Research Highlights

CREATE

When people are happy, they can find things faster

Everyday changes of mood were found to affect the performance of visual search

A wide range of social psychology studies support the premise that people are more creative when they are happy, and are more sociable when they are able to engage with many things and people. However, the effect of mood on people's ability to perform basic tasks such as noticing or finding things has not been clarified.

A team led by Noriko Yamagishi, a senior researcher at the CiNet Brain Networks and Communication Laboratory, has developed a smartphone app to record variations in people's level of happiness during their everyday lives, and by having them perform visual search tasks at the same time, it was revealed that a person's level of happiness affects their speed in visual search task (Fig.1).

> **"A person's degree of happiness is not a constant attribute like personality."**

Thirty-three research participants worked on tasks for about 5 minutes each time three times a day (morning, noon, and night) for two weeks (Fig.2). The results showed that a person's degree of happiness is not a constant attribute like personality, but changes from one moment to the next. When a person's happiness level is higher, he/she can locate more quickly a target object set among obstacles.

According to Dr. Yamagishi, "The results of this study suggest that it is possible to estimate how happy someone is by using a smartphone app to monitor their performance in visual search tasks. This could lead to the development of methods for visualizing the early stages of mental disorders such as depression."

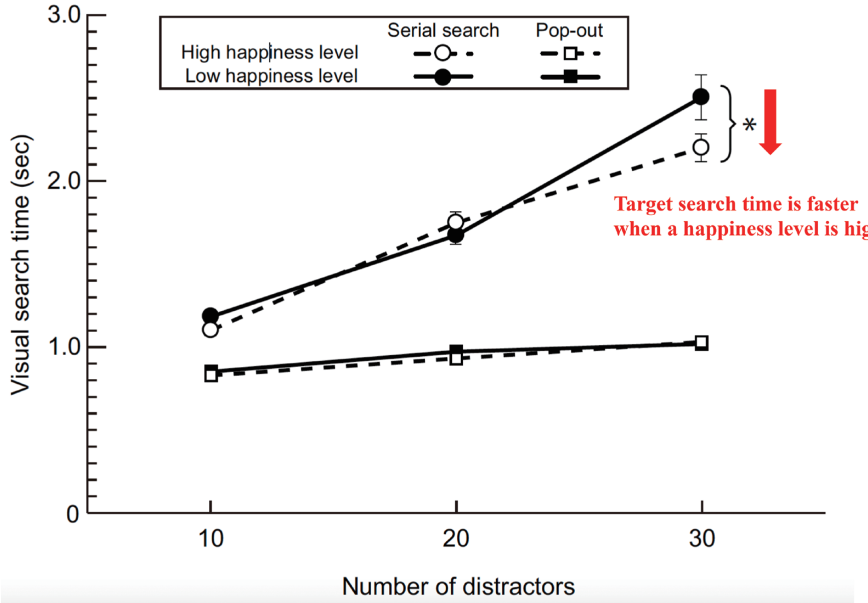


Fig.1 : Effect of happiness level on visual search times

Reference

PLOS ONE
URL: http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0195865
DOI: 10.1371/journal.pone.0195865
The effect of mood state on visual search times for detecting a target in noise:
An application of smartphone technology
Maekawa, T., Anderson, S. J., de Brecht, M., Yamagishi, N.

Collaboration Research Members
NICT : Toru Maekawa Matthew de Brecht
Noriko Yamagishi
Aston University(http://www.aston.ac.uk/) : Stephen J. Anderson

