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THE POSSIBILITY OF PEOPLE NAVIGATION IN UNKNOWN BUILDING COMPLEX

MOŽNOST NAVIGACE OSOB V KOMPLEXECH NEZNÁMÝCH BUDOV

Abstract

This paper focuses on the problems of navigation in a vast building with the possibility of detection of a subsequent movement in different parts of the object. It describes the design of documents used for 2D and 3D navigation of courier from point A (store) to point B (in a large office building). The article also describes a design of an algorithm for navigation of persons in the building and steps leading to the design of a navigation system for vast buildings. The application is developed within the project of the University Science Park and is designed for navigation at the University of Žilina.

Abstrakt

Tento príspevok sa zaoberá problematikou navigácie v rozľahlých budovách kritickej infraštruktúry s možnou detekciou jej následného pohybu v jednotlivých častiach objektov. Opisuje tvorbu podkladov pre 2D a 3D podklady slúžiace pre navigáciu kuriéra z bodu A (sklad) do bodu B (kancelária v rozľahlej budove). V článku je ďalej opísaný navrhnutý algoritmus určený na navigáciu vstupujúcej osoby a kroky ktoré viedli k návrhu systému navigácie pre rozľahlé budovy. Vytvorená aplikácia vyvíjaná v rámci projektu Univerzitný vedecký park je navrhnutá pre potreby navigácie v priestoroch Žilinskej univerzity.

Keywords

ITS, navigation, mobile applications, low cost

1 INTRODUCTION

Every manufacturer knows the traffic and information chaos which sometimes occurs on transport routes. Huge volumes of cargo with lots of information about transported products, senders, addressees, etc. get lost in a mysterious way or are delayed because of bad determination of the position in our case [1]. The stressful situation, loss of confidence or even the customer, the imminent penalty for delay of delivery and the other very unpleasant situation are associated with.

One of possible solutions able to eliminate a formation of that situation is using an accurate navigation of deliverers.

Generally the most important aim of logistics is to increase or to optimize the trade performance of companies. This is indicated by three factors: the quality of the product, the price of the product and delivery service (focus of this paper).

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Significant improvement in the accuracy of the end user and navigation to the delivery service was brought by the world wide net of satellites: GPS, GLONASS, GALILEO or possibly BEIDOV China. Using the Global Navigation Satellite Systems (GNSS) has become a standard part of most people and logistics companies. While a few years ago, the technology of satellite navigation system was only the prerogative of expensive luxury cars, now it is an affordable replacement of maps in the whole world. GNSS's great asset is the ability to view the current position of the deliverer, computing the route through map data for easy navigation from A to B (parking area of the recipient). However, the principle of its operation does not allow navigation within the whole logistics route (B - office) - because of the enclosed space there is no connection with the satellites.

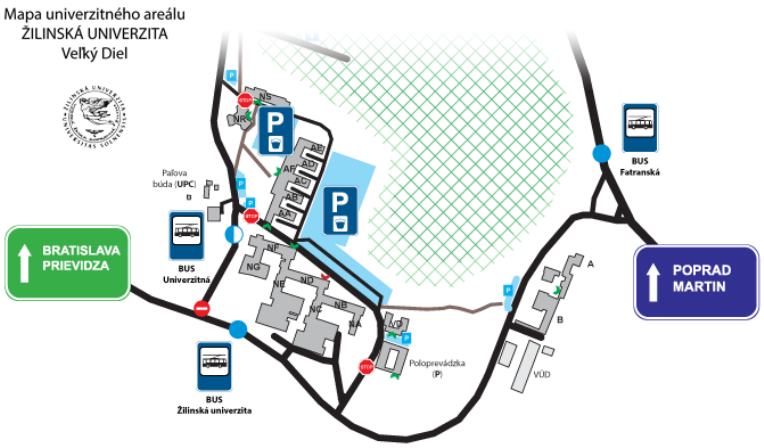

Fig. 1 Current possibilities – the map overview of logistics company's area of interest (university campus)

Therefore, their task is to ensure correct navigation of users to the object (parking area - Fig. 1), where the internal navigation will be used. The idea of this paper combines both navigation systems, public GNSS used outside buildings and the internal navigation system used inside buildings. This will allow navigating through the building and the deliverer goes exactly to a particular room (person) they have been looking for.

2 CURRENT POSSIBILITIES IN NAVIGATION THROUGHT THE BUILDING

The problem of direct visibility of GNSS satellite inside buildings solves internal (local) systems called Indoor Positioning Systems (IPS). 'Local' means that localization is focused on a local area, a group of buildings or the building itself. Although the area of IPS coverage is quite small they have several advantages. The biggest of them is precise targeting and localization. These positioning systems can work with an accuracy of a few centimetres or millimetres, according to the technology used in the device.

