receives signals of a patient regularly and analyze the signals. Due to the advent of AI, person is not required to call PAMS for emergency. PAMS automatically initiate its vehicle towards the destinations. Also, various sensor devices can read personal health information. PAMS mobile hospital analyzes these signals for urgency. There are numerous sensors yet to be invented, for instance, Blood Sample Reader sensor [21]. BSR sensor will read the parameters of blood of a person and send these sample to pathology to analyze. Therefore, BSR sensor is needle-free sensor and which is immensely necessary for elderly services.

Accident Aid Medical Service. Accidents Aids Medical Services (AAMS) are mobile hospital designed for accident detection in real-time and treating the injured persons on time in the mobile hospital while travelling from the accident location to the hospital. Modern vehicles are equipped with accident sensors, and thus, detection of accident requires wireless connectivity. Also, IWD will be equipped with accident sensors. Therefore, the accident can be correctly identified by both IWD sensor and vehicle sensor. Moreover, it is necessary to correctly identify the location of the accident to provide AAMS. AAMS receives signal from both vehicle and person. In this case, intelligent drones can stream videos to the AAMS mobile hospital. Also, BSR sensor sends the sample of blood such that blood can be ready on the spot.

Fire Aid Medical Services. Fire Aid Medical Services (FAMS) are mobile hospital that provides medical service to treat injuries related to fire. Fire sensors are installed in buildings and other places. This sensor sends the signal to the fire control station, FAMS and other centers. The drones will reach the spot and stream the videos of the situations. Also, the drones can spray CO_2 gases to extinguish the fire. FAMS can assists the injuries on the spot similar to other mobile hospitals.

7.2. Mobile Hospital Services

The mobile hospital detects an emergency, make a decision and proceeds to the destination. The mobile hospital services start from initiation that determine whether to proceed to destination or not. Also, it decides the shortest route. It's very tough challenge to reach the destination on time and detecting the emergency in real-time. Treatment is started inside the mobile hospital. However, there may be various kinds of emergency, for instance, excessive bleeding. Thus, mobile hospital is responsible for transporting the patients safely to the hospital for treatment.

Initiation. It is an open challenge to detection of an emergency events in real-time for mobile hospital. Medical staffs, medicine and IIoMT are installed in the mobile hospital as per their service categories (AAMS, PAMS and FAMS). Mobile hospital initiates it's a process from detection of an emergency medical service. The emergency signal is received by mobile hospital and it may be accident, specific patients or fire caught in a building. As per the requirements, a particular mobile hospital is initiated. The AAMS mobile hospital is initiated upon receiving accident signal. The alarm may be true or false. However, the AI decides the severeness of the accident. Then, AAMS mobile hospital locates the destination with precision and move towards the destination. The accident may be crimes, mob lynching, vehicles and sports accident. Similarly, SPAMS and FIMS mobile hospital also receives a specific signal and decides the severeness of the emergency.

Destination. It is a grand challenge of mobile hospital to reach at destination at an emergency situation. Due to advent of sensor technology and wireless communication, it is possible to detect an emergency service as early as possible. Moreover, the mobile hospital requires to calculate the shortest route to reach the destination quickly. Also, mobile hospital requires to calculate the nearest hospital to admit the patients. However, drones may reach before the mobile hospitals. Therefore, drones can stream the videos to mobile hospitals for preparedness of the medical staffs. At the destination, patients are loaded into the mobile hospitals for treatment.

Treatment. The treatment starts from destinations. Most of the patients dies inside the conventional ambulance. To save many lives, doctors start treating the patients in mobile hospitals. For instance, blood insulation, oxygen installation, medications, etc., is started from destination to hospital and the treatment is provided to patients in the mobile hospital to save their lives. It can save many lives. In a sport, AAMS mobile service must be always present to save sport participants in case of accidents. In a VIP service (for instance, gathering of the President of any country), all three services must present at the spot for providing emergency services.