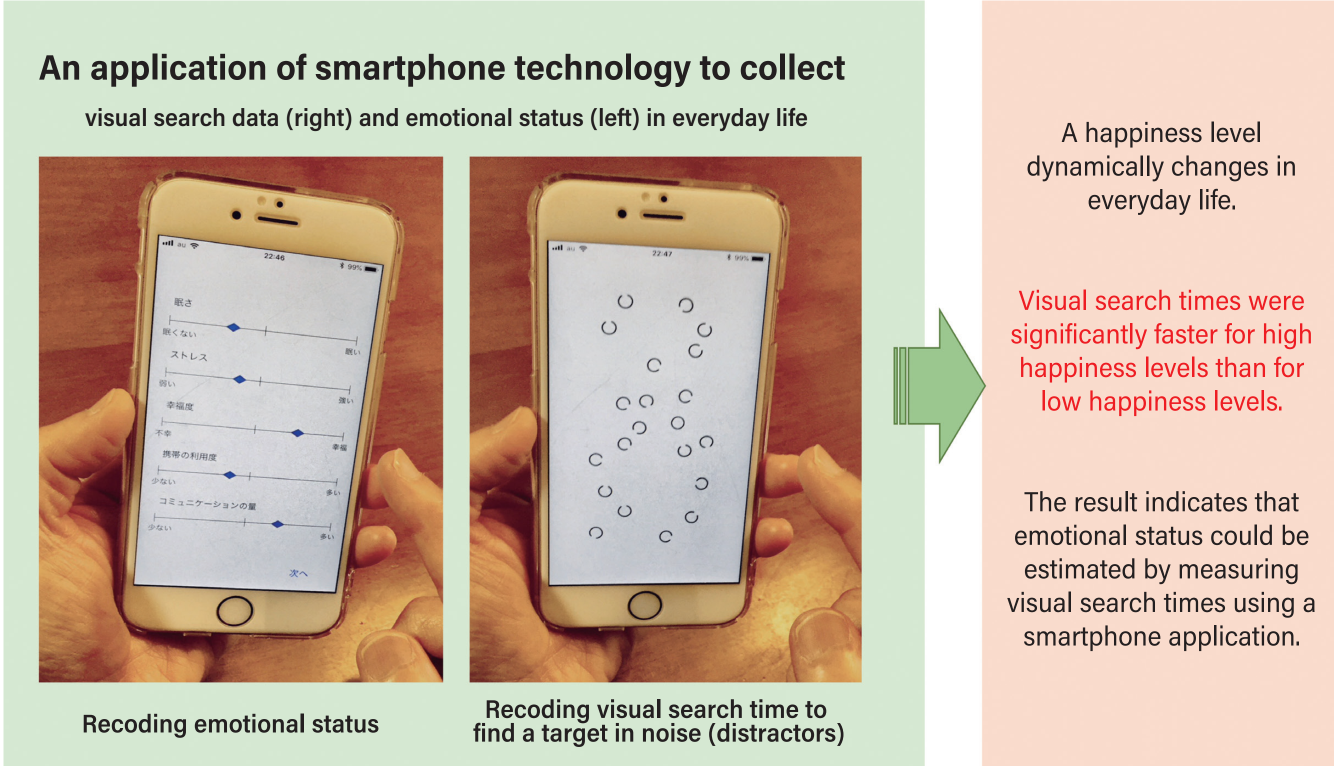


Fig.2 : Smartphone application to collect emotional status and visual performance in everyday life

CONNECT

Uninterrupted communication for users moving at 500km/h

Proof of concept demonstration of high-capacity seamless communication for high-speed railways

The demands for high-speed and smooth communications are rapidly increasing, including from users who are on rapidly moving vehicles such as high-speed trains, because of the explosive popularization of smartphones and other personal multimedia devices. In current cellular networks, however, connections to Internet networks during high-speed movement are frequently interrupted because of radio station switching (handover).

NICT Network System Research Institute (NSRI) researchers performed a proof-of-concept demonstration of an uninterrupted communication system for high-speed trains by combining a linear cell network configuration, a high-speed seamless fiber-wireless system in the millimeter-wave (mmWave) band, and an ultra-fast optical-path switching technique. This work was conducted as part of a project titled "Research and development of millimeter-wave backhaul technology for high-speed vehicles" funded by the Ministry of Internal Affairs and Communications (MIC), Japan (Research representative: Hitachi Kokusai Electric Inc.).

In this work, the NICT researchers developed a technology to transmit approximately 20-Gbit/s radio signals (16-QAM, carrier frequency of 7 GHz and sampling rate of 6 GHz) in the 90-GHz band from a central station to 50 remote radio stations using a switchable wavelength-division-multiplexing radio-over-fiber and mmWave wireless network. The switching of the remote radio stations in accordance with the movement of trains can be controlled from the central station, and a switching time of less than 10 μs was achieved using high-speed wavelength-tunable lasers.