There are several reasons for usage of a smartphone or a tablet for internal navigation. Smartphones have additional facilities such as Wifi, Camera, Bleutooth, but also a compass and accelerometer. Combination of mentioned additional devices can be use at internal localization in different ways.

Buildings constructed of steel and concrete have specific spatial **magnetic field**. It could be compared to a unique signature of buildings. Since the first of the described navigation systems works on the principle of magnetic field, this feature of buildings is very good pre-requisite. The

application is designed primarily for mapping objects like department stores or office buildings. It is therefore necessary to supply the database of application with maps of the buildings.

The application designed by IndoorAtlas Company collects data from the built-in compass, which is a part of every type of smartphones. It measures the anomalies of the Earth's magnetic field. This technique determines the position in the building with an accuracy of 0.1 m to 2 m [2].

Fig. 2 Current possibilities - navigation in the building using magnetic fields

Other IPS methods include distance measurement methods which reduce demands on calculation and determine the distance between the mobile device and base stations. The approximate location is determined using the parameter information signal received from the reference stations located in the vicinity of the device. The ideal case of this method is network with a high number of nodes (base stations). Their quality and accuracy is dependent on the number of deployed reference stations.

Local navigation using the method FootPath [3] defines the need to obtain a database with current maps of buildings in the beginning. The next step is to choose the way that we want to reach the destination. Local navigation footpath uses two devices of smartphones - compass to determine the direction and accelerometer to count the number of steps. Based on the values of the compass and accelerometer the appropriate algorithm calculates where the mobile phone is located.

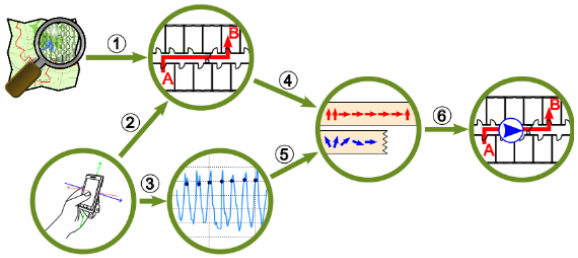

Fig. 3 Current possibilities - navigation model of the FootPath method

Next, the camera of smartphone can record the surrounding areas of the building where we are. Deployment of barcodes (or QR codes) in selected locations within the building and subsequently scanning them with the camera can determine our location. The information about the geographical position or the URL address of the image of the relevant part of the building is thus obtained. This low cost and handy method of locating was first described by Mulloni al [5].

Fig. 4 Current possibilities – principle of the FootPath method

Local navigation via WiFi is a local positioning system designed primarily for positioning inside buildings. It uses a method of intensity signal detection. It works in the networks using the WLAN standard IEEE 802.11g. The system architecture is based on a client-server type.

Based on the placement of computational mechanism, we can distinguish whether the position detection uses access points or direct localization in the cell phone.

The first way (fig. 5A) is based on the fact that the smart phone is a passive device, which transmits signals to base station. The references stations process data received from the smartphone and send them for further processing to the control unit. There data is calculated using pre-built algorithms. Determined position value is sent back to the smartphone so that it records its current position.

The second way (fig. 5B) is the smart phone as an active device responsible for the entire process of positioning. The smart phone can receive and process signals transmitted from the reference stations. This process requires software and hardware interventions into the device. An advantage is reducing the load on the network.

The device may process the input data from the reference stations and forward them to the network for further processing in combined system (fig. 5C). The network is thus relieved while processing data from mobile device. The position algorithm can provide a more complex and demanding performance because it is handled a more adapted device in the network.

