The Genie of Huxley

The union of telecommunications, nanotechnology and biology are poised to pave the way for incredible advances in the human race within the next quarter of the century.

Professor Ilhan Fuat Akyildiz is extremely happy that the erstwhile coach of Fenerbahce, Aykut Cetin, left the team. After a long hiatus of three and half years, as he did in the old times the professor came to Istanbul specifically to watch the soccer match, between Fenerbahce and Galatasaray (Fenerbahce won 2-0 as usual) last month.

The following day, he flew to Jeddah, Saudi Arabia, to direct projects at the 2 million dollar research center that he founded in the King Abdulaziz University. From there, he went to Riyadh and attended important government meetings organized to shape the science and technology vision of Saudi Arabia.

The life of this professor of Georgia Institute of Technology, Electrical and Computer Engineering Department and the Director of Broadband Wireless Networking Laboratory bears an uncanny resemblance to the Evliya Celebi (an Ottoman traveler). He spends most of his time travelling back and forth between the institutes that he founded all over the world. He is an honorary professor at Universitat Politecnica de Catalunya (UPC) in Barcelona, Spain and he manages the NaNoNetworking Center in the same university. He leads the research in the field of nanotechnology and wireless networks at Tampere Institute of Technology in Finland, Pretoria University in South Africa, and King Abdulaziz University in Jeddah, Saudi Arabia. Last October, he has been granted a 9 million dollar budget called “Mega Grant” for the foundation of an institute in St. Petersburg, Russia. He has also been offered to setup yet another center in Paris, France.

Besides being a tall, sharp-witted and pleasant man, Professor Akyildiz also knows how to expertly manage the business world. He directs a 4 million dollar project for Saudi oil company Aramco concerned with developing nanosensors that report the reserve levels in oil wells (see figure 1). He is also developing a new generation of network technology using software defined networks (SDN) for the leading Chinese company Huawei, with a similar amount of funds at his disposal. Furthermore, he also manages projects awarded by major US governmental institutions, such as the research wing of the US Army. In addition to all of these, he owns a consulting company named Truva, which makes a 1.5 million dollar yearly revenue. He says, “Since I was a child, I always wanted to be one of the best researchers in the world. This is why I came to USA. However, when I look back, I could as well have been a billionaire businessman”.

Ilhan F. Akyildiz was born in 1954, as the youngest child of his family. His father was a business man who owned a timber factory and a construction company. He attended the Austrian High School in Istanbul early in his life, and later went to Austria to continue his education. He graduated from high school in Linz. He completed his undergraduate and PhD studies at Erlangen-Nürnberg University in Germany in 1978 and 1984, respectively. He remembers his early life in the following words: "My father was a rich man. He passed away when I was in my second year in the university and my brothers could not carry on the business. I gave away my share of the inheritance to my mother. I was in a difficult situation financially. After the second year, I could only continue studies with a German scholarship, while still sending half of my scholarship, then an amount of 740 Mark, to my mother. "

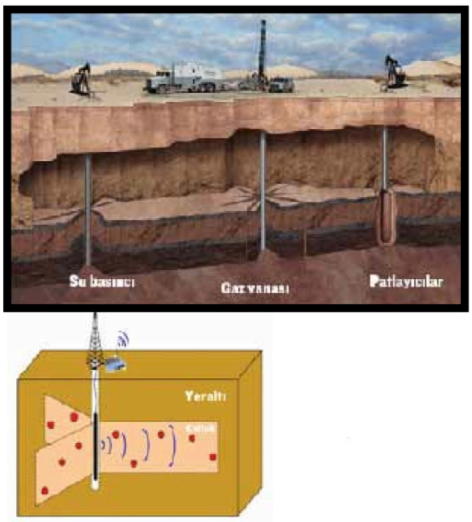

Figure 1. Prof. Akyildiz and his team developed the first nanosensors of size 1x1 mm that can be placed underground. These sensors will be used to measure the level of petroleum reservoir in the wells of Saudi Aramco. As part of this project, hundreds of these sensors will be deployed underworld. At a distance of 50 feet on either side of the main well, the two pipes will be opened. Pressurized water and gas will be sent through these two pipes. In this way, the underground sensors will be distributed through the cracks. These sensors will communicate with the centers aboveground, reporting the region's topographic situation and petroleum availability. Today, only 30 percent of the reserves in oil wells can be utilized. At the end of the project, Aramco targets to increase this rate to 75 percent.

