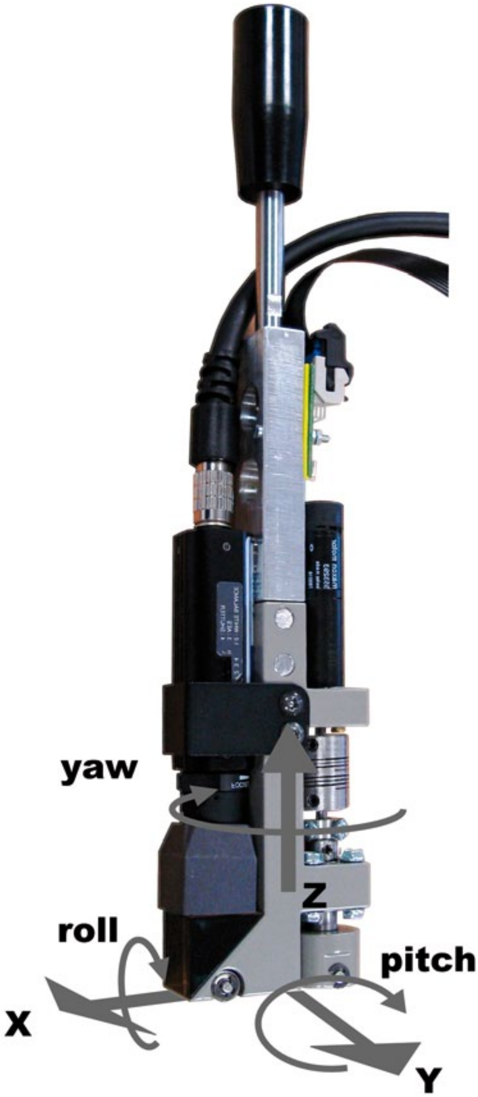
yaw
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Microcar, a Camera Holder Vehicle for Urban and Architectural Endoscopy Simulation Laboratories

1. Introduction

The study of the town planning through the use of scale model of districts and buildings is an involving, effective, intuitive, and of great impact, technique. The main difficulties are the manufacture of the plastic model with the desired quality, but especially making a film that simulates the vision of a resident of the future district.

The DiAP, Department of Architecture and Planning at the Politecnico di Milano, is studying the Porta Nuova project, a central and strategic quarter of the city.

For the camera holder system, the DiAP contacted the Beta Nit srl company, that had already collaborated with the University supplying the B.E.S.T., Building, Environment, Sciences and Technology Department with an automatic and programmable heliodon (Podestà, Prati, 2006).

The DiAP specifications were essentially of a device of immediate use, versatile, intuitive, and with dimensions compatible with the 1:500 scale model largely already built and compatible with the laboratory, not very spacious because of many pillars and ceiling beams. Moreover the Department required to use a specific analogic videocamera made by Elmo, with manual focus, no wireless connections, and with cylindrical shape of diameter 19mm and length about 100mm.

2. Considered solutions

We have evaluated several solutions before reaching the definitive one. The three main were:

1. A Gantry structure system with three independent motors for the movement inside the model along X and Y, and the rotation of the video camera around the vertical axis Z. Pros: this solution guarantees precise and repetitive movements with great smoothness if the system is rigid enough and well controlled. Cons: the limitations are evident, this solution requires an expansive, cumbersome and complicated structure, it needs an huge quantity of space around the plastic, it's difficult to use and to define any new path, it strictly requires great attention and safety regulations because of an accidental strong movement can damage people and things, these safety regulations are often very hard to satisfy in an academic building attended by thousands of students and other people, this refined solution is

Figure 1 (left)

also very expensive and subject to maintenance contracts. This solution, first of all for space reasons has been discarded.

2. Carrying videocamera device guided by tracks directly built in the plastic model. Pros: if tracks are well done, this solution provides good films at a very low price. Cons: this solution has been discarded because the tracks would have perverted the nature of the realistic reconstruction of the district, they would have been visible in the film and they could cause noxious reflections. The Politecnico had already many scale models of good quality and for the Department, adding railways did not make sense. Secondly, every change of path would have required the hard repositioning of the tracks or to fulfill the plastic of lines and railway junctions that can cause vibrations and light reflections.