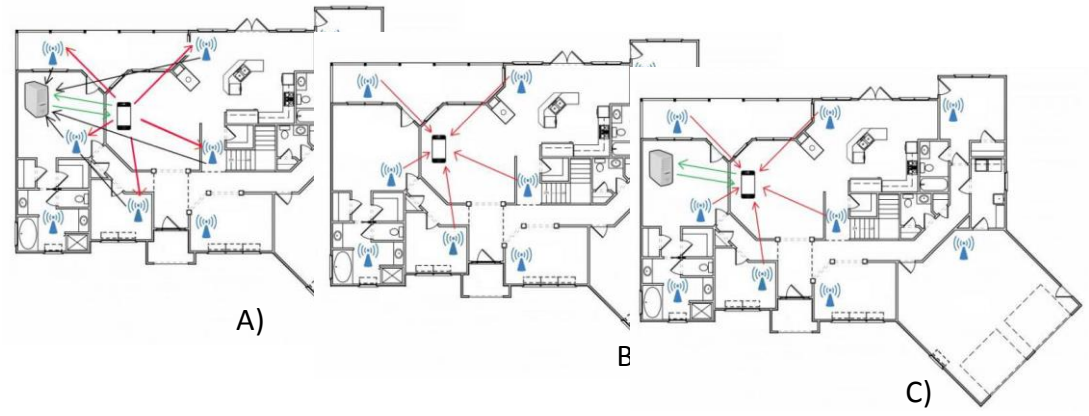

Fig. 5 Local navigation using access Wifi points

3 DESIGN OF 3D MODELS BASED ON TECHNICAL DOCUMENTS

Knowledge of the building floor plan is important for better navigation inside the building. AutoCad was used because it is user friendly and compatible with other software tools. Rooms can be drawn with millimetre accuracy and doors, windows or stairs are marked. The figure shows the floor plan of department control and information systems. After completion of floors, the project is exported into DWG format so that it is compatible with software intended for 3D model.

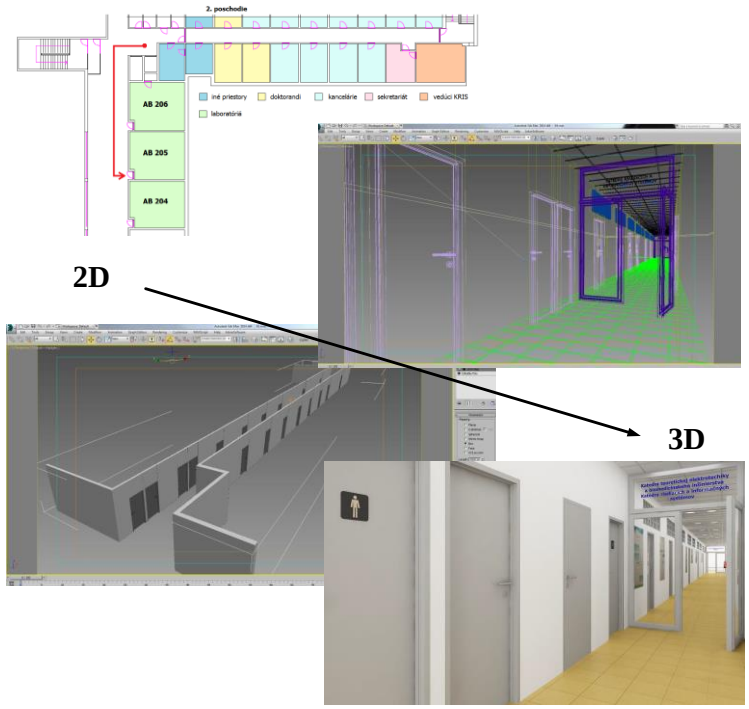

Fig. 6 Sample of the 3D model of corridor proposed for the application.

After creating the building floor plan a 3D model of object is created. DWG file is imported and the building floor plans are pulled out into the space - the walls and then a variety of accessories such as windows, doors, stairs to achieve the real picture of the building are added. 3D model is important for creating animations (fig. 7), which will serve as a guide for navigating through the object to the specified destination.

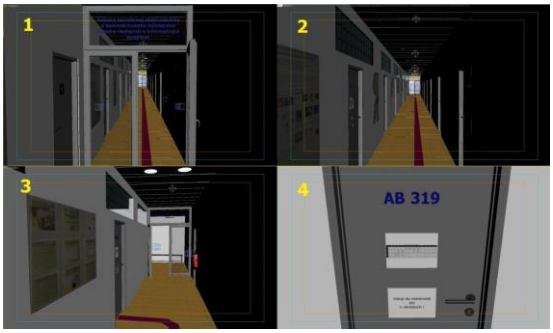

Fig. 7 An animation process in 3D MAX program

4 DESIGN OF SYSTEM FOR NAVIGATION IN BUILDING

IPS application designed to navigate in the building is constructed in a way enabling choosing the destination room in the beginning. The room is possible to choose from slider with name Destination. There is a list of the laboratories and offices of the Department of Information Systems. Next, the building entrances are selected using a map of university campus (Fig.8).