Professor Akyildiz first came to USA at the beginning of 1985, and started to work at Louisiana State University. He did not like the city initially, but there was no immediate job offer from a different university. "I worked hard," he says. "I aggressively searched for research funding –this is the way how success comes. I called the research division of the US Air Force almost everyday for one year to get my first funding, and then went on to publish many papers."

The 100,000 dollars that he got from the US Air Force in the Fall of 1986 opened the doors of Georgia Tech, which was in the top 15 schools of USA. At Georgia Tech, he got his Associate Professor title in only one year, which normally takes 5 years. He says, "At first, I focused on theoretical studies. I published many papers, but the story completely changed once I started to work on applications. In 1989, my achievements started being recognized." At the mid of 1990s, he was a full professor. In this elevated role, he was conducting projects for the US Army and working on a "satellite"-based project for NASA, for establishing communication between Earth and a station on Mars.

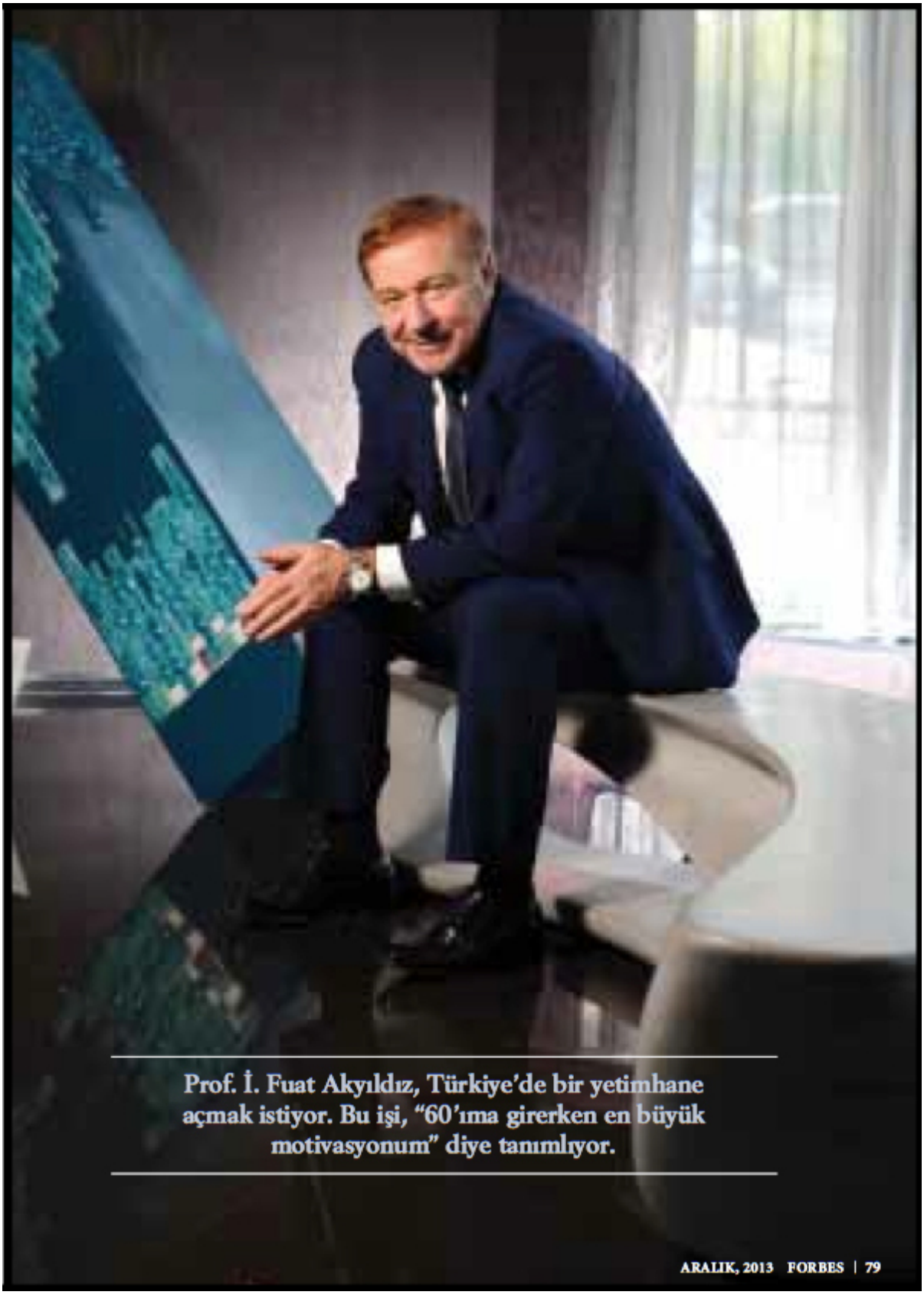

Figure 2. Prof. I. Fuat Akyildiz wants to open an orphanage in Turkey. He describes this objective as: "While I am entering my 60th year, this remains my greatest motivation in life".

