Psychological Type Oriented Adaptive 3D Map in the Mobility

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Abstract Navigation systems and maps are very useful for a visitor to attain to the destination. However the visitor should find out the target building by himself/herself after the navigation is done. It is sometimes difficult for the visitor to do so in hard environments such that a road has no name and the margin of error of GPS is bigger than the width of the block in a city. Both functions of a map and communication between the user and the map become more important in such hard environments. Adaptive guides corresponding to the psychological preferences make the communication better. In this paper we propose three types of 3D maps based on psychological preference in the mobility and a methodology for adapting to the psychological types of user. 3D maps that supplies spatial information corresponding to the psychological types are also discussed. We evaluated the 3D maps and discuss how the 3D maps works for the users.

Keywords: adaptive 3D map, psychological preference type, mobility, navigation system, mashup.

1 INTRODUCTION

Navigation systems (NAVI) in car navigation systems, PC, PND and cell phones [7, 8] are useful not only for driving a car but also for walking. However NAVI guides a user only to a place near the destination in Japan since most roads have no name and the margin of error of GPS (Global Positioning System) is sometimes bigger than the width of the block in a city. The user has to discover a target building that has an address in the block. Then communication between human and a map of NAVI becomes very important near the destination. Human has psychological preferences and personality. Adaptive guides for the psychological preferences make the communication easy.

In this paper we propose three psychological types in mobility (a)intuition, (b)rationality and (c)thinking based on MBTI [1] in order to reduce the communication gap. We also propose symbolized 3D map with the altitude corresponding to the psychological types and a method for mashing up them in a Google map [7] in order not to loose the direction on a slanted ground and to find the target building in spite of hard conditions like night etc.

2 THE CHANGE OF ENVIRONMENTS AND PSYCHOLOGICAL TYPES IN THE MOBILITY

The environments for ubiquitous computing have been built in order to solve issues based on sensor networks and web sites. Lots kinds of basic information and useful information in a specific condition are utilized for the solution. However the environment changes every moment.

2.1 The change of environments and misrecognition

Lots of people live in slanted lands next to flat lands in Japan since Japan has small flat ground (30m times 30m /person) and large mountain lands. There are complex junctions and near-by corners in a small area in the slanted lands and at the foot of a mountain.

Navigation systems (NAVI) have been popular for not only driving a car but also walking etc. However NAVI guides a user only to a place near the destination both in a residential area and in an office area with crowded tall buildings in Japan because of roads with no name and the margin of error of GPS. The user has to discover a target building that has an address in the block by himself/herself.

On the other hand there are many persons who easily loose their ways. People sometimes loose the direction in hard environments. Human's ability for the mobility is lowered in hard environments.

NAVI finds the shortest root for a given destination by tracing connections of the roads even if the route would include the complex junctions with narrow roads. The mobility often becomes hard both at night and in a rainy day.

The major hard environments are (i) to (viii).

(i) Continual small changes: The slanted land with curved roads,
(ii) Daily difficulties in nature: Night
(iii) Natural phenomenon and sudden events: Rain, snow and road works
(iv) Duplication problems. Duplication of address: Many buildings locate in the same address
(v) Similar names: Sato building, Saito building
(vi) View problems. Out of view: An entrance behind the block or behind buildings.
(vii) Psychological effects: Fear, anxiety of getting lost
(viii) Differences with some predictions based on the description of map.

Suitable complementary information should be added so as to adapt for the hard changes.

2.2 Psychological types in mobility

Carl Gustav Jung found that human has psychological preferences that influence ways for processing information, making decisions, and perceiving the environments [2].

The communication between a user and a map of NAVI is indispensable in the hard environments after the end of navigation. Human has each character and wavers in unfamiliar situations. Human acts based on his/her true nature in the hard situation. He/she chooses the reliable way for himself/herself to start communication with a map corresponding to his/her psychological preference and disquiet (refer to Fig. 1). He/she also tries to reduce misrecognition both of geometry information in the map and of landmarks in the real route.

