Spatiotemporal big data analysis based on social sensing

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The report outline

1. **Concept**
2. **Sensors for Social Sensing**
3. **Applications**
    - **Social media**
    - **Smartphone**
    - **Navigation Device**
    - **Video Surveillance**
    - **Wearable Device**
4. **Conclusions**

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1. Social Sensing—Concept

The ternary world (physical world, human society and cyber world) is a dynamic and open network society.

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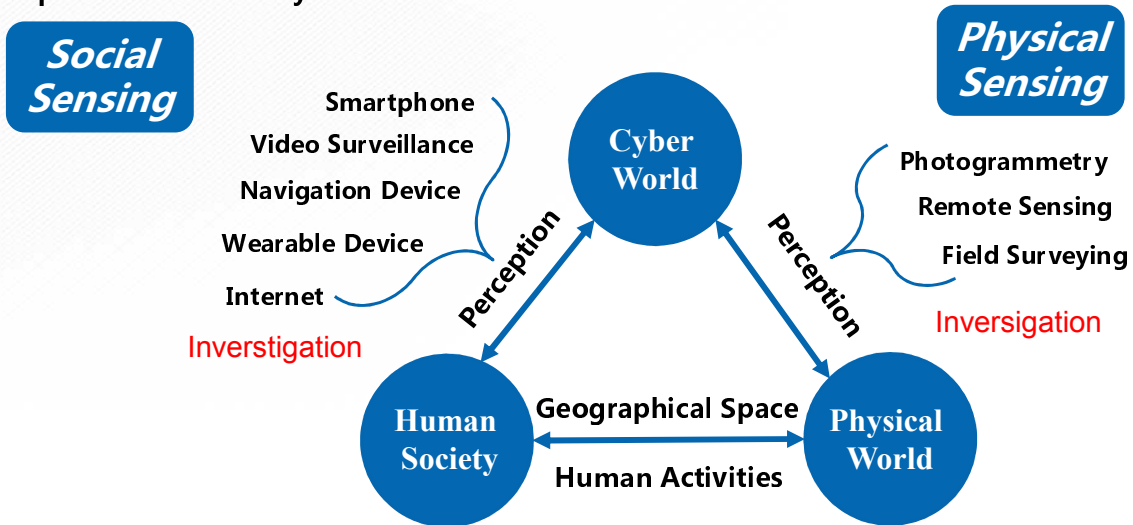
Remote Sensing vs Social Sensing

- **Remote Sensing**：based on different types of platform to obtain remote sensing signals, mainly used to obtain the information from the natural landscape.
- **Social Sensing**：based on the human as sensors to obtain the behavior patterns, revealing socio-economic factors.
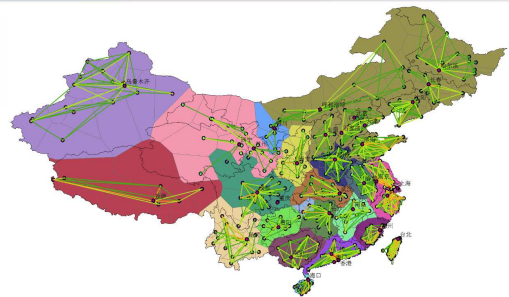

| Remote Sensing | + | Social Sensing | = | Better understand geographical space |

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1. Social Sensing—Concept

Macro Groups

To study the spatio-temporal behavior of human group, and reveal the human activities and socio-economic environments by using various means of social sensing.