Today, he is one of the top telecommunication researchers in the world. He has 540 scientific publications and 15 patents. The total citation of his works since 1998 is around 55,000. This number is more than the half of the total citations of all universities in Turkey combined. The inventions by Professor Akyildiz cover almost every area in the larger domain of wireless communications, including ATM networks, 3G, satellite networks, mobility management and several other technical areas that are not directly visible to the general public. However, all these works have considerable contributions to the current state-of-the-art in the wireless communication. “The protocols and technologies that I developed have been used in several existing systems.” At his current age of 59, Professor Akyildiz says, “I was working on 3G in 1997, on 4G in 2001. I have been contributing to telecommunication technologies, which we now use nearly 10 years later.”

The professor has always been ahead of his time. For example, he has been working on Terahertz Band communication systems since 2001. As this frequency can support data rates up to terabit/s, Turkcell, for instance, reached 900Mbps during 4G trials on August. Today, broadband is one of the hot topics and it has a significant focus area for countries. For example, the EU devoted 9.2 billion Euro fund for the dissemination of the usage of broadband in 2011, and in the next year, added another 20 billion Euro into this investment.

In the terahertz band, realizing fast Internet has its share of challenges. A high data rate is possible only if the distance between two communicating machines is no more than 1.5 meters. Meanwhile, 3G base stations can be positioned at intervals of 300 meters. Therefore, teraheartz band communication little commercial potential in its current form. "We are working towards increasing the communication distance," says Dr. Akyildiz. "Nano-antennas can enable this paradigm change."

His team of researchers succeeded in developing a nano-antenna using graphene in March 2013, which is a super conductive and synthetic material based on carbon. Through the support of sponsored projects with total funding of $6 million by NSF and DoD, they filled four patent applications already.

The use of nanotechnology in telecommunications had captured Professor Akyildiz’s fascination. However, what makes him really excited is the “molecular nano-scale communication” project, abbreviated as MONACO, (supported by NSF at 3 Million Dollars level) on which he has been working for the past three years. Nanotechnology enables development of devices with sizes varying from one to several hundred nanometers. However, the communication between nano-scale devices (nanonetworks) cannot be established by the traditional communication technologies (existing transmitters, receivers and additional processing components) due to the limitations of size and energy consumption.

Nanonetworks is one of the hottest new frontiers of science. "This is a

new communication paradigm," says Professor Akyildiz, "And it opens the door to many new ideas in the field of medicine." The goal here is to perform communication among nano machines via propagation of molecules. The professor defines this as a “bio-inspired paradigm”. He says, "Human cells and bacteria work like a computer. Mitochondria provide energy and power, the cell nucleus is the processor and memory. In addition, communication occurs between cells. Based on this structure, we are working on developing synthetic nano-scale machines."

But what is the motivation behind his next generation research? Professor Akyildiz and his team believe that these artificial machines can be potentially injected into the bloodstream of people in the future, and will work alongwith white and red blood cells as reinforcements. Since they are programmed, they will be able to fight against diseases. A caveat here, however, is that artificial human cells cannot be produced. The good news is that it creation of these programmed biological entities may be possible via bacteria. "25 years in the future," says Professor Akyildiz, while accepting the TUBITAK (Turkish NSF) Special Science Award, "we can develop drug delivery systems and eventually extend human life.”

This incredible vision of utopia, where human beings do not get sick, and live long lives of up to 200 years, looks like it has popped out of Aldous Huxley. However, science has repeatedly transformed science-fiction into reality. “I explained the workings of one of my projects once to listeners” says Dr. Akyildiz. “They immediately said it is impossible. However, we are doing research because the path is unknown, and we wish to explore if this future is possible. It will be an incredible achievement if we can make this happen! Even otherwise, we will be gaining through a terrific accumulation of knowledge in this exciting journey.”