Technical Report Series of DCGI, Volume 1, Year 2018

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Supplementary Material: Situations Classification, Evaluation, Route Examples

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CS–TR–DCGI–2018–1 March 2018

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Funding Acknowledgements

The research has been supported by projects: Navigation of handicapped people funded by grant no. SGS16/236/OHK3/3T/13; Automated mapping of routes and barriers for pedestrians and disabled people funded by grant no. TH02010839 of the Technology Agency of the Czech Republic realized by Central European Data Agency, a.s.

Technical Report Series of DCGI, available at http://dcgi.fel.cvut.cz/techreps, Department of Computer Graphics and Interaction, Czech Technical University in Prague, Faculty of Electrical Engineering, Czech Republic.

ISSN 1805-6180

Abstract

This technical report provides extended data on classification of situations in navigation of people with visual impairment in public transport and intermodal navigation in general. Here, you can find, what could not be fit into our paper: Indoor-Outdoor Intermodal Sidewalk-based Navigation Instructions for Pedestrians with Visual Impairments.

Keywords

technical report, navigation, blind, experiment data, evaluation, classification, cannot-fit-in-paper

Contents

1 Situations and Environment Classification

Following sections describe our contribution to classification of situations people with visual impairment encounter in urban navigation. Further, we classify environments in which these situations can happen.

In this section are identified various situations in pedestrian navigation within multiple modes of transport. Different types of environment are also classified. Methodology for descripting these situation was designed with respect to principles of landmark-enhanced navigation instructions.

1.1 Environment classification

Change of the environment can mean to go from exterior inside some building or vice versa. But the problem of changing environments is not only within classical indoor and outdoor. There are also semi-outdoor and semi-indoor environments. Whenever user changed environment, the system should give user information about this environment. This information should contain structured description about space characteristics, to help user to create mental map of this space, followed by information about next action.

1.1.1 Indoor

Buildings

Properties:

- Name of the building
- Additional info - type of building (e.g. historical building), building is under reconstruction, building has not typical shape of corridors (e.g. corridors are not perpendicular)
- Door accessibility information – information about the method of opening the door (e.g. if chip or card is needed).
- Reception position – where is the reception after entering the building.

Description: {Name of the building}, {Additional info}. Building has {number} floors. In building {is/is not} lift. {Door accessibility information}. {Reception position}.

Railway station buildings

Railway station buildings especially the main stations in cities are very complicated indoor environments, so we consider it as typical indoor environment.

User can typically enter/exit the building from more entrances/exits, he should get the information about the shape of the building, where he can find the ticket office and information

stand. Then the route towards platforms, or exit (depends whether he arrived or he is departing) with respect to his position, i.e. from each entrance or from platforms.

Properties:

- Station name
- Building characteristics - shape and brief characteristic of station building
- Type of station - passable/not passable
- Ticket office - Position of ticket office and information stand
- Access to platforms - with respect to current position, there can level or off-level access to platforms.
- Numbering of platforms
- Acoustic beacons - presence of acoustic beacons
- Guiding lines – presence of guiding lines
- Objects - present in station building (shops, columns, entrance to metro station, etc.)

Description: You're in {Station name}, station is {Type of station}. Building is {Building characteristics}. {Ticket office}. {Access to platforms}, {Numbering of platforms}. {Acoustic beacons}, {Guiding lines}. In building are {Objects}.

1.1.2 Semi-indoor

In this section contains list of semi-indoor environments we identified that users can encounter with in urban areas.

Pedestrian underpasses

Properties:

- Shape of underpass – (e.g. "underpass is perpendicular to its entrances from tram station")
- Exits – description of exits from underpass
- Guiding lines – presence of guiding lines

Description: You're in underpass that is {Shape of underpass}. From underpass lead {Exits}. {Guiding lines}.

Underground stations and vestibules

Way how to describe this situation is written in detail in sections Underground station and Underground vestibule.

Passageway

Passageway can be described in similar way as underpasses. Main difference is that it is not underground environment, but they are mostly in ground floors of bigger, typically historical, buildings. Passageways often contain a lot of small shops and various objects such as columns, steps, etc.

Properties:

- Name of passageway – usually passageways in Prague have own
- Entrances – list of entrances, described as address, to passageway
- Shape of the passageway – passage can be form of just one straight corridor, but also exist much more complicated shapes of passageways.
- Objects in passageway – e.g. shops, restaurants, columns, steps.
- Guiding lines – presence of guiding lines for visually impaired

Description: You're in passageway {Name of passageway}. There are entrances from {Entrances}. Passageway has {Shape of passageway}. {There are {Objects} at {Position}}. {Guiding lines}.

1.1.3 Semi-outdoor

Identified examples of semi-outdoor environments:

- Courtyards
- Garden/Park
- Compound (e.g. Hospital compound)

We identified these environments as semi-outdoor because they differ from classical outdoor environments. Users can use different types of landmarks, instead of roads and sidewalks users follow paths or even can go on the roads that are used with cars also (it was part of our route for experiments). It is more probable that user will encounter walkthrough some free spaces more often than in outdoor environment. Nevertheless, it is important to inform user clearly that he is in different environment, and we should still give him/her navigation instructions base on same principles as in outdoor, i.e. find some guiding line (building, edge of the path), and inform him/her about important landmarks.