Micro Individual

To Take people as the perceptual unit, and extract the spatio-temporal behavior patterns and relationship of human beings based on social sensing data.
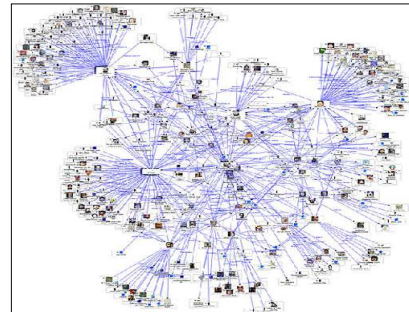
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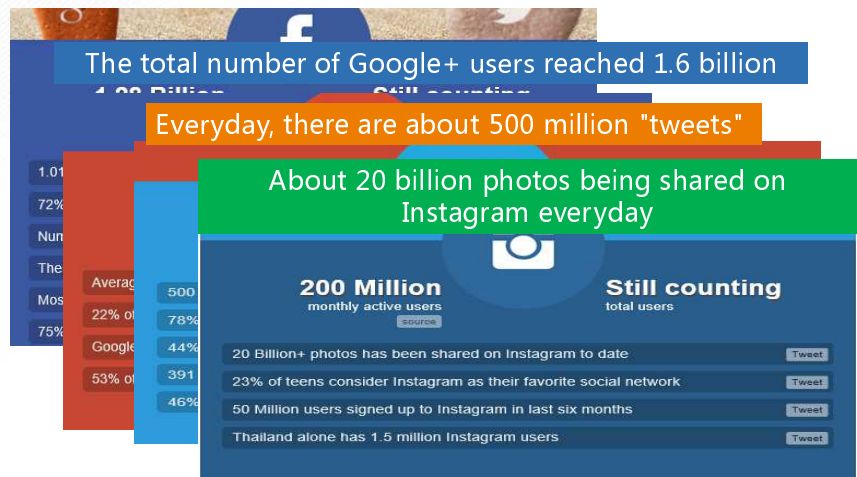   - **-Wearable Device**
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2. Social Sensing—Techniques

1) Internet(Web 2.0) social media

Facebook breaks through 1.28 billion for a month

The total number of Google+ users reached 1.6 billion

Everyday, there are about 500 million "tweets"

About 20 billion photos being shared on Instagram everyday

200 Million
monthly active users

Still counting
total users

20 Billion+ photos has been shared on Instagram to date   Tweet
23% of teens consider Instagram as their favorite social network   Tweet
50 Million users signed up to Instagram in last six months   Tweet
Thailand alone has 1.5 million Instagram users   Tweet

Massive social media and unstructured web

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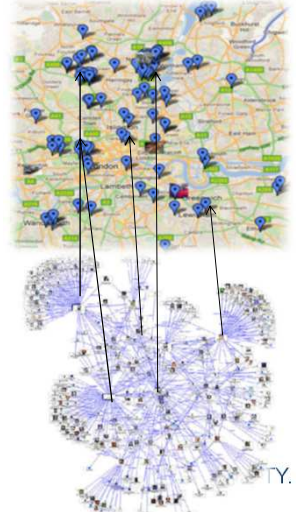
Social Sensing—Data

1) Social Media Data

More Time Dimension
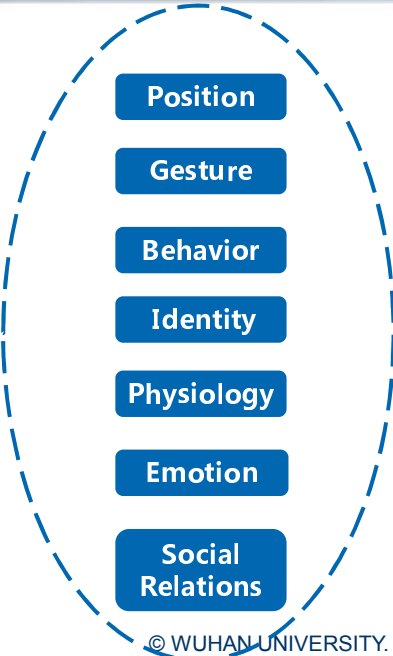
Rich Text Semantics

Social Network

2. Social Sensing—Techniques

2) Smartphone

Sensors:

Camera
GPS
INS
…..

