Fusing Events, Tasks and Spatial Awareness in an Ambient-Enabled Work Environment

Juri Buchmüller, Manuel Stein, Alexander Jäger, Sabrina Schmidt, Hansi Senaratne, Halldór Janetzko
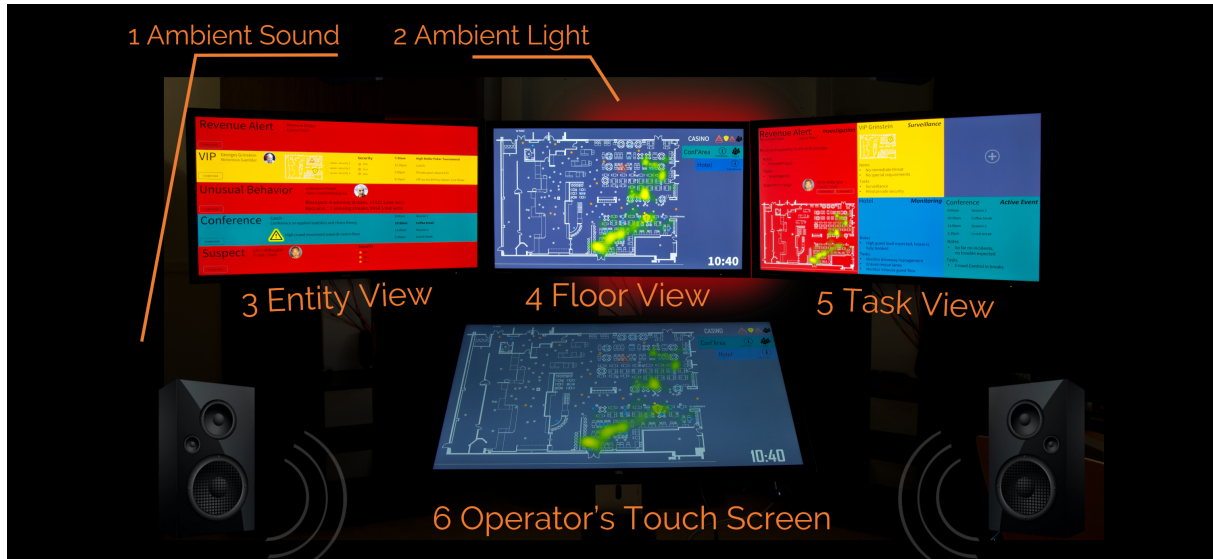
Fig. 1. Control room setup for an interactive resort surveillance and investigation system. Beside several data-driven views, we enhance situational awareness by ambient light and sound. Each operator can interact with the underlying data using his own large touch screen.

Abstract—Supervising a large complex environment is quite challenging due to the high amount of data incoming each second and asking for the operators' attention. We increase the situational awareness by fusing events, tasks, and spatial awareness employing a combination of the visual and the acoustical channel. Our control room setup allows collaborative hypothesis generation and verification in a shared working environment. Global views can be put on each operator's touch screen for detailed analyses and annotations. All information is shared automatically between all operators.

Index Terms—Situational Awareness, Ambient Sound and Light, Control Rooms

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1 INTRODUCTION

In complex control room scenarios, successful recognition and handling of events is highly dependent on situational awareness and interactive support for hypotheses generation and verification. Our approach employs both the audible and visual channel enhancing overall situational awareness. We support the knowledge generation process by multiple, interrelated views based on entities, space, time, and tasks. We consider that a facility like Eubia Resort is too complex to be monitored by just looking at guests and/or reading sensors. Therefore, we assume an automatic threat and event model enhancing the cognition of the operators, being able to hint at developing situations or showing unsuspected connections. The model automatically detects unusual situations with a broad spectrum by fusing basic, measurable data, e.g. changes in revenue, guest density, movement direction of guests, event schedules,

- J. Buchmüller, M. Stein, A. Jäger, H. Senaratne and H. Janetzko are with University of Konstanz, Germany. E-mail: forename.lastname@uni-konstanz.de
- S. Schmidt is a freelance photographer. E-Mail: info@passion-fotografie.de

CCTV and many more. If the operators detect other events, these can be added into the system by just adding a task. The system then helps tracking all relevant entities. Also, the ambient sound and light system feeds from the threat model and improves the alertness of the operators. As the sound is generated directly from unfiltered incoming data, the operators can hear a certain critical situation build up before the threat model would be certain to display an entity, and thus take immediate preventive action. Aiding the threat model as well is the link to police databases so that known suspects can be identified easily.