3. Magnetic solution. Completely manual vehicle that, at the beginning of the curve, magnetically couples up a lever located below the plastic and whose fulcrum is on the center of the curve and its free angle is exactly the angle between the two crossing roads of the above plastic. Pros: easy, economical solution to guide the device through a curve. Cons: the lower part of the plastic must be very easy reachable, and user must continuously adapt the lever to the new path without contemporary seeing the upper side of the plastic. If the plastic has a solid base, the system needs a strong magnet that can interact with some electronic components like the videocamera. The user has to push the vehicle in the direction tangent to the curve, in case of wrong positioning, it is difficult to correct the position after the magnetic coupling up. This solution has been discarded because the below part of the big plastic was almost completely inaccessible and because the Department DiAP needed maximum freedom and versatility in the definition of the vehicle paths.

3. Adopted solution

According to the Department DiAP requests, we has defined all the specifications for our device, called Microcar. Objective has been to develop a vehicle with manual motorization, compact, agile, versatile, able to pass across avenue wide little more than 10 m (20 mm in the 1:500 scale plastic model), with buildings 100 m high. The main issues were to optimize the execution of the curves and to position the optic of the videocamera in such a way to maximize the luminosity and minimize the glares and the flashes. We have chosen a three wheels vehicle, that in comparison with a four wheels guarantees great compactness, agility, controllability to little less stability detriment. The wheelbase and the dimensions have been chosen according to the minimum radius of curvature of the curves of the Porta Nuova project. The main wheel can steer via a motor controlled by a drive with position feedback. This solution enables the automatic control and execution of the curves. Because of the dimension specifications it has not been possible to add a motor wheel. The videocamera is positioned vertically towards an optical prism with a special cover in such a way that we reach optimal luminosity without having negative reflections coming inside or outside the prism. The great luminosity of the prism provides a better depth of field, image quality, and a good focus. The control knob can freely rotate around the vertical axis Z (Fig. 1) to avoid the user to oppose to the automatic controlled execution of the curve and it is positioned at a height such that it does not intercept the highest buildings.

The figure 4 shows an isometric drawing of the Microcar.

4. How Microcar works

The user connects with a cable the Microcar to the computer (Fig. 2) running the GUI, graphical user interface, he connects the cable of the videocamera to the acquisition system, he sets via the GUI (Fig. 3) the scale of the model, the velocity of the real observer, and the radius and the angle of each curve of the chosen sequence. He positions the device at the beginning of the path, starts the acquisition process, and pushes the vehicle at the velocity of the observer, pedestrian or motorist whoever it is. At the approaching of the curve, the user has two ways of control to choose. In the automatic one, he presses a button located close to the Microcar and the device executes automatically the curve. This automatism gives also the user the opportunity to check and adjust the velocity of the virtual observer, in fact if for instance, the automatic curve movement takes too long to complete, it means that the user is pushing the vehicle too fast compared to the target speed. The second way of control is the manual mode. In manual mode the user can control every little rotation of the vehicle, so during the execution of a curve, he is able to start a movement and to stop it when he wants, or he can make several micro rotations in every directions. The manual mode feature has been developed in a second moment on Department DiAP request, when the first users of the device had trouble to control

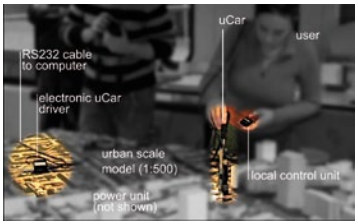

Figure 2

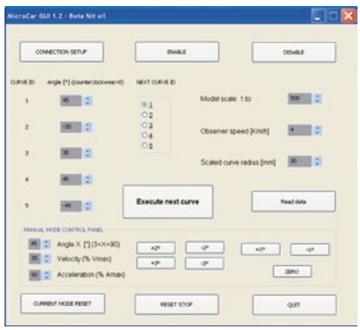

Figure 3

the machine not much during a curve, but especially during long straight roads because of the irregularity of some parts of the plastic basement.