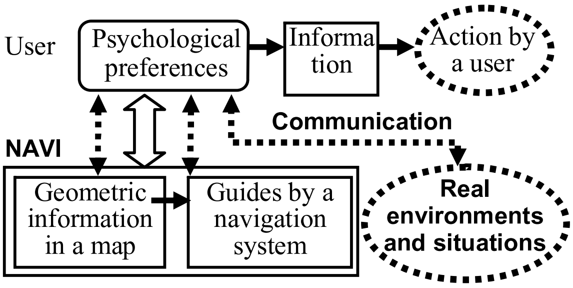


Fig. 1 Communication between a user with psychological preferences and a navigation system

Human can easily understand a message from the others and reduce the communication gap with them if human could consider the differences between psychological preferences each other.

C. G. Jung proposed the existence of two dichotomous pairs of cognitive functions [2]:

- The "rational" (judging) functions: thinking and feeling
- The "irrational" (perceiving) functions: sensing and intuition

The Myers-Briggs Type Indicator (MBTI) assessment is a psychometric questionnaire designed to measure psychological preferences in how people perceive the world and make decisions [1]. These preferences were extrapolated from the typological theories originated by C. G. Jung. The MBTI sorts some of psychological differences into four opposite pairs, or "dichotomies," with a resulting 16 possible psychological types.

We propose three psychological types (a) to (c) for the communication in the mobility based on MBTI in order to allow users to easily understanding both geographic information and the environments and to reduce communication gaps between a user and a navigation system with maps.

(a) Intuition: only key information concerning both the destination and the direction are enough for the communication

(b) Rationality: essentials of geographic information for the mobility are prepared for the communication.

(c) Thinking: detailed information for the mobility in many kinds of case is required for avoiding many kinds of risks.

3 ADAPTIVE NAVIGATION BY SYMBOLIZED 3D MAP

People can easily reach near the destination by NAVI. They must find out the target building by themselves with an address in the block in Japan. It becomes harder for them to do so in hard environment like darkness at night.

3.1 Adaptive navigation corresponding to psychological preferences

A visitor tries to discover a clue for the right recognition of the surroundings and to get the geographic idea of the target building in the whole area in the hard environments. He/she should also take care of avoiding both dangers and risks that are caused by his/her actions. The visitor chooses the reliable way to acquire useful information in hard environments according to his/her psychological preferences. The psychological preferences are classified into some different types. A psychological preference type of a user often changes into the other type according to user's low capability of consulting maps and the hard environments.

Adaptive guides for psychological preferences make the communication better. NAVI should adjust its type of psychological preference to the type of user (refer to Fig. 2).

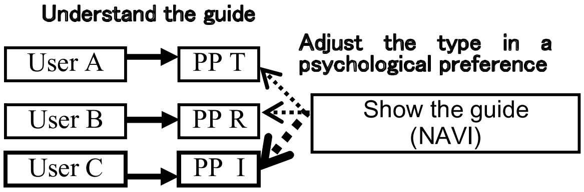


Fig. 2 Psychological preferences for processing based on the ability

NAVI should also adapt for the change of psychological preference type of the user that has changed in a hard environment (refer to Fig. 3). The anxiety of getting lost also changes the type.

User C that can not consult with a map needs the detailed guide and expects to easily recognize the surroundings with landmarks. NAVI should show the user key landmarks and road conditions in order to easily find the landmarks and to map them into the real surroundings.

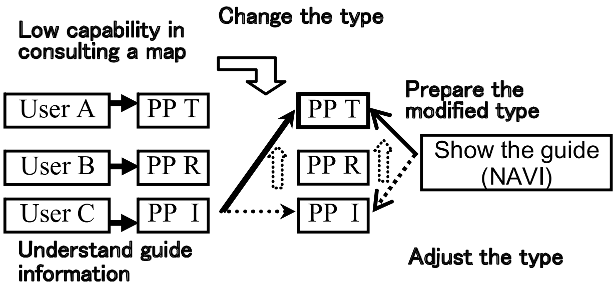


Fig. 3 Preparing navigation for the modified type of Psychological preferences

3.2 Three types of simple 3D MAP corresponding to the type of psychological preference

People can understand the geographic information in a map easier than that in a text. Maps are useful much more than navigation in order to find the target building since navigation systems only shows a point near the target building in Japan. People usually use minute maps and aerial photographs (refer to Fig. 4, 5) in order to know a route to the destination. However an intuitive image of 3D structure of installations like an entrance of highway can not be recognized with such minute maps.