Properties:

- Type of the path
  - Road, path, sidewalk
- Surface of the path – will help users to be sure they are at the right place
- Objects

  - Cars parking
  - Buildings, benches

- Additional information
  - Beware of riding cars/bikes

Suggestion for semi-outdoor description, which was created for experimental purposes.
Description: You are on the {Road/Path/Sidewalk} of the {Courtyard/Park/Garden/Compound Name}. Surface is made of {Surface Type}. {Object is at {Position}}. **Action:** Find borderline of the road and grass by your {Left/Right} hand. }Additional information}.

1.1.4 Means of transport

This is the list of various means of transport that were identified for cities.

- Buses
- Electric buses
- Trams
- Underground
- Trains
- Cable cars

1.1.5 Types of Stations/Stops

Following section describes various type of stations or stops that can pedestrians encounter with in cities. For each type of station/stop was created a methodology how it should be present in navigational instructions to visually impaired users.

Underground station

Underground stations are often very crowded and noisy thanks to arriving or departing metro trains. Various types of underground stations exist, there are stations with single tube and its platforms can be in the middle or on sides of the tube, there are also stations with three tubes which can have separated platforms from corridor in the middle of station.
Properties:

- Additional Info:
  - Station has {Number} tubes.
  - Platform is separated from middle part of the station.
- Objects on platform:
  - Benches, info tables and dustbins are {in the middle/by the side} of the platform.

- Information about line transfer:
  - In the middle of the platform are opposite {stairs/escalators} going {up/down}, transfer to {Line Name}.
  - Information about escalators or stairs leading from platform, e.g. number of escalators and presence of acoustic beacons.
- Guiding lines – presence of guiding lines
- Lift – presence of lift

Description (before getting off): Station {Station Name} has platform on the {left/right} in the direction of ride. {Additional Info}. {Information about line transfer}. {There are {Objects} at {Position}}. Station has exits at {end/both ends} of the platform. {Guiding lines}. {Lift is at {Position}}. **Action:** Get off the underground and step out from the train.

Description (at platform): You are at the platform. {Go through the columns to the middle of the station.} Action: Turn {Direction} and go to {Escalators/Stairs}.

Description (to vestibule): You are at {Escalators/Stairs}, {Information about escalators}. **Action:** Go {up/down}.

Underground vestibule

Underground vestibules are complicated semi-indoor environments, often very crowded and noisy thanks to arriving or departing metro trains. Entrance to vestibule can be inside bigger building which is designed for different purpose than public transport, e.g. shopping mall (Národní třída station in Prague), or university (CTU in Prague - Karlovo Nám.). There can be a corridor from vestibule directly to e.g. hospital compound (Faculty Hospital Motol in Prague).

Properties:

- Objects in vestibules:
  - Shops.
  - Pillars in the middle of vestibule, pillar barriers.
  - Glass door separating vestibule and transport space - likely opened.
- Information about acoustic beacons at exits/entrances to vestibules
- Guiding lines – presence of guiding lines

Description (through the vestibule): After the {escalators/stairs} follows the vestibule, separated by glass door about {Number} meters. Metal pillars are on the way. {Guiding lines}. Vestibule has {Number} exit(s). In the vestibule are {Objects at {Position}}. **Action:** Go straight in free space about {Number} meters. Then continue {Direction} {Number} meters. {Guiding line is by your {left/right} hand}. {Object will be by your {left/right} hand}.

Description (exit from vestibule): Exit has {{Stairs/Escalator} Stairs at {Left/Right} side and escalator at {Left/Right}}. {Stairs has {Number} landings}. Exit leads to {Street Name/Building Name/Passageway}. **Action:** Go up.

Isle

Isle type of station is in most cases station for trams or buses, as it was identified in city of Prague, and it is common type of station in other cities of Europe. Follows list of properties and descriptions.

Properties:

- Pedestrian crossing:
- Equipment of pedestrian crossing:
  - With/without tactile warning strip
  - With/without lowered curb
  - With/without acoustic signalization
- Pedestrian underpass
- No pedestrian crossing
- Objects on Isle:
  - Shelter, railing, info-table, benches, dustbin, ticket machine
- Tactile strip - presence of tactile strip

Description (arrival): You are at station {Station Name}. Station is isle type, which has {{Pedestrian crossing/Underpass} in {Front/Back/Middle} part of station}. {Object is at {Front/Back/Middle} part of station}. {Tactile strip}. **Action:** Turn {Direction}, go about {Number} meters to {Crossing/Underpass}. Have tram strip by your {Left/Right} hand, have {Street/Railing} by your {Left/Right} hand.

Description (entry): You are by the {Crossing/Underpass} to {Station Name} across {Street Name}. Station is isle type. **Action:** Cross the street to isle and turn {Direction}. Crossing has {Equipment}.

Description (departure): You are at station {Station Name}. {Object is at {Front/Back/Middle} part of station}. **Action:** Go about {Number} meters to info-table. Have tram strip by your {Left/Right} hand, have {Street/Railing} by your {Left/Right} hand.

Sidewalk

Sidewalk type of station is another very common station type, it has its platform on the sidewalk. Mostly the tram stops right next to the sidewalk, less common is when tram stops few meters from the sidewalk, then you get on the tram after crossing the street, or we can encounter with wiener type of station, when the road is raised to the level of sidewalk.

Properties:

- Tram/bus stops right next to sidewalk
- Tram/bus stops few meters from sidewalk, pedestrian must cross roadway to get on tram.
  - Road {is/is not} raised to the level of sidewalk

- Objects on Isle:
  - Shelter, info-table, benches, dustbin, ticket machine
- Opposite side of the sidewalk – object on the opposite side of the sidewalk that can be used as guideline.
- Tactile strip - presence of tactile strip

Description (arrival): You are at station {Station Name}. Station is at sidewalk {with boarding over the road, road {is/is not} raised to the level of sidewalk}. {Object is at {Front/Back/Middle} part of station}. On the opposite side of the sidewalk is {Building/Park/...}. {Tactile strip}. **Action:** After getting off go towards {Object} in front of you then turn {Direction}. Have {Object} by your {Left/Right} hand.

