

# Report on Completion of the Short-Stay Study Abroad Program

Name: Shuyu Shi

School and Dept.: School of Multidisciplinary Sciences, Department of Informatics

Present Year: Doctoral course 4th year of 5-year PhD course

Destination country: United States of America

Receiving univ./institute: Yale University, Yale Institute for Network Science

Period of study: 2014/07/01 – 2014/12/31

## A. Information regarding (or) A general description of the receiving university/institute

Yale University is a private Ivy League research university in New Haven, Connecticut, founded in 1701 as the "Collegiate School" by a group of Congregationalist ministers. Yale Institute for Network Science (YINS) is a newly-launched organization that facilitates interdisciplinary research on the scientific frontier of networked science.

## B. Preparation before leaving Japan

I knew the program from officemate in my research lab who has succeeded in application for this short-stay study abroad program two years ago. Therefore, when I received the announcement of application via email this year, I realized it is a great opportunity for me to work with some professors in my research area.

With the permission and recommendation of my supervisor, I contacted Prof. Wenjun Hu and asked her intention whether she can take me in as a visiting student in her group. She replied me with a definite answer. The next step for the application is to prepare the required documents on both sides of Yale and SOKENDAI including two recommendation letters, an invitation letter, personal statement, research proposal and TOFEL Test transcript. I also made some preparation for the research project.

## C. Study and/or research during the stay

I did not register any class in Yale. But I weekly attended a CE seminar series, which invited some experts in the research of Mobile Computing to give a talk. Also, during my visiting period, I also involved in two projects:

### 1. Optimizing Average-Maximum TTR Trade-off for Cognitive Radio Rendezvous

In cognitive radio (CR) networks, "TTR", a.k.a. time-to-rendezvous, is one of the most important metrics for evaluating the performance of a channel hopping (CH) rendezvous protocol, and it characterizes the rendezvous delay when two CRs perform channel hopping. There exists a trade-off of optimizing the average or maximum TTR in the CH rendezvous protocol design. On one

hand, the random CH protocol leads to the best “average” TTR without ensuring a finite “maximum” TTR (two CRs may never rendezvous in the worst case), or a high rendezvous diversity (multiple rendezvous channels). On the other hand, many sequence-based CH protocols ensure a finite maximum TTR (upper bound of TTR) and a high rendezvous diversity, while they inevitably yield a larger average TTR. In this paper, we strike a balance in the average-maximum TTR trade-off for CR rendezvous by leveraging the advantages of both random and sequence-based CH protocols. Inspired by the neighbor discovery problem, we establish a design framework of creating a wake-up schedule whereby every CR follows the sequence-based (or random) CH protocol in the awake (or asleep) mode. Analytical and simulation results show that the hybrid CH protocols under this framework are able to achieve a greatly improved average TTR as well as a low upper-bound of TTR, without sacrificing the rendezvous diversity.

## 2. Invisible Barcodes via Camera-display link

Human visual system cannot perceive the dynamics and motion beyond 60Hz, on the other hand, high frame refresh rate displays are becoming popular. We would like to design a new barcodes system, which can capture frames and decode data without any distraction to human visual system, when such barcode-embedded video is played at a high refresh rate display (120 fps and 240 fps). Also, high frequency contents like edges are easily detectable than low frequency component in an image, therefore, we can design a scheme to make the barcode-embedded images less intrusive to the video observer.

### D. Activities other than study or research during the stay

Since it only takes two hours to New York City from Yale University, I went there by train and visited some popular tourist attractions. like memorial site of the world trade center, Statue of Liberty, The Metropolitan Museum of Art, Wall Street, Fifth Avenue and etc. Also, I also visited Boston, where I went around the campus of Harvard and MIT.

### E. Expenses

As I stayed USA for six months, it was a better choice to rent a apartment rather than book a hotel. The leasing fee is \$700 per month. In addition, flight expense is about JYP 140,000. all of these can be covered by the budget of this program.

### F. Language at the receiving university/institute

I submitted the transcript of TOFEL iBT Test as a proof of my English ability.

### G. Things you found difficult (if any)

Language is the biggest obstacle when I communicated with these Natives.

## H. Advice for future applicants

I feel really fortunate that the short stay abroad program offers me such a great opportunity to collaborate with other researchers abroad, from which I have benefited a lot. Therefore, I highly recommend that eligible students of SOKENDAI apply for this program. I do believe that they can also gain research experience and broaden their vision through collaborative work with other professors via this program.