


Lifestyle Logging with eButton
Results from Dietary and Physical Activity Assessment Studies

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- Knowing the real-life events of a person (lifestyle logging) is important for health monitoring
- Self-reporting is a standard method, but it is inaccurate and biased, and needs high data processing burden
- **Using wearable devices could be a solution**



Technological Gaps

Although there are hundreds of wearable sensors that evaluate physical activity, **there is no wearable sensor that directly and objectively evaluates diet in real life.**

We built a wearable computer **eButton** to document diet, physical activity and lifestyle



Generations of eButton 2008-2016



Mock Design, 2008



Version A, 2009



Version B, 2009



Version C, 2010, 62 mm



Version D, 2011, 60 mm, 46g



Version E, 2014, 70mm, 52g

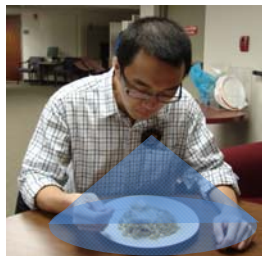


Version F, 2015, 52mm

Sensors within eButton

- Video camera(s)
- GPS – (associated with smartphone)
- 3-axis accelerometer
- 3-axis gyroscope
- 3-axis magnetometer } IMU (another set of IMU in smartphone)
- Temperature sensor
- Daylight sensor
- Barometer
- Microphone (also available in smartphone)

Dietary evaluation



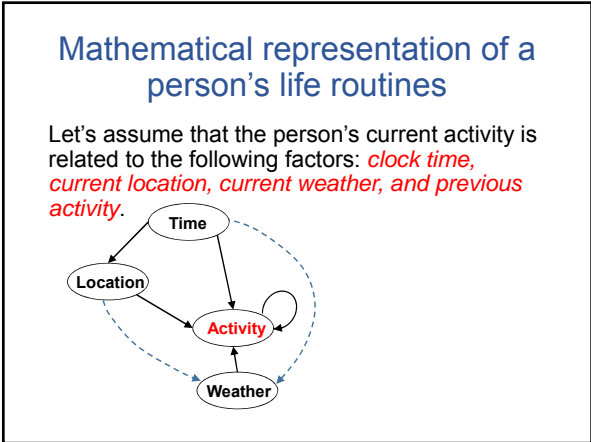
The Data Processing Problem

- eButton generates multiple forms of data
- Manual data reading requires tremendous efforts.
- Privacy is a serious concern because images and GPS data must be observed by another human (researcher).

Our Approach: Artificial Intelligence (AI)

To understand everyone's daily activity is difficult, but for each person, it is much easier.

So, eButton is personalized



Life routine matrices

Time \ Activity	Sleep	Going WC	Cooking	Eating	Transportation	Business	Outdoor Sports	Indoor Sports	TV watching	Shopping	Cleaning
7:00 am	5	4	4	3	0	0	2	1	3	0	1
8:00 am	4	5	5	5	4	1	2	0	0	0	3
9:00 am	0	2	0	4	5	5	0	0	0	0	0
10:00am	0	2	0	1	2	5	0	1	0	0	0
• • • • •											
9:00 pm	0	2	3	3	3	2	4	4	5	4	4
10:00pm	2	3	1	2	2	2	2	4	5	3	3
11:00pm	4	4	0	1	1	2	1	3	5	1	2
12:00am	5	4	0	0	1	1	1	2	4	1	1

Assume:
 1. Workday
 2. Summer
 3. Rating range 0-5

Relationships between Location-Activity

Location \ Activity	Sleep	Going WC	Cooking	Eating	Transportation	Business	Outdoor Sports	Indoor Sports	TV watching	Shopping	Cleaning
Bedroom	5	0	0	3	0	2	0	0	4	0	3
Restroom	0	5	0	1	0	1	0	0	0	0	4
Kitchen	0	0	5	5	0	2	0	0	3	0	5
Livingroom	0	0	0	3	0	2	0	4	5	0	3
• • • • •											
Office	3	0	3	3	0	5	0	2	0	0	3
Restaurant	0	0	0	5	0	1	0	0	2	0	0
Store	0	0	0	2	0	0	0	0	2	5	0
Gym	0	0	0	2	0	0	0	1	4	0	0
Car	0	0	0	3	5	0	0	0	0	0	2

Relationships between Activity-Activity

Activity \ Activity	Sleep	Going WC	Cooking	Eating	Transportation	Business	Outdoor Sports	Indoor Sports	TV watching	Shopping	Cleaning
Sleep	0	5	4	3	3	2	2	2	4	0	1
Going WC	4	0	4	1	3	3	3	3	3	3	3
Cooking	0	3	0	5	1	0	0	0	4	1	3
Eating		4	0	0							3
• • • • •											
Outdoor sports	3	3	2	3	3	2	2	1	1	2	1
Indoor sports	3	3	3	3	3	3	2	1	3	2	1
TV watching	4	3		3	3	2	3	3	1	2	2
Shopping	0	3		3	5	1	2	2	1	3	1
Cleaning		3	2	3	2	2	1	2	3	1	2

Assume: Red activity precedes white activity

Relationships between Weather-Activity

Weather	Activity	Sleep	Going WC	Cooking	Eating	Transportation	Business	Outdoor Sports	Indoor Sports	TV watching	Shopping	Cleaning
Normal						5	4				4	
Rain						4	1				3	
Foggy						3	2				3	
Hot						4	2				3	
Windy						4	3				3	

- Assume:
1. Workday
 2. Summer

What am I doing? make an intelligent guess by eButton

AI-based image reading

- We extract information from image tags to **understand** eButton acquired images
- The extracted information is further integrated with that from **personal life routines** and other **sensor data** to improve event detection accuracy



Tags from Computer Reading

car, vehicle, transportation system, exhibition, chrome, luxury, light, fast, show, classic, drive, road, headlight



Tags:

computer, screen, technology, business, indoor, light, laptop, room, no person, lamp, people, telephone, internet



Tags:

coffee, no person, indoors, drink, espresso, dark, food, breakfast, one



Tags:

furniture, indoors, people, room, adult, table, one, restaurant, food, seat, woman, hotel, man, drink



Tags:

group, adult, meeting, indoors, flatware, wood, grow, table, dairy product, spoon



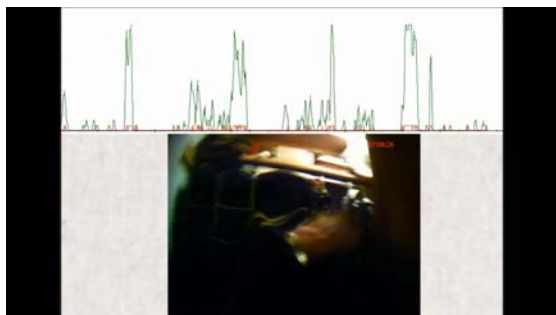
Tags:

Adult, commerce, man, woman, one, stock, wear, group, indoors, market, vehicle, shopping, industry, business

An Example

- A 67-year-old woman has a part-time job after retirement
- The duration of data is 12.5 hours between 7:06am and 21:22 pm
- It contains different activities, including eating, walking, computer work, shopping, driving, gym exercise, yard work, etc
- Totally number of processed pictures is 4490
- Each picture has 20 tags
- The number of unique tags is 804

12-Hour Video and Result



Future direction

Fully implementing AI-based lifestyle logging system