Terminus station

Terminus stations can be built in various ways, most common in case of trams and buses its place where they turn around (road or rail loop), so it has circle shape. The stops can be place either in the section of the track before the loop, or in the loop. Stops can be also separated to exit-stop and stop for departure. It is common that terminus station serves for more modes of transport (tram and buses together).

Railway station

Railway stations are complicated indoor and outdoor environments, especially the main stations in cities, it has typically more than one platforms, platforms are long, you usually don't know in what part of platform the train will stop. Platforms can be connected with underground corridors leading to railway building, or in some cases the smaller railway stations has not underground corridors, but pedestrian crossing over the railroad tracks, which are dangerous even for sighted pedestrian and typically not marked for visually impaired people. The railway station buildings are big, crowded and in case of main stations often multi-storey buildings with connection to other types of public platforms.

Railway stations divided by the type of access to platforms:

- Platforms are on the same level as railway station building (level access)
- Platforms can be accessed by underground corridor or by overpass (off-level access)
- Combination of both

Types of platforms

- Bay platform - track terminates there
- Through platform - track continues
  - Side platform - there is only one side where people get on the trains (platform has one number)
  - Island platform - this platform has two numbers, i.e. people get on the trains on both sides.

2 Evaluation

In this section are presented the information and results from conducted experiments with users. After each experiment recommendations for future design were created.

2.1 First experiment

2.1.1 Participants

Six visually impaired participants were recruited via e-mail leaflet. They were aged from 25 to 69 years (mean = 37.3, SD = 15.96). Three participants congenitally blind and three were late blind. Three participants had Category 4 visual impairment (light perception) and three participants had Category 5 (no light perception) according to WHO classification. Two participants had guiding dog, four participants don't and used only white cane. All of the participants were native Czech speakers.

2.1.2 Procedure

The first iteration of user testing experiment did not take place in field, it was conducted in laboratory setting instead. The purpose of the experiment was to test whether the participants understand route itineraries (in terms of nomenclature and navigation principles), what information in itineraries are sufficient or redundant. Firstly, the purpose of the experiment was explained to the participants. Then the sections of routes itinerary were played individually to the participants using screen reader on Android cell phone. Both routes were saved as HTML document, so that each section of the route was one paragraph. After every section the participant had time to express his or her opinion about the section.

Routes The first route led from the metro station to classroom inside the campus building of CTU. It consisted of 41 segments and was about 300 meters long. It contained the combination of indoor, semi-indoor and semi-outdoor environments. The second route led from tram station to classroom inside the campus building of CTU. It consisted of 34 segments and was about 450 meters long. It contained the combination of all classified environments.

2.1.3 Findings

The following section describe findings observed during user testing of first prototype.

Route 1

Route description

- In route description there is a recommendation where to get on the metro (in the middle of the train). P01 appreciate this information. P04, P05 think that this information is redundant.
- P06 would appreciate information about length of the whole route

Station description

- P03, P05 - Participants don't know how to imagine what "prostupy" is. They advised calling it "sloupy" (columns) instead.
- P01, P03 - "(Station) Has platform on the left in direction of the ride." were confused by this information, though that they are already on the platform.

Metro station and vestibule

- P04 - Section 2: Don't mention distance to escalators, it's not sure where user will get off the train.
- P05 - Section 3, 5: Repeated information about acoustic beacon.
- P01, P02, P05 - Section 5: "Go up, using escalator" should be assigned to previous section, where is action "go 10 meters to escalator"
- P01, P05 - Section 5: Information about what is after the escalator is redundant.
- P01, P05 - Section 6: Duplicated information about distance and repeated information from previous section about "area before vestibule".
- P05, P06 - Section 8: Confusing section, participants don't know exactly where to go and where the shops will be. Information about guiding line was not clear. Participants had to repeat this section.
- P05 - Section 9: Instead of "go at the end of the shop" use "go at the rounded corner of the shop"
- P03, P04, P06 - Section 10: "turn slightly left and go approx. 15 meters to stairs" change to: "turn slightly left and go straight in free space approx. 15 meters to stairs"
- P03, P05, P06 - Section 14: Too long description. Naming all the exits from arcade to streets and to metro vestibule seems to be useless.

Indoor Building A

- P04, P05 - Building A description: Information about two possible entrances to building is confusing.
- P01-P06 - Section 10: Information about vending machines was appreciated as good landmark.

Courtyard

- P04, P06 - Courtyard description: Add distance to the action of "find boundary of street and grass at your right hand"
- P06 - Courtyard description: For him would be better to say: "On the left and right are curbs, stay on the right" or "...go along the right curb"

- P01, P02, P03, P05 - Section 1: Problematic information about having building C by the left hand, building can be far away, if we are on the other side of the road.
- P04, P05 - Section 2: Road crossing may not be recognized by blind users. One solution could be to go to the building E in previous section. And in this section follow this building's wall.
- P01-P06: Section 3: (All participants did not say that they are preferring barrier-free entrances.)
- P01, P03, P05, P06 - Section 3: Information about main-entrance with pyramid stair is confusing, participants firstly thought that they will enter the building using this entrance. Going through the free space and not along the stairs is problematic too, far better would be use the stairs as guide line and go along them.

