Interaction techniques for multi-device environments: Applied to railways simulator training

Technique d'interaction pour environnement multi dispositif : Appliqué sur formation ferroviaire

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ABSTRACT

Simulation training is an essential part of railway networks worldwide. For the simulation to happen, an instructor prepares the environment using a specific scenario creation application (step 1), then goes to a simulation room to supervise trainees (step 2) (see fig. 1). These two steps are rather complex and involve tedious interactions. Our goal is to study the benefits of integrating multi-device interaction into these two environments. To this end, we first interviewed users to identify HCI issues in these platforms. For step 1, we developed SmartCom to enhance command selection in the scenario creation application, which combines a touchscreen with a keyboard. Next we propose a timeline interface to improve the supervision activity in step 2.

CCS CONCEPTS

• **Human-centered computing** → **Interaction techniques**.

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KEYWORDS

Interaction technique; Command selection, MDE, Simulation.

RÉSUMÉ

La formation à la simulation est un élément essentiel des réseaux ferroviaires dans le monde entier. Pour que la simulation ait lieu, un instructeur prépare l'environnement à l'aide d'une application de création de scénario spécifique (étape 1), puis se rend dans une salle de simulation pour superviser les stagiaires (étape 2) (voir fig. 1). Ces deux étapes sont assez complexes et impliquent des interactions fastidieuses. Notre objectif est d'étudier les avantages de l'intégration de l'interaction multi-device dans ces deux environnements. À cette fin, nous avons d'abord interviewé les utilisateurs afin d'identifier les problèmes d'IHM dans ces plateformes. Pour l'étape 1, nous avons développé SmartCom pour améliorer la sélection des commandes dans l'application de création de scénarios, qui combine un écran tactile avec un clavier. Ensuite, nous proposons une interface ligne de temps pour améliorer l'activité de supervision dans l'étape 2.

MOTS CLÉS

Techniques d'interaction ; Selection de commande, MDE, Simulation.

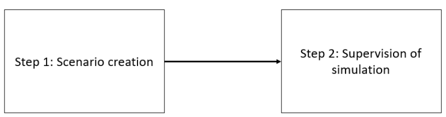

Figure 1: Steps for simulation training.

CONTEXT

OKTAL Sydac is a supplier of hardware and software platforms for railway simulations. Vehicle transportation simulation software are an essential part of every railway network in the world. It is used to let drivers practice a vehicle or an environment, put drivers (virtually) in stressful and dangerous scenarios, and evaluate drivers' skills. To create these environments and scenarios, a scenario creation software is used. Due to its richness in functionalities, the software becomes a complex environment that consists of many commands, windows, features, and this results with a dense user interface. In addition, after the scenario has been created, a driving instructor and up to 4 students go to a simulation room to test the created environment. The students sit in front of their simulator composed of up to 3 displays and physical manipulators (gears and buttons), whereas the instructor goes to the "instructor post" composed of up to 12 displays, 3 tactile screens (see fig. 3), a keyboard and a mouse. Furthermore, the instructor is in charge of monitoring and supervising the students, making sure that they follow all safety standards while driving. Thus, sometimes the instructor have to walk away from his desk and walk around the students making sure that they are using the simulators correctly. Therefore, an interface for a tablet has been proposed.

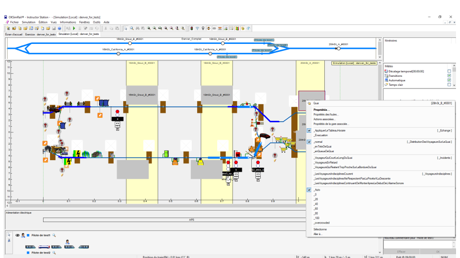

Figure 2: Contextual menu covering the primary UI in the scenario creation application.

ANALYSIS

To identify the existing interaction problems in this two steps of the simulation platform (i.e. step 1 in fig. 1) scenario creation application, and 2) student supervision system), we interviewed some of the employees from different backgrounds and some of the clients that are the end users of this platform. We also used the software extensively and we decomposed its complexity by generating hierarchical task tree analysis.