Fig. 4 An example of Google map

Fig. 5 An example of aerial photograph in Google map

3D map in a car navigation system shows intuitive image of 3D structure of an entrance of superhighway. The 3D maps are usually prepared for important spots like intersections and superhighways. Bing map shows buildings in 3D map in Tokyo and major cities (refer to Fig. 6)[9]. However ordinary 3D maps, Bing maps and even Street-view of google maps can not represent the detailed altitude of ground. Curved slopes, steep slopes, stairs by stones and complex roads in the slanted ground often make a visitor loose the direction and enter a dangerous spot. Adaptive guides with 3D maps corresponding to psychological preferences of the user make the communication easier even in such hard environments.

We propose adaptive 3D maps that supply a user with both geographical features and spatial information by symbolized roads with the altitude and warnings corresponding to his/her ability. Lots of people live in the slanted lands in Japan. It is not easy for a visitor to find the target building in such environments. We discuss 3D maps for the slanting land in order to easily reach the target building.

Important geographic information in a map in hard environments is classified into ten categories (1) to (10). (1)direction, (2)distance, (3)landmark, (4)intersection, (5)corner, (6)direction of the slant of land, (7) the degree of inclination of slope, (8)width of road, (9)danger, (10)risk

We propose three types of symbolized 3D maps corresponding to the type of psychological preferences.

(a)3D MAP-intuition: Only key information such as the direction to the destination, a list of corners to change direction, landmarks, and direction of the slant of land are shown (refer to Fig. 7). A higher road is described as a wider road. The lower parts of a down road are described in narrow. The Prefecture (State) roads are surrounded in yellow and major roads are surrounded in pink.

(b) 3D MAP-rationality: Essentials of geographic information from (1) to (6) for the mobility are prepared for the communication (refer to Fig. 8). The user can get the idea of route with the accurate distance with a few tens meter ruler.

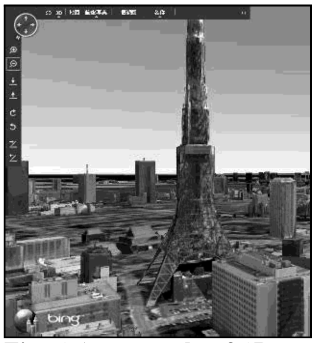


Fig. 6 An example of 3D map of Bing maps

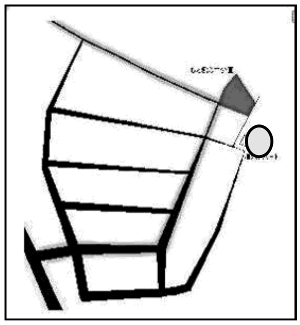


Fig. 7 A 3D map-intuition corresponding to intuition psycho-logical type

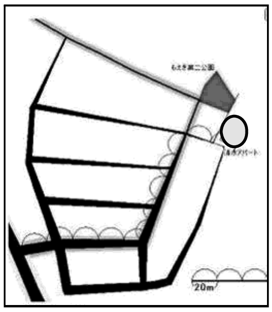


Fig. 8 3D Map-rationality

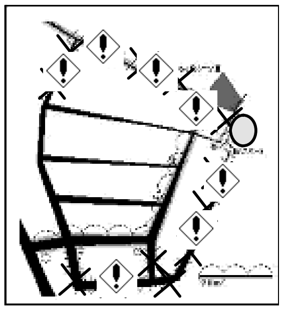


Fig.9 3D Map-thinking

(c) 3D MAP-thinking: Essentials of geographic information and warnings in many kinds of cases are shown for the user in order to avoid typical risks and to recover the wrong actions. The information from (1) to (10) is shown in the 3D map as a help information (refer to Fig.9). A user that looses his/her way could avoid the risks by risk icons in the 3D map.

Major functions of the 3D maps for each psychological type in the mobility are (1) to (7).