Indoor Building E

- P01, P03, P05, P06 - Section 9, 10 - Elevator: Redundant information about calling the elevator, it's clear that user should call it. Unite these section into one section. Description "Platform of the elevator" was confusing for participants, they were not sure if they are inside an elevator or in front of the elevator's door.
- P03, P04, P06 - Section 11: Missing information about where to place the card in elevator.
- P03 - P05: Section 13: Information about the turn at the end of the corridor is redundant and confusing, if user won't go there.
- P01 - P06: Section 14: Don't go from one door to another, but much better would be: "go by the left wall and count second door"

Route 2

Tram station description

- P06 - Presence of ticket machine can be redundant for blind people.
- P06 - Action: for him would be safer, to go towards buildings on the other side of sidewalk and then turn. He found turning after getting off the tram as very dangerous.
- P02 - Change "on the other side of the sidewalk are buildings" to "in front of you are buildings"
- P02, P04 - Bad turning instructions, users will turn by 180 degrees at first and in next section they will turn again by 90 degrees.

Exterior

- P05 - Don't know what "marked crossing" means, he would like to hear "you can find crossing by cane"
- P03, P06 - "You are located at" -¿ "You are at". Shorter version is better for them.

- P02, P05, P06 - Section 6 - entering the building: Instruction about the building address (building number) is not useful information to find the entrance. This section should be divided into two sections. In first section should be "find the stick out facade of building" and in the second section should be "count second niche and enter the building". Generally, participants want firstly find place where to find entrance and then obtain next information how to find correct door.

General

- P01, P02, P05: Actions like "go through the door" should be assigned to previous section, when user firstly hear information about the door. Similarly, with actions like "go up using escalators", "go upstairs", or "go to floor number 3"
- P01-P06: Repeating information about shape and measurements of card reader was distracting, participants want to hear it only once.
- Stairs
  - P03 - "Go up using stairs" replace by "Go up"
  - P03, P05 - Information about handrail is useful only when there is no handrail or it is danger to use the stairs.
  - P03, P05 - Number of steps is redundant information
  - P03 - "triple stairs" participant was not sure what this mean, better description will be "stairs with two heads"
- Building descriptions:
  - P01-P06: Descriptions are too long.
  - P01: Information about fire alarm is useless.
- P01 - Unify instructions about turning and directions, i.e. "left/right" and "to the right/to the left"

2.1.4 Recommendations for design

This section describes recommendations for design, which were extracted from findings mentioned above. These recommendations should be considered in future design. The questions about future design are specified too.

R1: Remove repeated information, e.g. acoustic beacon before every escalator, measurements of card reader. Remove redundant turning.

R2: Unify direction instructions and other terminology (environments, areas, surfaces, etc.).

R3: Descriptions of environments are too long. Perhaps two level of details for environment description should be implemented.

R4: Remove redundant information about stairs (handrail, number of steps). Inform users only when the stairs can be dangerous for them. It means that there is no wall or handrail on the sides of stair, and user can easily fall off.

R5: Merge sections containing first mention about door/escalator/stairs/lift and next section containing door/escalator/stairs/lift action together. Don't merge these sections if there is added information e.g. where to put chip card.

Merging vs. not-merging should be furthermore tested, because this finding can be biased by experiment conducted in laboratory, because in field testing the time between sections will take longer.

R6: When navigation through open spaces, always inform about direction user should go through it.

R7: Navigation in semi-outdoor environments should be considered as navigation in classical outdoor. If it is possible use buildings as guiding line, if not use pavement or road borderlines. Avoid navigating through open spaces.

R8: Avoid dangerous turning immediately after getting off tram/bus/metro.

R9: Indoors in final section, don't go from one door to another. Say "count XX door..." instead.

R10: When entering the building, split this section into two. First section should contain how to recognize the place where entrance is (e.g. there are steps, different surface, ramp, change in facade, etc.), second section should contain detail information about the position and description of correct door (e.g. second door in the niche).

2.2 Second experiment

After the first experiment we take into account recommendations R1, R2, R3, R4, R5, R6, R8, R9 and R10 for creation of new prototype route for second experiment. Recommendation R7 was not implemented because we have to follow information available in data structures for semi-outdoor environment in our prototype route, which meant to go through open space.

2.2.1 Participants

Six visually impaired participants were recruited via e-mail leaflet. They were aged from 25 to 70 years (mean = 40.17, SD = 16.70). Three participants congenitally blind and three were late blind. One participant had Category 4 visual impairment (light perception) and five participants had Category 5 (no light perception) according to WHO classification. Two participants had guiding dog, four participants don't and used only white cane. All of the participants were native Czech speakers.

2.2.2 Procedure

The second iteration of user testing experiment took place in field. The purpose of the experiment was to test whether the participants understand route itineraries in real environment and whether they can utilize these instructions for navigation to destination. Firstly, the purpose of the experiment was explained to the participants. Then participant can choose the level of detail for building descriptions, with assurance that s/he can change this decision during the route. To help them decide, we read example of detailed and brief description.

2.2.3 Equipment

Participants could use their own smartphone to read the route from the web browser, because route was saved on web as classic HTML document, participants were able to select from two versions first one with detailed general building descriptions and second one with brief descriptions. User can switch between these two versions during route with our assistance. Second option was to borrow Nokia 6120 phone with pre-installed application which reads each segment of the route and user can select detailed or brief descriptions during route.

Three participants used their own smartphone (iPhone), two participants used Nokia and for one of the participants we had to read the route itinerary, because of the broken Nokia phone.

