JAIST Information Science Seminar

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Title: "Lossy Multi-terminal Cooperative Networks, Queueing, and Decision Making: *Erlang, Shannon, and Neyman-Pearson Meet in 6G Networks*"

(Roughly 180 minutes including Q&A session)

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Abstract

The primary objective of this short lecture is to provide the participants with *outline knowledge* that the project, Internet-Of-Things network Analysis and Design base on the Chief Executive Officer problem (IoTAD-CEO), funded by a French Funding program, COMIN-Labs, is in part currently intensively researching, and that in part the project has achieved. The system considered is composed of three component techniques, Lossy Cooperative Multi-terminal Source Coding, Queueing System, and Decision Making, of which an exemplifying structure is shown in Fig. 1; This concept is referred to as *Erlang, Shannon, and Neyman-Pearson Meet in 6G Networks*.

Network Information Theory is an extension of Shannon's Information Theory to Networks. We believe that the key to the successful development of new mobile wireless communications system concept should be to utilize the latest results of Network Information Theory in the most suitable forms, so as to satisfy network objectives and requirements in efficient way. The IoTAD-CEO project has been focusing on the topics of how Lossy Distributed Multi-terminal Source Coding Theory, especially its theoretical framework, should be modified so that it can be best-suited to mobile wireless cooperative communications over fading multiple access channels (MACs). The reason for the focus on lossy communications is because even with distortions included in the recovered multi-terminals' transmitted information at the data center, still appropriate solutions can be obtained by pre-trained Artificial Intelligence (AI) system, as shown in Fig. 1. The system concept includes wireless

mesh networks, relay communications, sensor networks, Internet-of-Things (IoT) Vehicle-to-Things (V2X) networks, and Centralized Radio Access Network (C-RAN).

The system is assumed to have massive wireless devices, hence lossy transmission over MAC channel significantly reduces the latency. The freshness of the information recovery, with the system concept described above, is *not* important, but *fast* delivery of the solution *is* of significant importance. The freshness can be represented by Age-of-Information (AoI). The IoTAD-CEO project also covers AoI analysis for wireless queueing systems, because the network is assumed to have a queueing system to accommodate massive transmission devices. The queue control is one of the core topics of the project.

The IoTAD-CEO does not use AI systems as a black box tool, but the project models the decision-making part by Distributed Hypothesis Testing (DHT). In this case, the pre-training period is regarded as the process for determining empirical probability distribution to be used in DHT.

As a whole, the system where the concept, *"Erlang, Shannon, and Neyman-Pearson Meet in 6G Networks"* can be seen as a *Shaping History Road* towards *Ultra Reliable Low Latency Solution-making* (URLLS) system. Detailed derivations of the logic, information theoretic and queueing theoretic findings, and decision-making based on distributed hypothesis testing are to be covered in the JAIST Information Science Lecture.

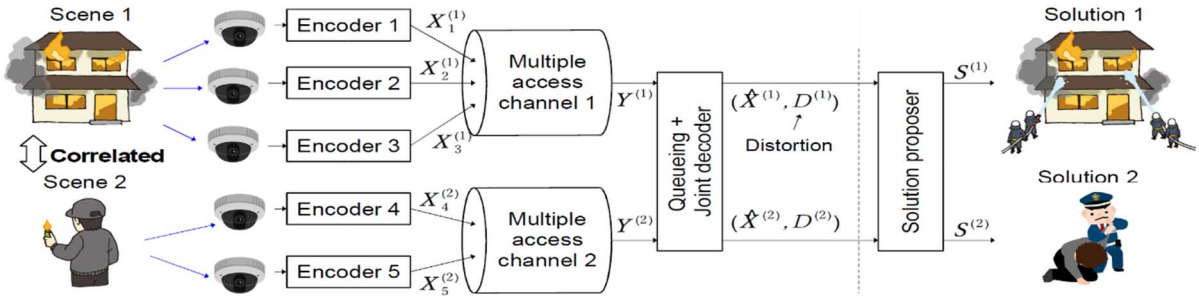

Fig. 1 Network Example IoTAD-CEO project is assumes.