■3D Map-intuition

(1)Geographical features. The widest road shows the highest road. The wider road is the higher road. A visitor can easily get the intuitive idea of the geographical features with major roads near the destination.

(2)Ensure the direction. A visitor often looses the direction after going down on the curved road in order to discover the target building. He/she can easily get the intuitive idea concerning direction of the slant of land in the 3D maps and can ensure the direction by the feeling of gravitation in the real world. He/she can also make a correspondence between 3D map and the real slope. A user that can consult a map easily finds a favorite root.

■3D Map-rationality

(3)Near-by corners. NAVI can not show an accurate guide in case that the margin of error of GPS (Global Positioning

System) is bigger than the distance between corners. The visitor can ensure the target corners by twenty meter ruler based on the distance between the related corners even if there would be many corners in a small area (refer to Fig. 8).

(4)Avoid passing the point with accurate distance. It is not easy for a visitor to find the target building if there would be no sign near the target building. A visitor can check the distance from the landmark by the few tens meter ruler and can avoid passing the point in the route (refer to Fig. 8).

■3D Map-thinking
(5)Discovery and recovery of passing the point. A visitor can notice that he/she passed the target point when he/she finds a landmark like a park if he/she would know that the park means passing the target point (refer to Fig.9). Then he/she can start the recovery of passing the target point.

(6)Avoid risks. A visitor must go up the steep slope if he/she would happen to go down on a curved road into a place under the cliff that has one or two entrances of path up to target area. It is not easy for him/her to find the entrance since he/she must choose the right path at a junction on the way back. The visitor could not often notice the existence of the other branch roads at the junction when he/she went down on the curved road. He/she surprises at the branch roads at the junction in the way back. Then it is difficult for him/her to choose the right road. 3D Map-thinking shows users such roads with the risk marks like "×" or "⚠" in order to avoid wandering into the risk area (refer to Fig.9). Visitors can ensure the safe route avoiding the risks.
(7)No sense of direction. Even a visitor who has no sense of direction can finds a route along the edge like a cliff and reaches the target building without getting lost. He/she only go along the edge after he/she reaches a point in the edge (refer to Fig.9 and Fig.14).

4 MASH-UPING MINUTE MAPS AND SYMBOLIZED 3D MAPS

Maps are very useful for showing the location of points of interest (POIs) [3]. People usually use a minute map and an aerial photograph for this purpose. Google map has excellent functions for this purpose.

Car navigations and pedestrian navigations are kinds of new applications of maps which need new functions. The views in photo at an intersection allows user to easily find the right route without fails. 3D maps are very useful for represent 3D spatial information in some situations such as showing both the entrance and the right lane at a junction into a superhighway. New types of information for new application should be supplied on demand. The navigation in hard environments is belonging to this type. A 3D map for a slope is a good example.

We propose a mush-up system [5, 6] so as to show 3D maps in an balloon for the destination in a minute map by Google (refer to Fig.10). The user can easily map the roads in the symbolized 3D map to those in the ordinary map since the symbolized map is displayed over the target area.

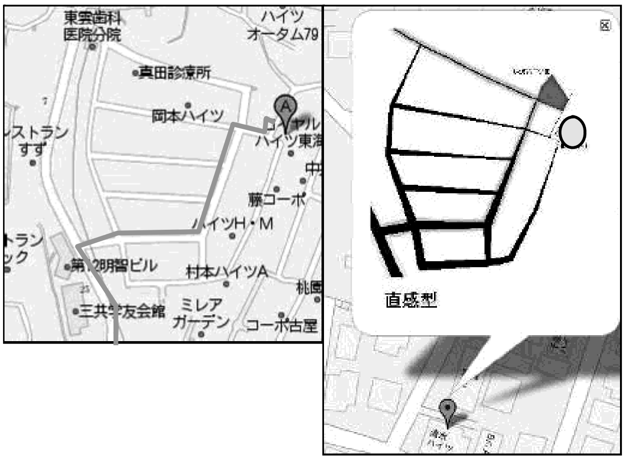


Fig.10 Mash-up with a minute map and 3D maps (3D Map-intuition)

A user can choose one of three psychological preference types of 3D maps corresponding to his/her psychological preference type that is decided based on both the trip ability of the user and the hard environments.