Perception

Position

Gesture

Behavior

Identity
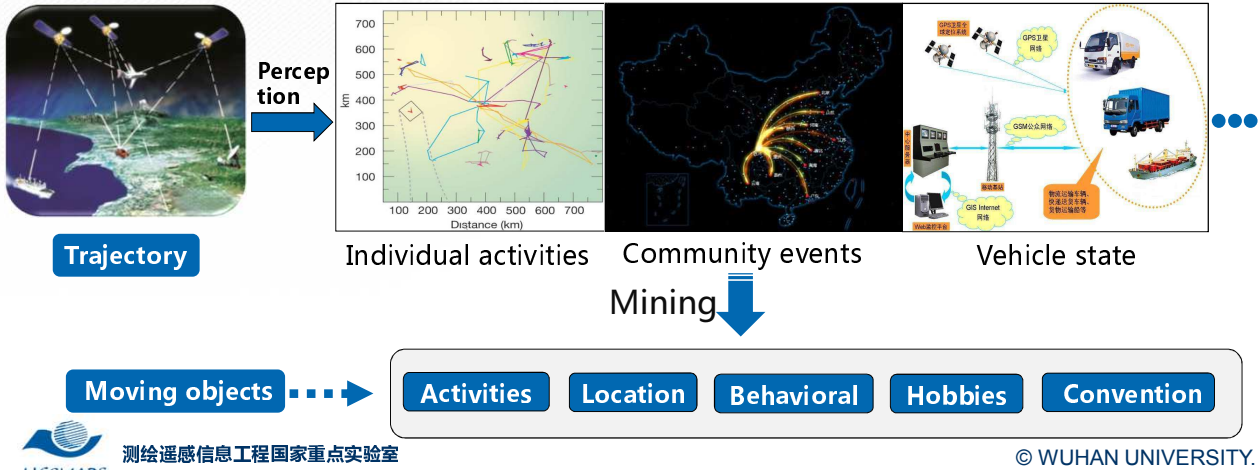
Physiology

Emotion

Social Relations

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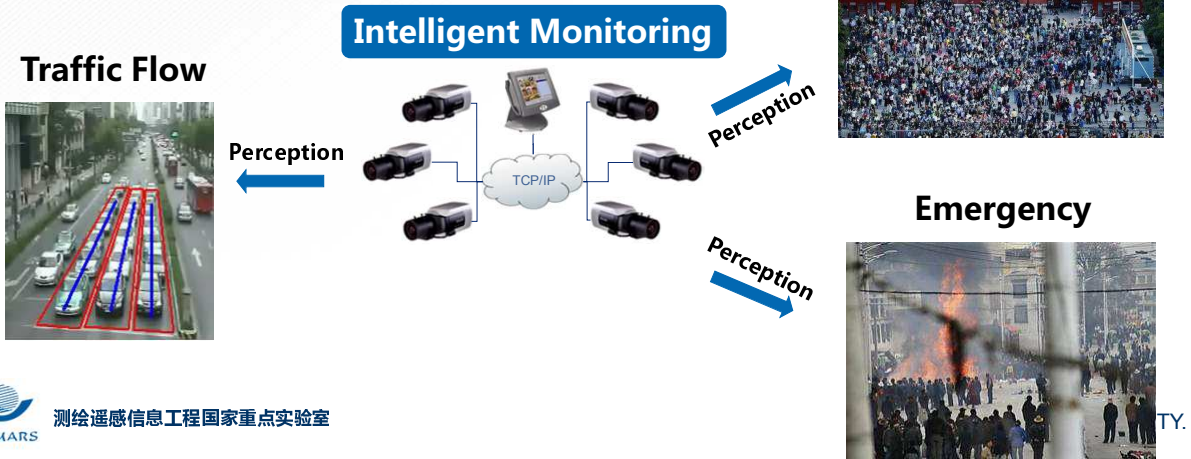## 2. Social Sensing—Techniques

3) Navigation Device

The user activity data (personal trajectory, group trajectory, vehicle trajectory) can be used to reflect the user's position and social preference by GNSS device.

Trajectory   Individual activities   Community events   Vehicle state

Percep tion

Mining

Moving objects ▸ ▸ ▸   **Activities**   **Location**   **Behavioral**   **Hobbies**   **Convention**

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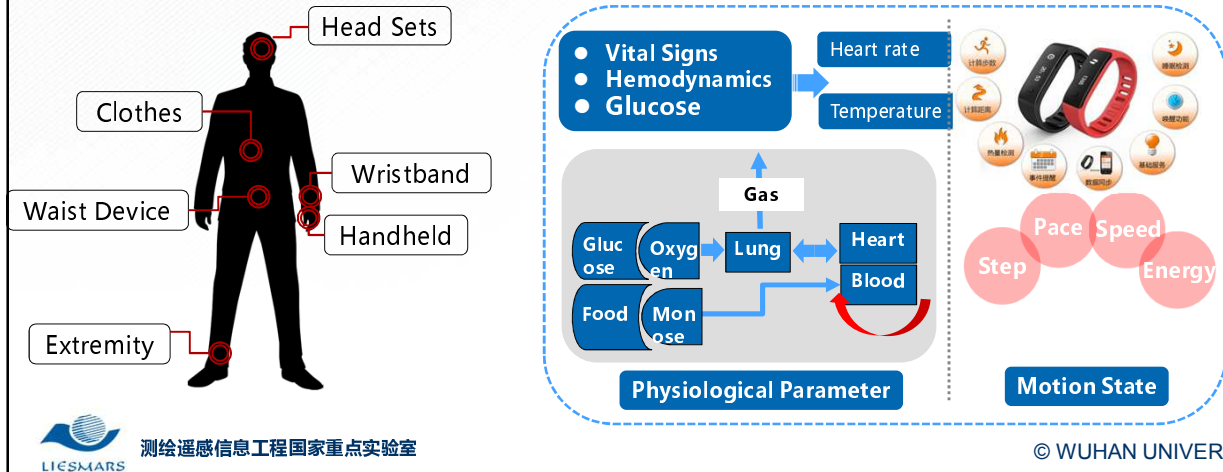## 2. Social Sensing—Techniques