2.2.4 Data collection

During each route walkthrough we were shadowing participants and recording them from third person view on mobile phone camera. After the walkthrough brief interview with each participant was done. Participants were also asked about their subjective judgment about comprehension, efficiency and safety during the route.

2.2.5 Route

The route led from the entrance to the campus building A of CTU to classroom inside the campus building E. The route was approximately 1300 meters long (850 meters walking), contained one-stop ride with tram and combination of all classified environments (See Fig. 1).

Figure 2.1: A photo from outdoor environment where the second experiment took part.

2.2.6 Results and Discussion

All participants successfully completed the route in the outdoor environment. The average completion time was 38 minutes (SD = 6.48 minutes) excluding waiting time for a tram.

First tram station P1, P3, P4 missed the isle of tram station Jiráskovo náměstí and continued farther away on pedestrian crossing, even if there was information about lowered curb. P6 didn't go straight on the crossing and hit the railing of the isle, he had guiding dog anyway it didn't help for finding the isle. P2 and P5 found the isle without problem but in the interview they said that they did not feel safe.

Second tram station All participants managed to get off the tram and navigate towards opposite buildings without problems. P1, P2, P3 and P5 used haptic strip on the ground. P4 and P6 did not because their dog guided them to buildings.

First entrance P3, P4 did not recognized the stick-out facade with entrance at all. P4 was guided by dog so s/he went in the middle of pavement and sporadically used white-cane to discover the facade. P6 found the facade and entrance but was not sure if it is the correct door, so s/he passed it.

P1, P2 and P5 found the facade and door to building without problem.

Courtyard This section was complicated by heavy noise from ongoing reconstruction and objects (stands for posters and transferable railing) placed in the way. P6 stopped in the middle of second segment and returned back to beginning, then continued without major problems. P4 misunderstood the direction instruction in third segment on the turn of the road and was confused where to go even s/he had guiding dog. All participants had not good feeling about going through open space in last segment toward the stair. P2 appreciated the information about transformer station on the right, because s/he was able to hear the noise from it and assure that s/he on the right way.

Second entrance All participants found the pyramidal stairs to the building and went through the door inside the building. P1 and P3 climb up the stairs from side, there was a danger of falling. Other participants went up in the straight direction. P3 was for a while stuck in front of the second door of the entrance, where s/he was not able to find correct leaf of this door that can be opened.

P2, P5 complained about the distance to the pyramidal stairs, they said that it was less than 30 meters and as a consequence of this they thought that there is another stairway, but eventually they recognized pyramidal shape of the stairs.

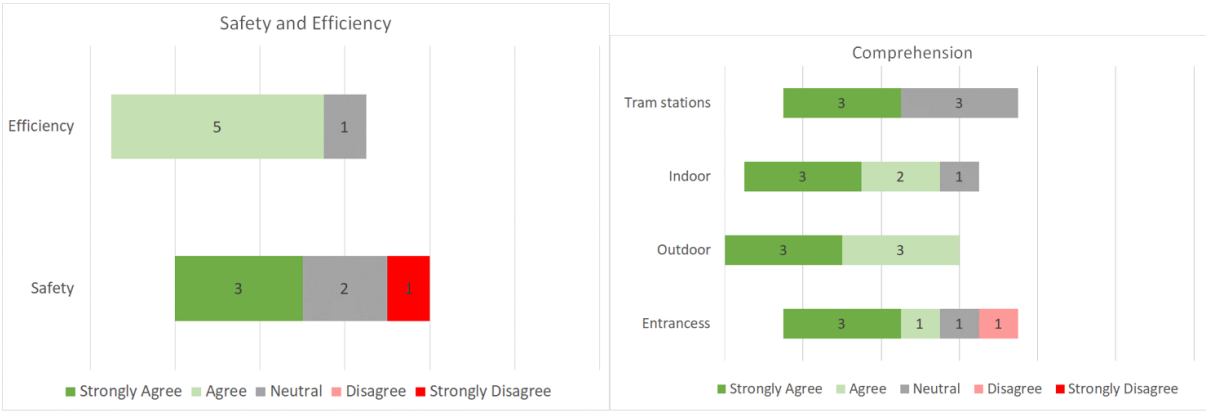
Interior P5 missed the finish (door to classroom) of the route, because the door was open and he thought that it is some corridor. Other participants found the finish successfully. P2 missed the lift door, P3 missed it as well, but s/he was able to recover from this and returned back.

All participants apart from P5 had problem with lift control, because there was no information about the card time limit for controlling the lift.

Building descriptions P1 was confused by information in building description about the position of reception, s/he thought that s/he should go there. P3 selected the version of route with detailed descriptions of buildings and afterwards was complaining about the redundant information in these descriptions. Participants with brief descriptions selected did not asked for detailed version and also evaluated the brief version as good and sufficient.

Subjective judgements

In this section the results of subjective judgements from second experiment are presented (see Fig. 2).



a) b)

Figure 2.2: Subjective judgement about safety and efficiency a) and comprehension b) of the navigation instructions.

The subjective judgments about efficiency and safety suggest usability of the templates – 5 participants agreed and 1 was neutral about efficiency; 3 strongly agreed, 2 were neutral and 1 disagreed about safety. Regarding comprehension of navigation instructions for different situations on the route 3 participants strongly agreed and 3 were neutral on comprehension of tram station; 3 strongly agreed, 2 agreed and 1 was neutral about comprehension of indoor segments; 3 strongly agreed and 3 agreed on comprehension of outdoor segments; and finally 3 strongly agreed, 1 agreed, 1 was neural and 1 disagree on comprehension of the building entrances.