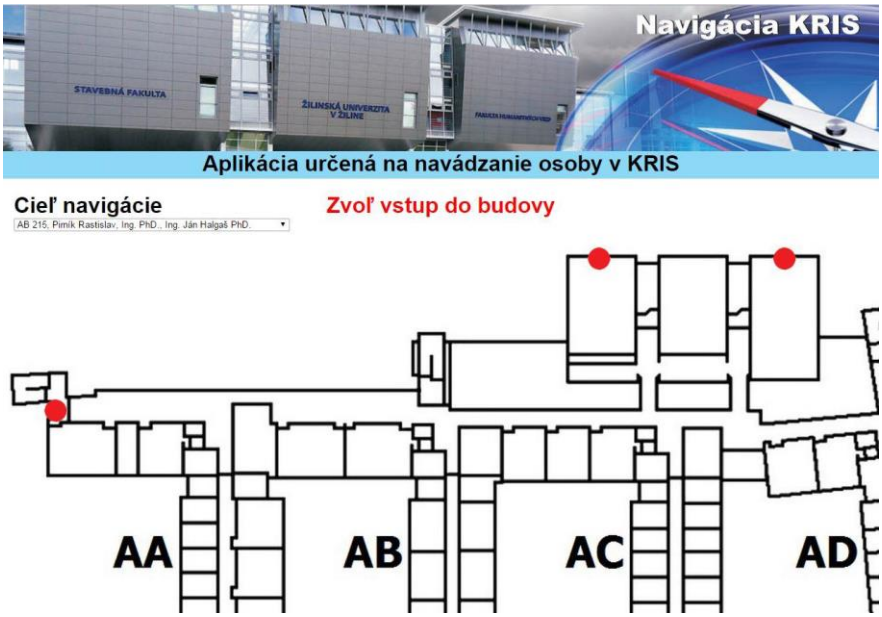

Fig. 8 Map of university campus

When the destination and entrance into the building are selected then the button Next is displayed. The navigation starts after pushing this button using visual navigation on the determined route.

Navigation view is designed in two versions, 2D (plan view) and 3D (spatial). Choosing between 2D and 3D navigation is implemented through the selection menu, which is located at the top of the application.

An assistance 2D navigation (Fig. 9A) is available to the user as a floor plan of the building. A user knows his actual position thanks to the starting point and the narrow marks on the map showing the course of the route.

3D navigation is realized by using short animations created in 3D program so the user is able to imagine the real part of building; respectively he checks visually whether he is in correct place on the proposed route.

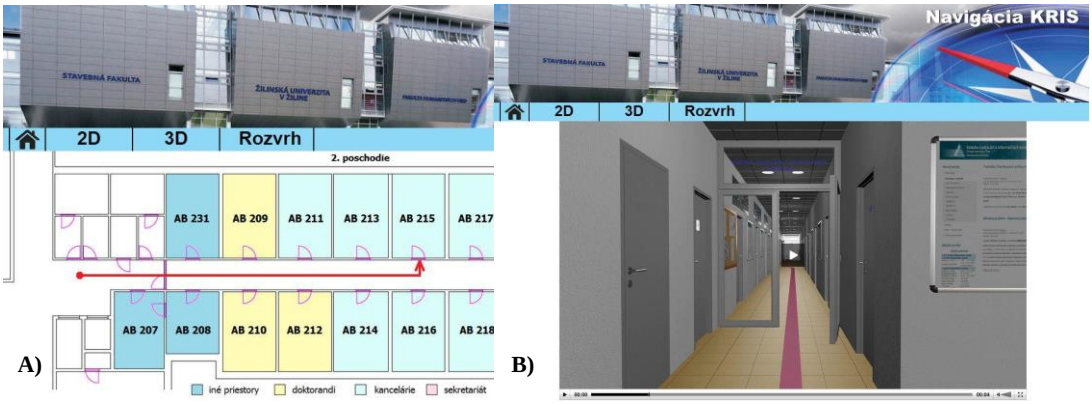

Fig. 9 Sample of 2D A). and 3D B). navigation

5 CONCLUSIONS

Research activities of University Science Park of the University of Zilina focus on development of new applications in area of Intelligent Transport Systems, using real data of operation of multimodal transport, information on the status of the traffic flow and transport infrastructure. The area of control systems for intelligent parking focused on the field of static traffic is priority. Research in this is focused on situational monitoring, statistical, visual aspect of the security and development of applications supporting effective way of managing calm traffic.

The designed and described IPS application in 3D shows a way of internal navigation. It can help logistic companies to avoid delays due long searching of a consignee address. This is connected with stressful situations, loss of confidence, or even the customer, imminent penalty for delay of delivery and other unpleasant situations.

ACKNOWLEDGEMENT

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