After each curve the user pushes the Microcar on the next straight way before approaching the next curve and so on.

The final result is impressive (see references for videos), the device compared to other solutions like Gantry systems is not so precise and repetitive, has user ability dependent performance and it suffers the irregularity of the model base, but is intuitive, very small, easy to use, not at all dangerous for people and scale model, maintenance free, it does not require complicated previous programming, it can follow the gradients of the model basement, feature for which a Gantry system would need the 4th motor, and especially it's very cheap so that many researchers will can use it, having money left to spend in other experimental studies. It is a patent pending device.

Current developments

The tests at the Department DiAP showed the features and the performance of the Microcar, strengths and weaknesses. Currently we are working to add more features, like the possibility to change the height of view, modifying the relative position of the videocamera and of the optical prism. We are also adding some more local digits, located close to the device, to make the user more independent from the GUI.

References

Giulio Maria Podestà, Michele Prati: "A New Scanning Sky Simulator" in Proceedings of the EUROSUN 2006 Conference, Glasgow, U.K., 27.-30 Jun. 2006

Some video demonstrations are available at our website:

http://www.betanit.com/category/catalog/architectural-endoscopy

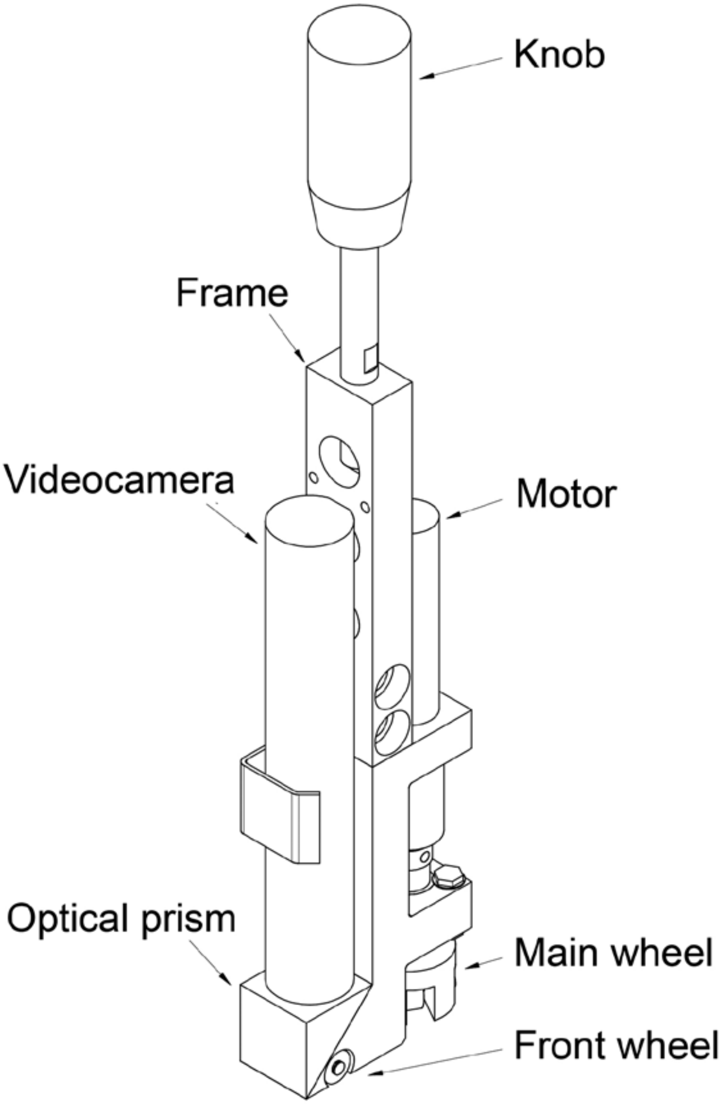
Knob
Frame
Videocamera
Motor
Optical prism
Main wheel
Front wheel

Figure 4