"We demonstrated that the signal distribution to radio stations can be switched in less than 10 μs."

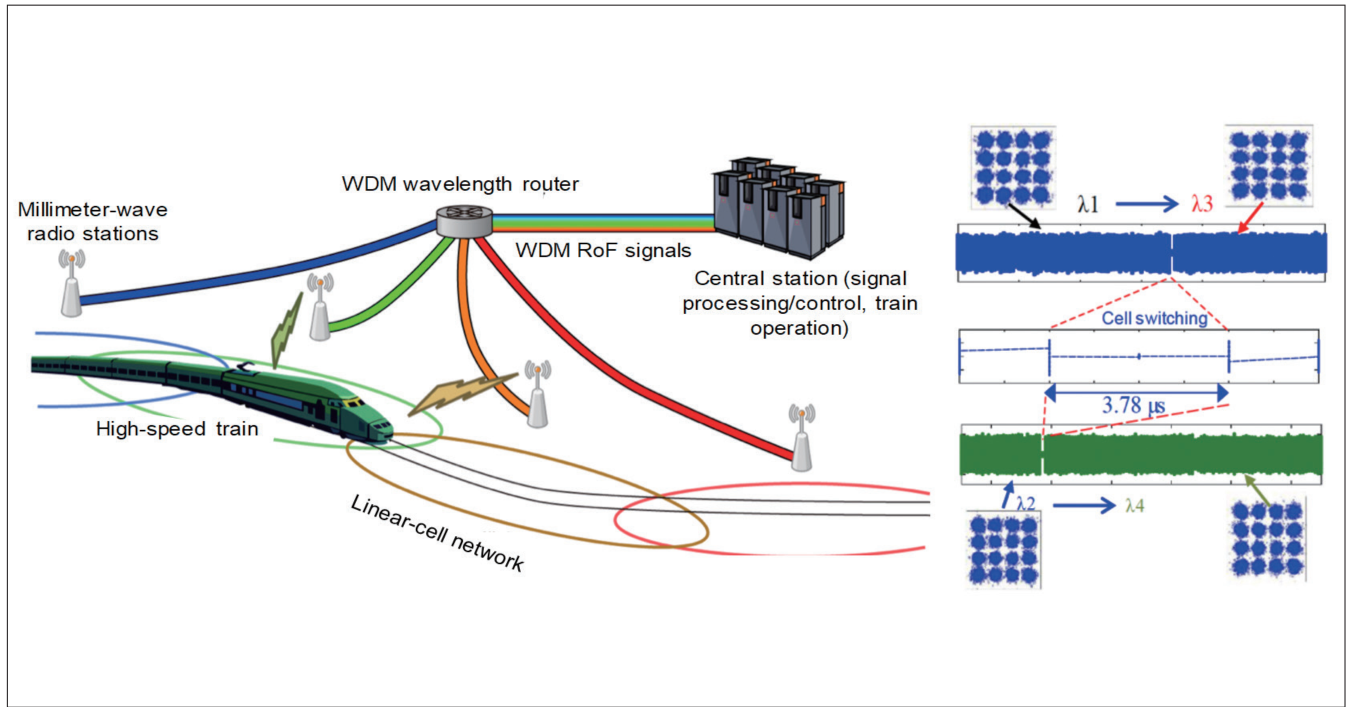
In high-speed railways, the radio stations that the trains are approaching can be precisely predicted using train information such as train location and velocity, which is available at the train operation center. Thus, appropriate signal distribution to the corresponding radio stations can be performed by means of high-speed optical switching technologies, such as high-speed wavelength-tunable lasers. Naokatsu Yamamoto, Director of the NSRI Network Science and Convergence Device Technology Laboratory, stated, "We demonstrated that the signal distribution to radio stations can be switched in less than 10 μs. This indicates that an uninterrupted communication system for high-speed railways can be constructed, even for trains moving at 500 km/h or faster."

Handover-free communication has faced a significant challenge in terms of avoiding significant degradation of the throughput of high-mobility users, which includes users on high-speed trains, due to the frequently interrupted connections with radio stations. With this network configuration, the development of an uninterrupted network for high-mobility users can be implemented in an easier way than in standard cellular networks because the necessary control signals are available at central stations.