5 EVALUATION

We evaluated the three types of symbolized 3D Maps comparing with Google map and NAVITIME map.

■**Subject**: Subjects are eight men (7 in their 20s one in his 50s) and one woman (in her 20s).

Test 1. Altitude. Can a user recognize the altitude of slope in either Googlemap or abstracted 3D maps ?
(Refer to Fig.11 and Fig.12)
Results 1. All subjects could not feel the altitude in a Google map (refer to Fig.11). All subjects except one subject could recognize the altitude in 3D map-intuition (refer to Fig.12). The one subject could not recognize the altitude exactly since there is no exact value of the degrees of an inclination in the map. He requested

Fig.11 An example of Google map

Fig.12 3D map-intuition in the annotation of the destination

additional explanation of the inclination in the 3D map. We found that the map had to display the meanings in it for such a user.

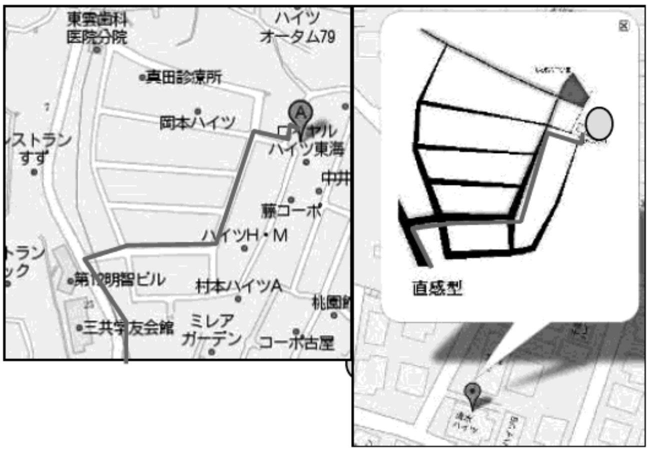
Test 2. Feature of ground. Can a user get an image of geographic feature of the ground?
Results 2. All subjects could not get the image of feature of ground in the Google map but could get the image of the feature in the 3D map-intuition (refer to Fig.11, 12).

Test 3. Distance. Can a user know the accurate distance between corners and intersections?
Results 3. All subjects could not know the distance in the Google map but could know the accurate distance between corners by the 20 meter ruler in the 3D map- rationality (refer to Fig.13 (c)).

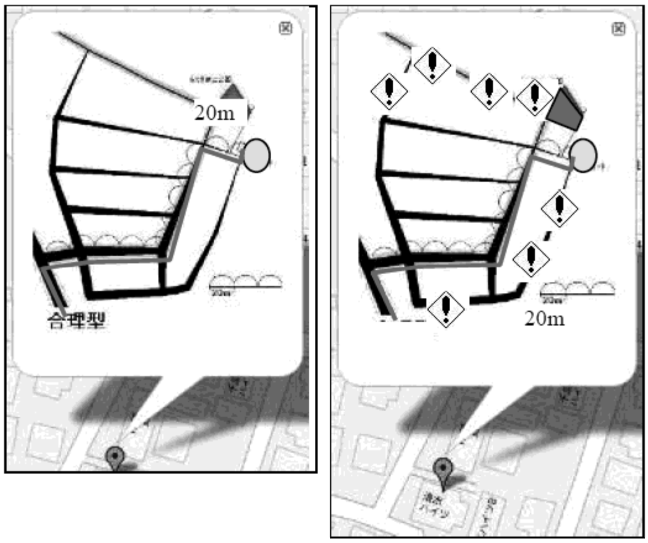
Test 4. Start a trip. Can a user of the maps start a trip and reach the target building without loosing his/her way?
Results 4. Six subjects answered that they could start the trip with Google map (refer to Fig.13 (a)). Two of them were confident of reaching the target building since they were good riders either of bicycle or car and had experiences of many trips. The other subjects did not have any confidence of reaching the building. Three subjects did not expect start with the Google map. They needed more geographic information for the start.