Recommendations for design

Following recommendations were extracted from the findings collected during the second experiment:

R11: When navigation lead to the isle of tram station, prefer using the front entrance if it is available. More than a half of the participants did not find or missed the isle. In interview they express themselves that they are used to enter the isle at the front where the info-table is. Also the guiding dogs are trained to find the info-table.

R12: When user get off the tram/bus inform where s/he should have it (behind the back, by the right/left hand). Not all of the participants use the haptic strips on the ground, mainly

participants with guiding dogs. This information will help them to orientate when getting off the tram or bus.

R13: In segments where users have to find and recognize the place with entrance to building, we should inform them in advance that there will be door to building. (i.e. "Go ahead and slightly uphill for 150 meters to facade that sticks out to pavement. There will be entrance to the building. Have buildings on your right.")

Finding entrances is challenging for most of the visually impaired people, this information can be helpful, because they will know what to expect and if they fail finding the place with entrance, they will be able to ask for the help from passer-by people.

R14: Give users precise and detailed description of entrance to building. Half of the participants was not able to recognize the first entrance, afterwards they said that it was difficult distinguish sticking out facade from other sticking out object during this segment.

R15: When door have two door leafs, inform if one or both leafs can be opened. Some participants had problems with opening the door, finally they managed to open it on their own, but it unnecessarily took them a little more time.

3 Example of Routes Used in Experiments

3.1 Route for Second Experiment

3.1.1 Route description

From CTU FEE building E at Karlovo Náměstí 13, to tram station Jiráskovo Náměstí. Then take tram to Myslikova station and then return back to Karlovo Náměstí 13 to building E, classroom KN:E 328 (third floor).

Following excerpt shows examples of navigation instructions translated to English.

9th segment from 11: You are at the crossing to Jiraskovo namesti station, across the Masarykovo nabrezi street. The station is isle type. Cross the Masarykovo nábřeží street to the isle via a marked crossing with traffic lights and one-way traffic from left. Attention the crossing has lowered curb.

10th segment from 11: You are at the station Jiraskovo namesti. Turn right and go about 40 meters to station info-table in the front part of the station. Have tram strip by your left hand, railing by your right hand.

11th segment from 11: You are at the station info-table. Take tram number 5 to station Myslikova. The number of stops is one.

5th segment from 7: You are at the rounded corner of Karlovo namesti and Odboru streets. Continue straight ahead about 150 meters, slightly uphill to building faced which is protruding into the sidewalk. Have buildings by your right hand.

6th segment from 7: You are at Karlovo namesti 293/13. In front of the entrance to building A, CTU at Karlovo namesti. Entrance to the building is in the second niche of the protruding facade. Go to the second niche.

7th segment from 7: Entrance to the building A consist of two double-wing doors. Extern tall, wood, historic door are still open during classroom. The inner glazed door opens mechanically. Go through the door.

Route description: The route from Karlovo namesti metro station - on line B (arrival from the direction Narodni trida, we recommend middle part of the metro train), to address Karlovo namesti 293/13, classroom KN:328 in building E. Route is approximately 300 meters long, goes through more types of environment.

Route description: The route from Myslikova tram station (arrival from the direction Narodni trida), to address Karlovo namesti 293/13, classroom KN:328 in building E. Route is approximately 450 meters long, goes across one route crossing and through more types of environment.

Route description: The route from address Karlovo namesti 293/13 to address Karlovo namesti 293/13 to classroom KN:328 in building E. Route is approximately 1000 meters long, goes across 5 route crossings and through more types of environment. Ride with the tram from Jiraskovo namesti station to Myslikova station is part of the route. Stand so that you have the building behind your back.

Following excerpt is available only in Czech language.

Popis trasy: Trasa z adresy Karlovo náměstí 293/13 na adresu Karlovo náměstí 293/13 do učebny Ká 328 v budově E. Trasa je dlouhá asi 1000 metrů a vede přes 5 přechodů. Součástí trasy je cesta tramvají ze zastávky Jiráskovo náměstí na zastávku Myslíkova. Postav se tak, abys měl budovy za zády.

1. úsek z 11. Jsi na adrese Karlovo náměstí 293/13 před budovou A. Otoč se vpravo a jdi asi 30 metrů na roh s ulicí Resslova. Po pravé ruce měj budovy.

2. úsek z 11. Jsi na rohu ulic Karlovo náměstí a Resslova. Odboč mírně vpravo a jdi asi 170 metrů mírně z kopce na roh s ulicí Na Zderaze. Po pravé ruce měj budovy.

3. úsek z 11. Jsi na rohu ulic Resslova a Na Zderaze. Pokračuj vpřed a přejdi ulici Na Zderaze na protější roh přes značený přechod s jednosměrným provozem zprava.

4. úsek z 11. Jsi na rohu ulic Resslova a Na Zderaze. Pokračuj vpřed a jdi asi 60 metrů mírně z kopce na roh s ulicí Dittrichova. Po pravé ruce měj budovy.

5. úsek z 11. Jsi na rohu ulic Resslova a Dittrichova. Pokračuj vpřed a přejdi ulici Dittrichova na protější roh přes značený přechod s jednosměrným provozem zprava.

6. úsek z 11. Jsi na rohu ulic Resslova a Dittrichova. Pokračuj vpřed a jdi asi 40 metrů mírně z kopce na zkosený roh s ulicí Jiráskovo náměstí. Po pravé ruce měj budovy.