Dr. Yamamoto further said, "In the future, in collaboration with Hitachi Kokusai Electric Inc., the Railway Technology Research Institute, the Electronic Navigation Research Institute (part of the National Institute of Maritime, Port and Aviation Technology Institute), and other related parties in the aforementioned MIC-funded project, we will implement field test demonstrations on actual railway lines."

Reference

Pham Tien Dat, Atsushi Kanno, Keizo Inagaki, Toshimasa Umezawa, Fançoir Rottenberg, Jérome Louveaux, Naokatsu Yamamoto, and Tetsuya Kawanishi, "High-Speed and Handover-Free Communications for High-Speed Trains Using Switched WDM Fiber–Wireless System," in Proc. 41st Optical Fiber Communication Conference and Exhibition (OFC), March 2018, paper Th4D. 2.



Conceptual diagram of the proposed communication system for high-speed railways (left) and radio station switching and performance of 16-QAM signals (right).

DEVELOP

Enhancing the energy controllability using strong interaction with photons

Observed huge Lamb shift shows potential of utilizing vacuum fluctuation in designing quantum circuit

The physics of extremely strong interaction between light and matter has not been well understood due to the lack of suitable experimental means. To find and understand new phenomena in this unexplored regime, a research group comprising Senior Researcher Fumiki Yoshihara, Senior Researcher Tomoko Fuse, and Executive Researcher Kouichi Semba of the NICT Advanced ICT Research Institute has been working on superconducting artificial atoms[*1] that can interact very strongly with an electromagnetic field mode in a resonator circuit. In 2016, they successfully implemented a new regime of very strong interactions between light and matter (deep-strong-coupling (DSC) regime), and became the first to demonstrate the existence of stable states molecule-like consisting of photons and artificial atoms.

In the DSC regime, interactions with just a single photon can cause tremendous changes in the energy levels of an artificial atom. Until now, there have been no reports of systematic experiments to explore phenomena (Lamb shift, Stark effect) in this regime.

In collaboration with NTT Corporation, Qatar Environment & Energy Research Institute, Tokyo Medical and Dental University, and Waseda University, this research group has become the first to successfully generate a very large energy change (optical shift) in artificial atoms interacting with photons. This experiment was conducted using the superconducting circuit shown in Fig.1. The superconducting artificial atoms (outlined in red) were prepared using microfabrication techniques. Artificial atoms have quantum properties equivalent to atoms, and can confine photons in the superconducting resonator circuit. New experiments using double resonance spectroscopy showed that the observable energy range became wider, and the team succeeded in observing a huge relative light shift about 100 times larger than in conventional experiments (Fig.2).

"The relative shift we observed is 6 orders of magnitude larger than that initially observed in the hydrogen atom."

The Lamb shift is caused by interactions with the vacuum electromagnetic field in resonator circuits. The effect was first discovered as a difference in the fine energy levels of hydrogen atoms. Since then, it has brought dramatic developments in quantum electrodynamics, and plays a key role in the sophisticated electronics technology supporting modern society. In the words of Kouichi Semba (Executive Researcher at the Frontier Research Laboratory), "The huge Lamb shift we observed this time is 6 orders of magnitude larger than the energy shift initially observed in the hydrogen atom, due to the effect of the zero point fluctuation current in the superconducting circuit. In this way, quantum technology using superconducting artificial atoms has lead to an era when it is necessary to change the idea in circuit design, to make use of the quantum fluctuation which was only a very small correction term in the past in a leading role"

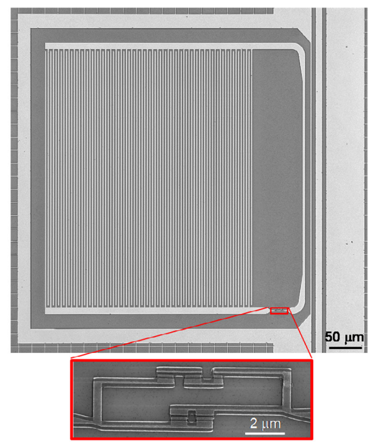


Fig.1 : The deep-strong-coupling circuit used in the experiments, consisting of an aluminum superconducting artificial atom (outlined in red) and an LC resonator circuit