LETTER

Towards Society Revolution: The Tactile Internet

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Sir,

It is expected that the 5G will change the landscape of the communication paradigm as it will offer a huge number of device connections, high data rate, evolutionary channel modulation, etc. The 5G predicts to have billions of devices connected through its new scenarios involving Internet of Things (IoT), Machine Type Communications (MTC), and Machine- to- Machine Communications (M2M) via the use of different types of devices including but not restricted to smartphones which are based on IP packets.

Along with 5G, the evolution is progressing not only in the access networks, core networks and backbone networks, but also in the types of traffic that flow across the Internet. Generally, the conventional kinds of traffic travelling through the Internet are video, audio and data. However, there is another type of traffic that can be introduced which is the touch traffic. From here, the term of Tactile Internet is introduced in order to deal with haptic communication and convert the touch through Tactile codec in order to be adapted for the transfer through the Internet.

Haptic communication will revolutionize the society and will introduce different business and economic models that can be adapted to different scenarios. The domain of use of haptic communication can include teleoperation, education, network engineering, entertainment, automation and smart grid. However, since we are dealing with touch, this means the reaction in the other end should be as fast as possible as the touch interaction time to a screen is only one 1 ms. The ability to transfer a touch in a round trip delay of 1 ms is the main challenge that can face the Tactile Internet. It is expected that the fiber optic will be the best solution for the data transfer; however, with the big size of the data packet, this would not be possible. Therefore, the packet size should be re-divided into smaller sizes so they can be transferred as fast as possible. The round trip delay of 1 ms is only the time of travelling which does not include the time of processing (Antonakoglou *et al*, 2018).

5G is the best enabler for the Tactile Internet through the different techniques deployed in the core network that guarantees the Quality of Service (QoS) and the Quality of Experience (QoE) of the users. Since the communication should be fast, a method of resource reservation is needed, and this can be achieved by Network Slicing that abstracts the resources from the physical ones and isolates them to be dedicated to one application or a service. Network slicing promotes two technologies, namely Software Defined Networks (SDN) and Network Function Virtualization (NFV). The former is a form of network automation that deals mainly with switches, routers, etc., and the latter deals with the functionalities that the network is offering and adapting it to the context.

The Tactile Internet can combine telecommunication engineers, computer scientists and mechanical engineers. The telecommunication engineer should provide a suitable haptic communication with high reliability, while Artificial Intelligence is needed in order to improve the human-machine interaction which is the basis of the Tactile Internet. Mechanical engineers are also needed for building the robots that interact with the touch or kinesthetic experience.

Technically, the main part of the Tactile Internet is the master domain which is responsible for reproducing touch

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and kinesthetic codecs. These touches will be transferred through the Internet (access network and core network) as we call it network domain and then the slave domain or the controlled domain where the touch is received. Generally, since we are talking about action in the master domain, there should be a reaction in the slave domain and vice versa. For that purpose, the Tactile Internet can be combined keenly with IoT, and sensors can be deployed in both domains in order to sense and actuate the whole process of touch and sense (Li *et al*, 2018). One can imagine a robot in the slave domain that palpates a patient through touches of the doctor in the master domain, but at the same time and in order that the doctor feels the body of the patient, he/she can wear a glove that actuates the sense of the patient.

Further, the Tactile Internet is called the Internet of Skills since a touch is transferring a skill such as while teaching a kid the piano in the other end of the world, or diagnosing a patient by a distant doctor, or practicing a chirurgical operation through a robot. Here, the focus is on the skill being transferred rather than the process of touching itself.

The standardization of 5G as an enabler of the Tactile Internet is in progress but the evolution in the domain of electronics like 3D chips, communication modulation such as carrier aggregation and high data rate make it feasible for Tactile Internet to see the light and not be only some science fiction story. However, the fast round trip is still the main challenge which can be solved by the previously-mentioned technologies through making the Base Stations more intelligent, broadly speaking by introducing Mobile Edge Computing to them. This means bringing storage and processing to the vicinity of the users especially when dealing with real-time applications (Moskvitch, 2015).

The deployment of 5G and its divers scenarios will require high QoS guarantee which is the network vision of the level of the service provided by the operators. This would increase the revenue of the operators through the introduction of new case studies that require haptic communication and resource isolation. On the other hand, this would create a new opportunity for business drivers, various applications, and is a revolutionary way of transferring skills, or learning methods far from what we have learnt in the past.

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