4) Video Monitoring

China has installed more than 30 million surveillance cameras, producing thousands of PB(PetaByte) data each year. The number of video surveillance devices is growing at a rapid rate of more than 30%.

People Flow

Intelligent Monitoring

Traffic Flow

Perception

Perception

TCP/IP

Emergency

Perception

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2. Social Sensing—Techniques
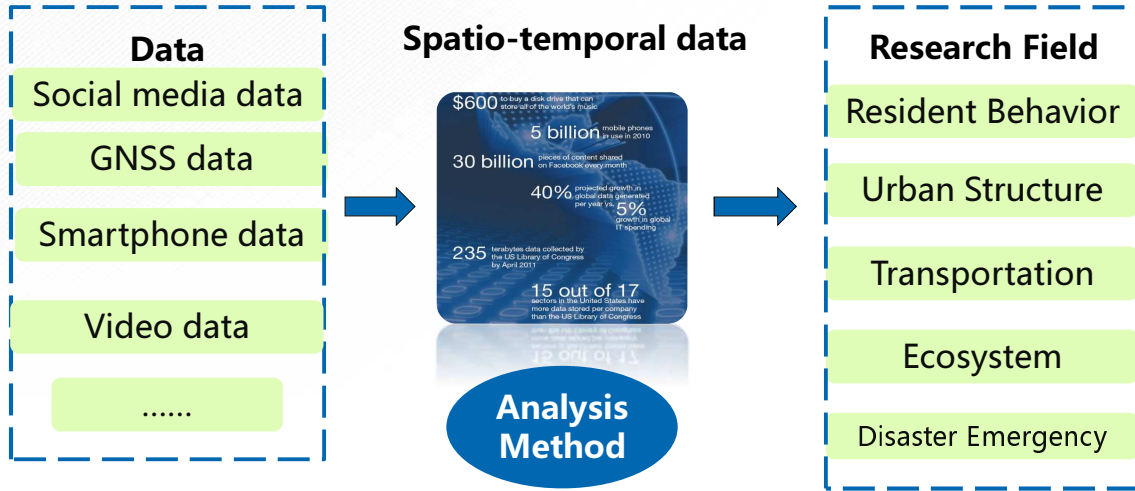
5) Wearable Device

The interactive form of wearable devices and human body is mainly based on the ability of human body and the built-in equipment, with the concept of "people-oriented".
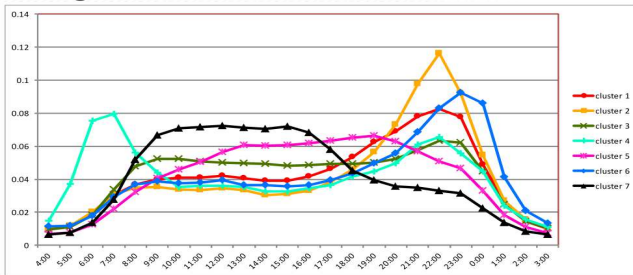

Head Sets

Clothes

Wristband

Waist Device

Handheld

Extremity

- Vital Signs
- Hemodynamics
- Glucose

Heart rate

Temperature

Gas

Glucose · Oxygen · Lung · Heart · Blood

Food · Monose

Physiological Parameter

Pace · Speed · Step · Energy

Motion State

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Social Sensing—Applications

Data
- Social media data
- GNSS data
- Smartphone data
- Video data
- ......