7. úsek z 11. Jsi na zkoseném rohu ulic Resslova a Jiráskovo náměstí. Pokračuj vpřed a přejdi ulici Jiráskovo náměstí na protější chodník přes značený přechod s jednosměrným provozem zleva.

8. úsek z 11. Jsi v ulici Jiráskovo náměstí. Pokračuj vpřed a jdi asi 20 metrů k přechodu proti tobě. Po pravé ruce měj zeleň. Po levé ruce měj vozovku.

9. úsek z 11. Jsi u přechodu na zastávku Jiráskovo náměstí přes ulici Masarykovo nábřeží. Zastávka je typu ostrůvek. Přejdi ulici Masarykovo nábřeží na ostrůvek přes značený přechod se světelnou signalizací s jednosměrným provozem zleva. Pozor přechod má snížený obrubník.

10. úsek z 11. Jsi na ostrůvku zastávky Jiráskovo náměstí. Otoč se vpravo a jdi asi 40 metrů k označníku v přední části zastávky. Po pravé ruce měj zábradlí. Po levé ruce měj tramvajový pás.

11. úsek z 11. Jsi u označníku zastávky. Dojeď tramvají číslo 5 na zastávku Myslíkova. Počet zastávek je jedna.

1. úsek z 7. Zastávka Myslíkova u chodníku, na zastávce se nachází označník zastávky v přední části zastávky, přístřešek a koš v prostřední části. U druhého okraje chodníku jsou budovy. Dojdi k budově před tebou pomocí signálního pásu a otoč se vlevo.

2. úsek z 7. Jsi v ulici Myslíkova. Jdi rovně asi 60 metrů. Ulice je zalomená doprava. Po pravé ruce měj budovy.

3. úsek z 7. Jsi v ulici Spálená. Otoč se vpravo a jdi asi 60 metrů na zkosený roh s ulicí Odborů. Po pravé ruce měj budovy.

4. úsek z 7. Jsi na zkoseném rohu ulic Karlovo náměstí a Odborů. Pokračuj vpřed a přejdi ulici Odborů na protější roh přes značený přechod se světelnou signalizací s jednosměrným provozem zleva.

5. úsek z 7. Jsi na kulatém rohu ulic Karlovo náměstí a Odborů. Pokračuj vpřed a jdi asi 150 metrů mírně do kopce k fasádě vyčnívající do prostoru chodníku. Po pravé ruce měj budovy.

6. úsek z 7. Jsi na adrese Karlovo náměstí 293/13. Před vstupem do budovy A, ČVUT na Karlově náměstí. Vstup do budovy je v druhém výklenku vyčnívající fasády budovy. Jdi ke

druhému výklenku.

7. úsek z 7. Vstup do budovy A. Je tvořen dvěma dvoukřídlými dveřmi. Vnější vysoké, dřevěné, historické dveře jsou během výuky stále otevřené. Vnitřní prosklené dveře se mechanicky otevírají směrem ven. Projdi dveřmi.

Stručný popis: Jsi v budově A, ČVUT na Karlově náměstí. Počet pater je 4. Mnoho zavřených dveří se otevírá pomocí čipové karty, kterou je nutné přiložit ke čtečce karet a po krátkém pípnutí otevřít. Vrátnice je po pravé ruce po vstupu z ulice.

Detailní popis: Jsi v budově A, ČVUT na Karlově náměstí. Jedná se o historickou budovu. Budova je velmi rozmanitá, má několik různých typů schodišť, počet pater je čtyři. Mnoho zavřených dveří se otevírá pomocí čipové karty, kterou je nutné přiložit ke čtečce karet o velikosti 10 krát 5 krát 3 cm a po krátkém pípnutí otevřít. Vrátnice se nachází po pravé ruce po vstupu z ulice, potažmo přímo proti vstupu z pasáže, na druhém konci místnosti.

1. úsek z 7. Jsi ve vstupní hale budovy A, ČVUT. Jdi rovně asi 5 metrů volným prostorem k turniketům před tebou.

2. úsek z 7. Vstupní turnikety uprostřed vstupní haly. Čtečka karet je ve výšce pasu po levé ruce u každého z celkem 4 turniketů. Projdi turnikety

3. úsek z 7. Volný prostor asi 6 metrů dlouhý, po levé i pravé ruce schodiště nahoru. Poté dva sloupy vlevo i vpravo. Na konci prostoru jsou dřevěné dveře se skleněnou výplní, většinou otevřené. Jdi rovně a projdi dveřmi.

4. úsek z 7. Úzká rovná chodba asi 10 m dlouhá, před koncem chodby většinou otevřené dvojkřídlé skleněné dveře s madlem. Jdi chodbou ke dveřím a projdi.

5. úsek z 7. Atrium spojující budovu A s budovou B. Po obvodu jsou dřevěné stoly a lavice, mírně vpravo před tebou je krátké schodiště směrem dolů. Jdi mírně vpravo volným prostorem asi 10 metrů ke schodišti a sejdi dolu.

6. úsek z 7. Před tebou jsou Dvoukřídlé skleněné dveře s madly, většinou otevřené. Projdi dveřmi.

7. úsek z 7. Chodba asi 13 metrů dlouhá. Po levé ruce jsou nápojové automaty (hučí), na konci chodby dvoje dřevěné dveře se skleněnou výplní hned za sebou. Jdi rovně na konec chodby ke dveřím a projdi. Pozor následuje vstup na dvůr areálu ČVUT.