From the data we gathered, we concluded the following issues:

- For the scenario preparation phase, we noticed that 1) the implemented menus and auxiliary windows hide a big part of the primary UI. 2) Due to the huge amount of command and features, users often spend a long time navigating menus to search for a needed command (see fig. 2). Moreover, 3) users still use the traditional mouse and pointing gesture to reach the menus and access commands. As a result, homing cost is elevated.
- During the simulation phase we found that it is impossible to deport all of the windows displayed on the instructor desk to the tablet. Therefore, we proposed using a spatial-temporal timeline view that represents all the students with respect to their position in the track, events of the scenario and has access to all the commands used by the instructor.

Figure 3: Example of an instructor's post for simulation supervision.

In the next section we will present SmartCom, our proposed solution to enhance command selection for the scenario creation software. In the final section we will discuss the future work we plan to do on the simulation environment during this research project.

SMARTCOM

Despite having keyboard shortcuts implemented as solution to have direct access to some of the commands, users have to memorize all the hotkeys for these commands [13], [14]. Researchers from the HCI community have proposed many solutions [10], [11], [13], [16], [9], [1], [12], [4], [5] to facilitate command selection. Solutions to the 3 problems are in many forms. 1) New menu interfaces (e.g. Marking menus [15], [2], [20], Pie menu [8] and many more). 2) New interaction techniques that facilitate command selection and encourage hotkey usage [9], [21], [7]. 3) Augmented and new physical input devices that can be used to enhance command selection [18], [17], [19], [6] and [3] (e.g. RPM, LensMouse, TDK, and Métamorphe). However, all of the proposed solutions do not address all of the 3 listed issues together. Therefore we propose SmartCom, a novel and practical solution for enhanced command selection.

Figure 4: SmartCom setup.

SmartCom (see fig. 4) is a combination of a smartphone and the keyboard that allows increasing the interaction technique vocabulary by combining the keyboard keys and the tactile screen of the smartphone. To activate a menu on SmartCom, users hold the modifier key (e.g. Ctrl) with their pinky finger, leaving the thumb free for touch gestures (see fig. 5). In addition, users can hold the modifier

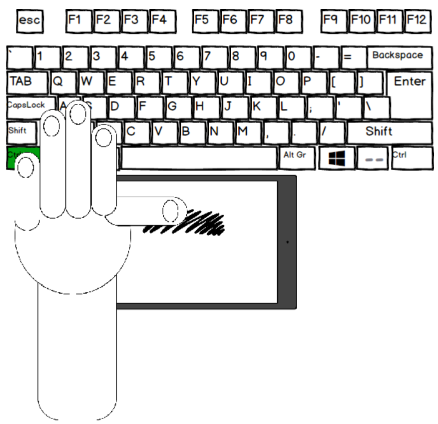

Figure 5: Sketch representing hand and fingers position for SmartCom command access usage.

Figure 6: Participant using SmartCom during the reachability study.

key, and then press and release a letter key to access the 2nd level menu on SmartCom. Moreover, it is possible to deport all auxiliary windows from the primary screen to SmartCom and make interaction with those at the users' fingertips. For example, instead of opening contextual menus on the primary UI, we can have the same menu on SmartCom and interact with it using direct touch.

Moreover, our priority is to help users access command faster and not memorize them due to their large number. Hence, the necessity of having a visual feedback. Additionally, the visual feedback can be adapted to users's expertise. (i.e. a command can be an icon, text, icon+text, or even a preview of what the command does.). Before proceeding to the design and evaluation phase of the interaction techniques, we performed a reachability study (see fig. 6) to get the reachable areas beneath the keyboard. We concluded that there is no major difference in difficulty between the left and right side, and that 80% of a 5.8" smartphone is comfortably reachable when positioned beneath the keyboard. These results are promising and show us that our approach is viable. Accordingly, we are going to proceed to the design phase in the upcoming months.

FUTURE WORK

In the near future we will be providing OKTAL Sydac with new proof of concepts of SmartCom. In addition, we will be designing and evaluating interaction techniques for enhanced command selection on SmartCom. Afterwards, we will begin our conceptualization phase for the timeline we proposed and the interaction techniques that goes with it. We will start with a brainstorming session to see how people imagine filtering layers of a timeline can happen on a tablet. Then we will provide OKTAL Sydac with interaction techniques to navigate the timeline, filter information layers on and off it, and launch commands from the same interface, without affecting the instructors' cognitive workload. Furthermore, in cases where the scenario creator (step 1 in fig. 1) is the same person as the instructor (step 2 in fig. 1), the user will be able to use the same tactile device to have control on both steps.

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