Spatio-temporal data

Analysis Method

Research Field
- Resident Behavior
- Urban Structure
- Transportation
- Ecosystem
- Disaster Emergency

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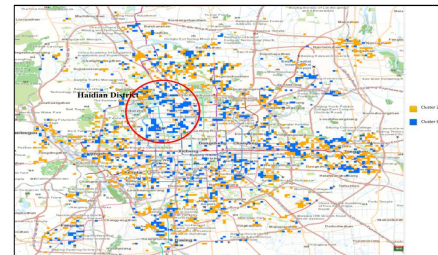
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Applications—Social media

Using Sina Weibo to detect urban function areas

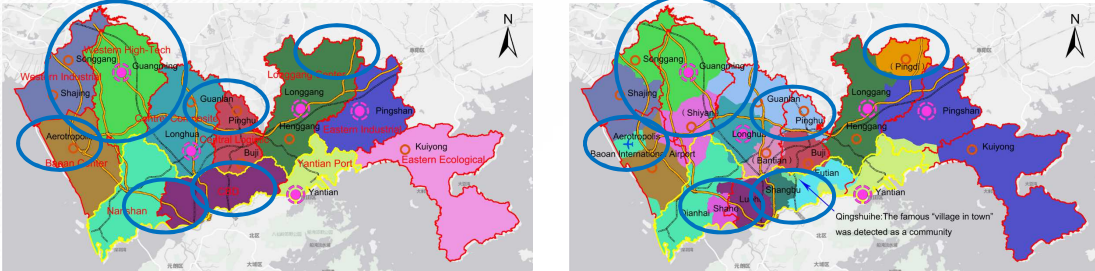Sina-Weibo daily (24 hours) temporal patterns of different clusters using K-means cluster algorithm

Residential areas(cluster 6)

Commercial areas and work areas(cluster 5)
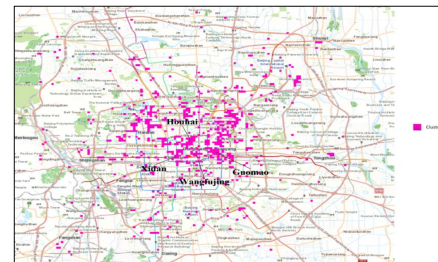
Applications—Smartphone

1)Urban Multi-center structure

> Multi-Center classification results of Shenzhen are consistent with that of human traffic generation.

> **2/3** crowd movement appears on the planned development belt

> The multi-center boundary is consistent with **70%** of the community boundary detected by population movement
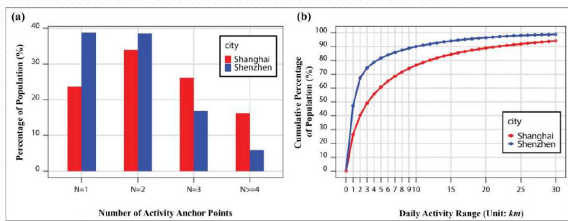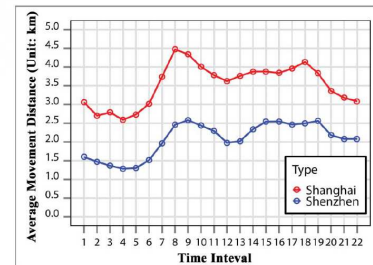
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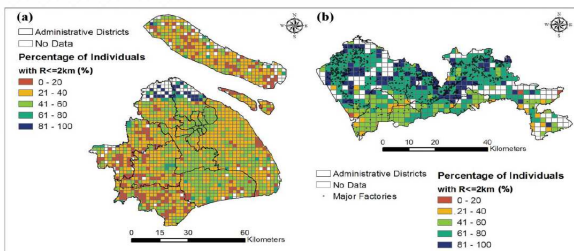© WUHAN UNIVERSITY.