Stručný popis: Jsi na vozovce ve dvoře areálu ČVUT, povrch vozovky je tvořen kočičími hlavami. Po pravé ruce vyhledej rozhraní vozovky a trávníku s nízkým obrubníkem. Pozor ve dvoře jezdí a parkují vozidla, nemají vyhrazené stání.

Detailní popis: Jsi na vozovce ve dvoře areálu ČVUT, povrch vozovky je tvořen kočičími hlavami s nízkými obrubníky, které v některých částech již chybí. Z dvora vedou vstupy do budov B, C, D, E, F, G. Po pravé ruce vyhledej rozhraní chodníku a trávníku s nízkým obrubníkem. Pozor ve dvoře jezdí a parkují vozidla, nemají vyhrazené stání.

1. úsek z 4. Jsi u rozhraní vozovky a trávníku u vstupu do budovy B. Jdi asi pět metrů rovně volným prostorem na křížení vozovky.

2.úsek z 4. Jsi na křížení vozovky. Otoč se vpravo a jdi rovně asi 40 metrů volným prostorem na odbočku vozovky, po pravé ruce bude nejprve zeleň poté bude trafo stanice.

3. úsek z 4. Jsi na odbočce vozovky, před tebou je budova E. Otoč se vlevo a jdi asi 30 metrů rovně volným prostorem k pyramidovému schodišti po pravé ruce, budovu E měj po pravé ruce.

4. úsek z 4. Jsi u vstupu do budovy E tvořeného pyramidovým schodištěm. Nad schodištěm jsou velké dřevěné dveře do budovy a hned za nimi dřevěné prosklené lítačky. Vyjdi schodiště nahoru a projdi oběma dveřmi.

Stručný popis: Jsi v budově E v areálu ČVUT. Počet pater je čtyři. Mnoho zavřených dveří se otevírá pomocí čipové karty, kterou je nutné přiložit ke čtečce karet a po krátkém pípnutí otevřít. V budově je výtah. Vrátnice je po tvé pravé ruce.

Detailní popis: Jsi v budově E v areálu ČVUT. Počet pater je čtyři. Jedná se o historickou budovu. Budova je velmi rozmanitá. Nachází se zde několik různých typů schodišť. V budově je výtah. Vrátnice je po tvé pravé ruce. Mnoho zavřených dveří se otevírá pomocí čipové karty, kterou je nutné přiložit ke čtečce karet o velikosti 10 krát 5 krát 3 cm a po krátkém pípnutí otevřít. V budově se také můžete setkat s mnoha dveřmi, které jsou označeny jako většinou otevřené. Tyto dveře je proto možné snadno minout.

1. úsek z 10. Plošina asi 5 metrů dlouhá. Povrch gumová rohož. Na konci plošiny je přímé schodiště nahoru. Dojdi ke schodišti na konec plošiny.

2. úsek z 10. Přímé kamenné schodiště. Hned nad schodištěm jsou dřevěné lítačky. Vyjdi nahoru a projdi dveřmi. Pozor plošina nad schodištěm je velmi krátká.

3. úsek z 10. Plošina hlavního schodiště v přízemí. Povrch dlaždice. Před tebou jsou schody nahoru. Vlevo jsou dřevěné dveře se skleněnou výplní. Otoč se vlevo a dojdi ke dveřím. Pozor, vpravo i vlevo od schodiště nahoru jsou schody dolů.

4. úsek z 10. Dveře se otvírají na kartu. Čtečka je na stěně vlevo od dveří. Projdi dveřmi.

5. úsek z 10. Chodba asi 20 metrů dlouhá, vpravo za dveřmi je výtah ve výklenku. Dojdi k výtahu, drž se u stěny vpravo.

6. úsek z 10. Výtah v nultém patře, tlačítko přivolání výtahu vpravo od dveří výtahu. Otoč se vpravo, ke dveřím výtahu a přivolej výtah.

7. úsek z 10. Výtah. Ovládání je vlevo hned za dveřmi výtahu. Stanici je možné zvolit pouze po přiložení karty ke čtečce karet nad ovládacím panelem. Ovládání má 6 tlačítek ve dvou sloupcích. Výtah je vybaven akustickou i hlasovou signalizací a hmatovým značením. Dojeď výtahem do třetího patra.

8. úsek z 10. Třetí patro. Vyjdi ven z výtahu a otoč se vpravo.

9. úsek z 10. Chodba asi 30 metrů dlouhá, vpravo jsou okna, vlevo jsou dveře učeben, drž se vlevo. Jsi v cílovém segmentu. Dojdi k prvním dveřím na levé straně.

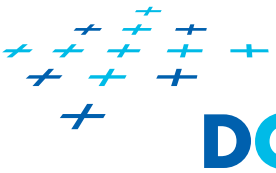
10. úsek z 10. Jsi v cíli. Dveře místnosti Ká 328.

4 Conclusion

This technical report provides supplementary materials and technical details to for the paper Indoor-Outdoor Intermodal Sidewalk-based Navigation Instructions for Pedestrians with Visual Impairments by Jan Balata, Jakub Berka and Zdenek Mikovec published on 16th International Conference on Computers Helping People with Special Needs (ICCHP 2018).

Acknowledgements

The research has been supported by projects: Navigation of handicapped people funded by grant no. SGS16/236/OHK3/3T/13; Automated mapping of routes and barriers for pedestrians and disabled people funded by grant no. TH02010839 of the Technology Agency of the Czech Republic realized by Central European Data Agency, a.s.



Technical Report Series of DCGI, Volume 1, Year 2018

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