All subjects answered “yes” for starting the trip with 3D map-rationality. Three subjects were full of confidence that they could reach the building since they could know the accurate distance between corners by the 20 meter ruler (refer to Fig.13 (c)).

Test 5. Notice risks and have fear of dangers
Results 5. Three subjects could feel relieved about ensuring areas with risks in the 3D map-thinking (refer to Fig.13 (d)). One subject did not need information concerning danger since he was a good rider of bicycle and could go anywhere without loosing his ways.



(a) Route guide in Google map (b) Mash-up with a minute map and **3D Map-intuition**



(c) Mash-up with a minute map and 3D Map-rationality (d) Mash-up with a minute map and **3D Map-thinking**

Fig.13: 3D maps corresponding to psychological types

Test 6. Avoid getting lost by going along the edge
Results 6. One wise subject that always looses his way proposed a route that utilizes the edge like a cliff in spite that there are marks of risks on the route (refer to Fig.14). He expected to turn right at the first corner and to go to the edge since he only kept going along the edge to the destination after he reached the edge.

■ Discussion. We propose three types of 3D map representation to provide required and sufficient information for a visitor based on the psychological preference such as intuition, rationality and thinking**.** Information to be displayed is controlled to tell the users only the truly required information since a visitor does not need too much detailed information. A visitor who easily looses his/her way usually is a user of 3D Map-thinking. We found that the wise subject in Test 6 is a kind of special user of 3D Map-thinking since he basically believes that he usually looses his way. 3D Map-thinking should provide both the shortest route and

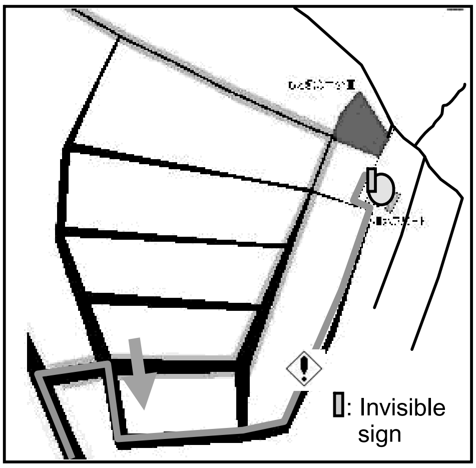


Fig.14 A safe route along the edge without loosing ways

of the controlled display is the sign of the target the safe route for such a special visitor. The other reason apartment could not be seen from the safe route. 3D Map-thinking should not display the sign with the safe route. The special visitor can not find the sign and passes over the apartment. Unfortunately he un-intentionally goes down into a curved narrow road and notices that he lost his way after a while. He can not recognize the right road to return on his way back at the intersection that he passed.

Most people that choose the shorter route avoid the safe route in the wrong direction. They feel dread when he entered into a narrow side road that is also a curved road if they would choose this road. Many of them need not such information in 3D map-intuition and 3D map-rationality.

6. CONCLUSION

A visitor should find out the target building even in the hard environments at the destination where a navigation system brings the visitor. He/she communicates with maps based on his/her psychological preferences then. We propose three types of psychological preferences in the mobility (a) intuition, (b) rationality, and (c) thinking based on MBTI in order to allow the user to easily acquire key information for the mobility. A visitor feels fear and easily changes into the different type when he looses the direction either in the night or at the curved slope etc. We also propose three types of adaptive symbolized 3D maps corresponding to the three types of psychological preferences in order to supplies the user with the altitude, the feature of ground like a slope, near-by corners and dangers etc.

We tested the adaptive 3D maps for eight subjects. All subjects could get an image of the slanted slope and the altitude in the 3D maps. All subjects also answered that they could start the trip with 3D map-rationality. Three subjects were full of confidence that they could reach the building since they could know the accurate distance between corners by the 20 meter ruler. Three subjects could feel relieved about ensuring areas with risks in the 3D map-thinking. We could ensure the usefulness of the 3D maps corresponding to the three types of psychological preferences in the mobility.

We would like to investigate on navigation systems that can flexibly adapt for a variety of change of psychological preferences in future.

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