Applications—Smartphone

2）Human activity Space

Distribution patterns of number of activity points and daily activity range

Temporal variation of average movement distance

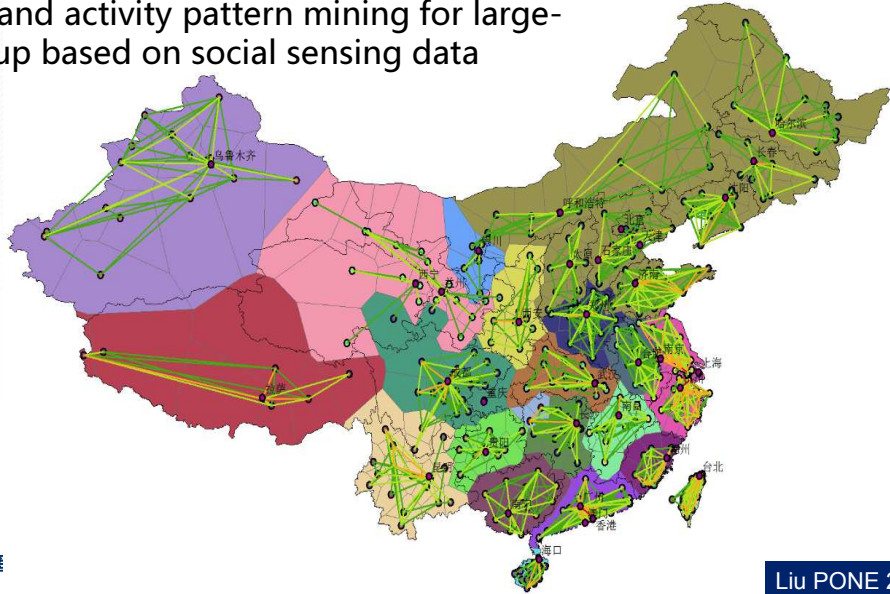Geographic distributions of individuals with daily activity range<2 km

The geographic disparity of people's travel range in Shenzhen and Shanghai is significant

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Applications—Smartphone

2) Human activity Space

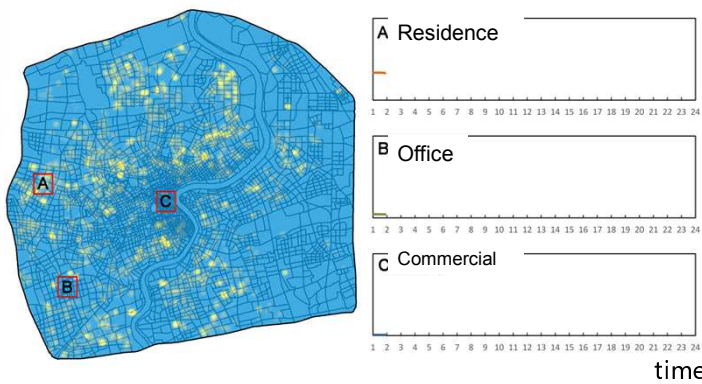Behavior and activity pattern mining for large-scale group based on social sensing data

Liu PONE 2014

Applications—Smartphone

3) An inversion method based on spatio-temporal behavior distribution pattern

The quantitative solution of the land use type and the degree of mixed land use is realized, which solves the problem of geo-spatial differentiation pattern inversion and provides scientific basis for urban and regional planning.

Dynamic change of activity distribution based on social sensing data

A Residence

B Office

C Commercial

time

Applications—Navigation Device

1) Urban Functional Network Extraction

(a) Nodes with three properties   (b) Kernel density map   (c) Contour map

(f) FCNLs   (e) Centroid of every cluster   (d) Aggregated contour lines
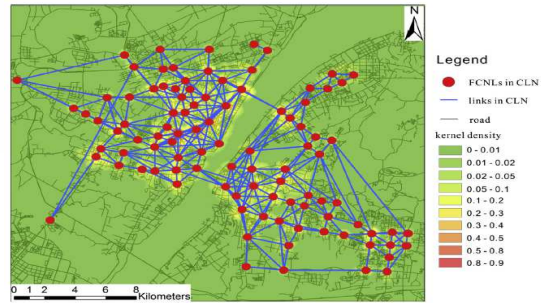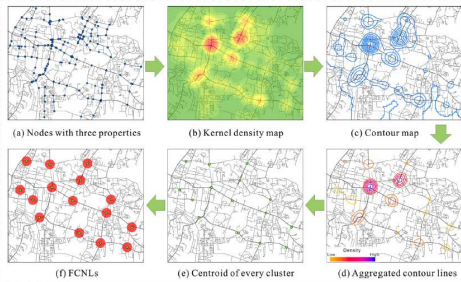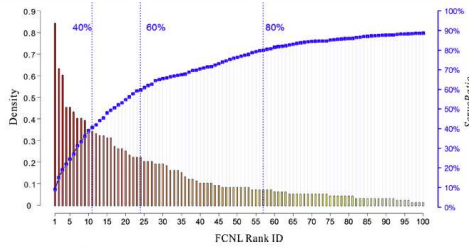

Fig. 5. The top 100 FCNLs in Wuhan at r18.