7.3. Intelligent Wearable Devices

The Intelligent Wearable Devices (IWD) [21] plays critical role in emergency services. IWD will be equipped with accident sensors and various sensors to measure body parameters. Current state-of-the-art sensor technology, there is no accident sensors for a person. It is believed that it will be devised in future. IWD will help in the detection of many emergency situations, for instance, accident sensor, fire sensors and health sensors. Such kinds of sensors emit panic

signal, for instance, SOS signal. Sensors will be installed in IWD to monitor personal health, mental health and physical activities. Similarly, there are numerous research work going on BSR sensors [28] which is under developed. BSR sensor will be also installed in IWD to read blood parameters. Moreover, BSR sensor will help in identifying diseases. BSR sensor could play a vital role in Epidemic and Pandemic detection and prevention without risking the medical workers, police, bankers and other support teams. Apparently, Epidemic and Pandemic occur due to human to human transmission viruses. BSR sensor sends the blood sample to pathology for examination. The pathology can declare that either the person is affected by the virus or not. If affected, then prevention can easily be done. Also, the total number of infections could be measured in real-time. Thus, Epidemic and Pandemic could easily be prevented from spreading, if BSR sensor exists and works perfectly as desired by the pathologist. Therefore, this is the another grand challenge to develop BSR sensor. However, research is being carried out to develop such kind of sensor.

8. Key Challenges

There are many diverse key challenges for development of the emergency services. One big challenge with emergency services is the technology have to be robust and reliable. Because, during an emergency many lives are at risk. Therefore, any kind of failures or delay is not permitted. The key challenges of intelligent medical emergency services are discussed below-

Communication Network: The 5G communication network has many issues, therefore, beyond 5G communication network promises to solve all the issues of 5G. Some issues and challenges of 5G are connectivity in IoT, interoperability, low power and low-cost communication, big data analytics, security, trust and privacy [1]. 6G also has many issues and challenges which are discussed in section 2.1. Again, highlighting the important issues. The issues and challenges of 6G are efficient bandwidth for transmission, providing services in space-air-water, < 1ms latency, high capacity, high density, heterogeneity, security, privacy and many more. Another important point is 6G has to solve all these issues. Solving one issue and ignoring some will not be possible because all issues are interlinked and their solution is required to provide high QoS.

Accident Sensor: An accident sensor is a sensor that detects accidents. Currently, there is no accident sensor available. This is a great challenge to develop an accident sensor for human beings which can be attached with IWD. However, there are huge challenges to face to develop such kind of sensors. Various parameters have to consider while developing accident sensors. Accident sensor is based on video analysis. The sensor will constantly analyze the video to determine whether an accident has occurred. Analysis will be performed using video analytics in Edge nodes. Currently, Edge technology is an emerging technology. Moreover, Edge nodes are small devices similar to gateway devices, but capable of computation and analysis. Edge computing [35] is responsible for computation. And, Edge analytics are responsible for the analysis. Both Edge computing and Edge analytics [10] implement AI algorithms. However, AI algorithms are high computation algorithms. Therefore, current Edge nodes are dependent on the Cloud. AI algorithms are executed in the Cloud and the inferences are transmitted to Edge nodes. These inferences perform the analysis for prediction. An important point is future communication networks such as 6G and beyond will use Edge nodes as network nodes to provide high QoS. Thus, Edge technology has to break free from the dependence of Cloud to provide services with latency < 1ms. Moreover, there are requirements for new AI algorithms which are less computational yet powerful, for instance Federated Learning [14]. These algorithms also have to complete execution using constrained resources and low power. Accident sensor is a complex sensor because in case the accident happened far from the sensor, then determining there is an accident is difficult. Because, the more the distance between sensor and accident site, more information, i.e. surrounding need to be analyzed. Another important point is defining the rule set to determine an accident. Because some abnormal incidents may occur which do not require medical or emergency service. For example, a person accidentally entered the footpath late at night on a lonely road and the driver stopped the car. In such a situation the driver just stops the car on its own after a small mistake happened. However, an accident sensor may determine this situation as an accident because the car got diverted from the road. Therefore, it is a big challenge to develop an accident sensor.

BSR Sensor: It is a grand challenge to develop a BSR sensor to detect diseases without using a needle. The needle-free BSR will be proven as a game changer in medical history. The future of intelligent devices where the patient will be constantly monitored requires a BSR

sensor. Many body parameters and confirmation of diseases depend on blood tests. But, without visiting a clinic or hospital and not using a syringe it is not possible to have a blood test report. However, usage of syringes requires high precaution. Because unsterilized syringes may lead to infection or some deadly diseases eg., AIDS. During an epidemic or pandemic, it will be a huge help. For example, in the current situation of Covid19 visiting hospitals is highly risky. Using a BSR sensor the patient will send the sample online for testing. And, the report is received through the mail. In the case of intelligent medical emergency service, a BSR sensor is a necessity because the majority of the medical history of the patient is unavailable. Therefore, using a BSR sensor sample can be sent for testing and quickly the result will be sent to the mobile hospital. But, without BSR sensor in some cases H2H just has to act as the conventional ambulance of transferring patients to hospital.