Fig. 6. Node density (bars) and ServeRatio (diamonds) as a function of FCNL rank order i in r18.

Yang ZHOU, *Zhixiang Fang**, Jean-Claude Thill, Qingquan Li, Yuguang Li. Functionally critical locations in an urban transportation network: Identification and space-time analysis using taxi trajectories. *Computers, Environment and Urban Systems,* 2015, 52, 34–47.

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Applications—Video Surveillance

1) Population density can be detected based on video data

For video real-time, dynamic and local characteristics, as well as the static and macro features of the geographical scene, combined with road network constraints, the population density of the blind area is deduced.
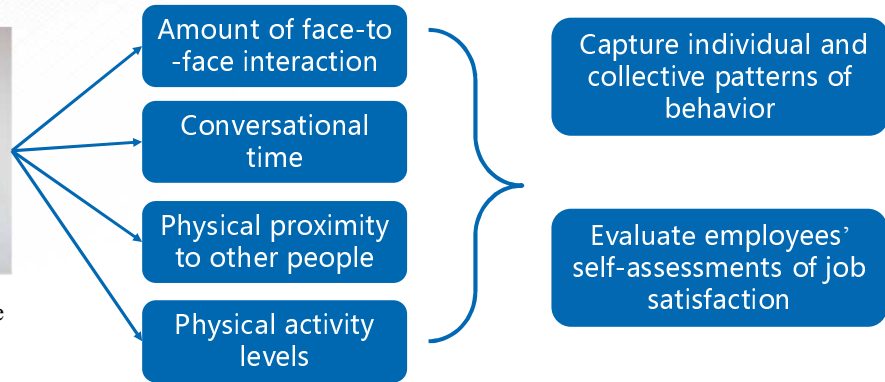

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Applications—Wearable Device

1） Personality and organizational behavior Analysis

By using the wearable social measurement sensor (Sociometric Badge), the data of individual movement, speech and proximity were sensed to analyzes the personality and organizational behavior of employees

Wearable sociometric badge

- Amount of face-to-face interaction
- Conversational time
- Physical proximity to other people
- Physical activity levels

- Capture individual and collective patterns of behavior
- Evaluate employees' self-assessments of job satisfaction

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Olguín et al. Sensible organizations: Technology and methodology for automatically measuring organizational behavior

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Applications—Wearable Device

2） Enhance social networking

To build and maintain social networks using wearable computing devices to enhance face-to-face social interaction in the real world.
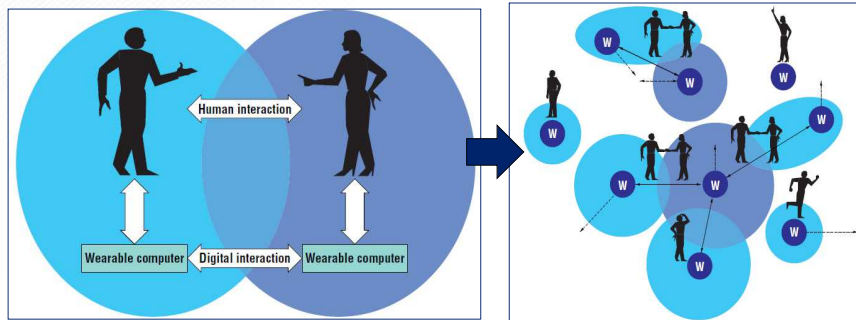
Augmenting social space with wearable computers.

A wearable community system

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LIESMARS

Kortuem G, Segall Z. Wearable communities: augmenting social networks with wearable computers

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4. Conclusions

Social sensing

- Social sensing has brought us a big data related to human.
- The big data spatiotemporal analysis is working for human's life, such as environment, emergency, economy, urban planning.
- Big Data：The next frontier for innovation, competition and productivity.

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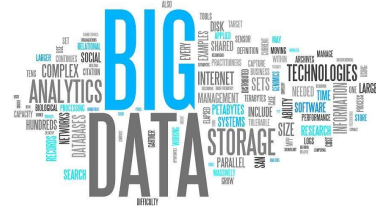
International Geocomputation Center for Social Sciences

Participants：

University of Chicago

Wuhan University

You are welcome to join us!

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Thank you!