Hospital to Home: As we described, H2H is vital in modern lifestyle. Also, it is another grand challenge to develop such hospital in intelligent vehicles. H2H is a mini hospital. Hence, the biggest challenge will be installing medical equipment inside an ambulance. Because of space constraints and requirements for installing sophisticated medical equipment. During emergencies, many sophisticated medical equipment is required for quick analysis and further treatment. However, many such equipment may be of big size. Therefore, there is a requirement for developing small size equipment yet similarly effective or more. H2H also requires an intelligent vehicle. The related issues of intelligent vehicle are discussed in the following section.

IWD: IWD is emerging and becoming more popular among common people. Because, today everyone wants to stay healthy. To achieve that people want to remain constantly updated about their body parameters such as walking step count, heart beat, calorie burns, etc. Also, people are taking these data seriously and want to store these data securely. Therefore, billions of IWD is connected to the Internet with multiple IWD owned by a single user. In such scenarios, 6G has to provide high QoS and maintain security. But the most important issue will be the capacity of 6G. 6G promises to deploy a large number of Edge nodes to increase its capacity. However, deployment of a huge number of Edge nodes will increase the infrastructure cost along with monitoring an overwhelming number of network nodes. Thus, density is another issue of 6G. Current state-of-the-art IWDs are in the initial stage and yet to integrate many sensors which can improve health. IWD for patients is very different compared to IWD used by common people. Patient IWD monitors more parameters such as body temperature, blood sugar, blood pressure etc. However, using a single sensor to monitor all the parameters is very difficult. In addition, the constraints to design IWD i.e small size similar to a watch, low power supply etc. need to be followed. Thus, designing such a universal powerful sensor is very difficult. Another important issue is the data sent by the patient IWD has to be real time because the body condition of the patient may change at any time and the patient will require emergency services. Hence, the data need to be evaluated in real-time. To achieve this, advanced Edge nodes are required equipped with advanced Edge computing and Edge analytics.

Intelligent Vehicles: An intelligent vehicle is a desperate need to provide emergency services. With the development of the whole world the quality of life of the people is increasing. Luxurious cars, high speed travelling, traffic jams for hours during peak time is the current scenario. These are some of the small issues that the emergency services need to solve. But, their presence is very overwhelming. An intelligent vehicle requires an advanced GPS system to locate the emergency location. To handle the traffic jams the intelligent vehicle will constantly share its location and at appropriate times the Edge nodes will open the traffic for smooth movement. However, the intelligent vehicle has to repeatedly change interaction with Edge nodes when it is outside of a coverage area of an Edge node. The intelligent vehicle establishes a secure and reliable connection with an Edge node, exchanging destination location and finally terminating the connection after crossing coverage area. These processes are performed repetitively. Thus, it may affect the performance. A solution is an Edge node connecting to a neighbor node based on the destination path. However, in some situations the planned path may not be possible to follow, for instance, an accident causing road blockage. In such a situation the intelligent vehicle will come back to the previous issue of repeated connection and termination. 6G will support constant global coverage. Hence, during disaster which destroys or fails the network nodes i.e Edge nodes 6G will deploy drones to immediately establish the connection. However, drones are costly. Moreover, during an emergency, drones will also be used to

control the situations, for instance, spreading fire extinguishers on the fire. Such drones have to be specially designed to act both as a network node and emergency service provider. Therefore, intelligent vehicles have many issues that need to be addressed because without an intelligent vehicle implementing an intelligent medical emergency service provider will not be possible.

9. Conclusion

In this Chapter, we have exposed various emergency services and envisioned the future possible solution for emergency services. This emergency services include fire break, accident and patients. Thus, we narrow down the emergency services. Also, we have discussed various possible intelligent emergency services to save many human lives. Also, we demonstrate the impact of vehicular technology in emergency services to save human lives, for instance, drones. Furthermore, we elaborate the requirements of Hospital-to-Home services to save millions of lives. H2H is implemented on intelligent vehicles to move the entire hospital to destination to serve the casualties for on-spot treatment.

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