2 CONTROL ROOM SETUP

We designed a task-based interface for an interactive resort surveillance and investigation system with a setup similar to [2]. Yet, besides three main views for Entity-, Spatio-Temporal, and Task-Tracking, which are displayed for all operators on three big central wall screens, a core part of our system is the integration of the investigators' direct work environment, which we enhance with ambient light and sound systems guiding the investigators attention. By employing additional clues about the current state by ambient light and sound, we are able to increase the situational awareness of the operators. Operators bring one of the main screens to their own large high-resolution touchscreen and can transparently for the other operators edit hypotheses. The results of the individual analyses is automatically synced between views and shared among all operators. We sketched our proposed system in Figure 1.
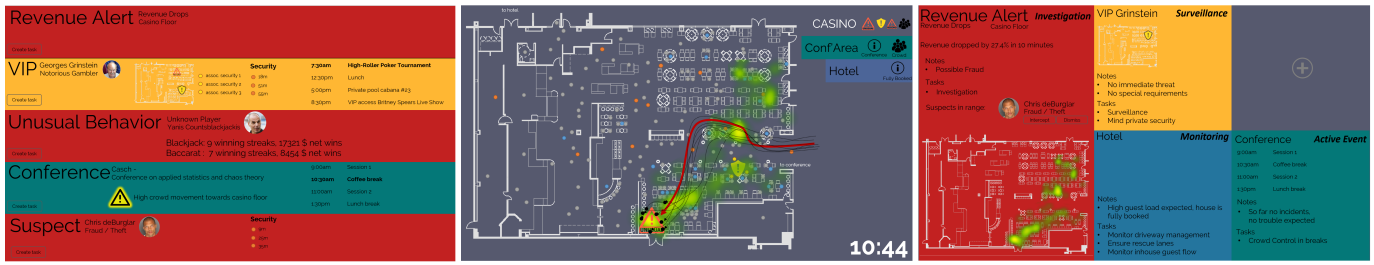
Fig. 2. Three big central wall screens display our three main views for Entity-, Spatio-Temporal, and Task-Tracking.

Ambient Sound

Ambient sound can be used to steer the attention without any visual cues [1]. Ambient sound, much like a car engine, produces a constant ambient noise that does not distract the operators. The noise is generated from a combination of influence factors automatically gathered from resort information: Guest load, on-site crime reports, CCTV imagery, movement behavior models, VIP presence and many more. As situations in the resort arise, e.g. unusually high guest loads, sinking casino revenue or increasing theft/fraud, the frequencies of the noise changes. Our proposed noise is constructed by overlaying several noise frequencies corresponding to the situational aspects. In normal state, all noise frequencies have the same amplitude. By pre-attentive cognition, operators immediately notice the change in their "engine" and shift their attention and concentration directly to the situation, subconsciously already identifying the problem location.

Ambient Light

Ambient Light is publicly known thanks to the development of televisions with lighting capabilities. Research indicates that the use of ambient light to indicate important areas helps analysts to prioritize and to prevent frustration [3], thus enhancing productivity and alertness. The basic idea in our setup is to create a higher immersion by image correlated lighting. We follow this idea by identifying important spots in our visualizations to look at and highlight the respective border region with ambient lighting with the corresponding color. Consequently, operators perceive further guidance by ambient lighting guiding their attention towards newly emerging elements on the screens.

3 MAIN VIEWS

When we designed our control room setup in combination with the three main visualizations, we had the idea of connecting events or incidents with tasks. Consequently, the threat model will prioritize the detected events and operators create responsive tasks or add tasks based on their domain knowledge manually. All visualizations will be synchronized to ensure transparency between the operators without communication overhead. The color scheme used for the design elements between the screens adheres to the cognitive perception of color in the varying contexts and always remains the same to keep context: VIPs/Entities to be guarded in yellow, dangerous situations, unusual behavior by suspects or known criminals in red, events like conferences in green and general situations like a high guest load in blue. We describe each visualization depicted in Figure 2 in the following subsections.

Event View

The leftmost screen displays a list of entities relevant to current operations, annotated with the most important information such as schedules, guest backgrounds, nearest security, and any other suitable information. Interaction possibilities specific to the type of entity are provided (e.g., having security monitor / approach suspect). Entities shown can be persons (e.g. VIPs, or known or detected suspects), events (e.g. conferences, crimes), or situations (e.g. high guest load) that require attention. The list is sorted automatically or manually by an importance ranking of the entity (e.g. a VIP needs to be guarded at all cost, so he is at first place in the ranking). Alerts can connect entities visually, for example grouping VIPs and potentially dangerous suspects.

Task View

The right screen shows tasks the operators can define. It is a note-taking environment where tasks can be created from entities, managed, and freely arranged. Here, the operators collect information, define and track tasks, and gather knowledge transparently in the collaborative setting. The view will furthermore be automatically annotated with all available information on the entity, e.g. schedule if known, police records, interaction possibilities, floor position, and more. Orders to employees can directly be issued from the task screen, and the nearest free employee will attend to orders. A task can be annotated with free text notes about general relevant information, about what has to be accomplished, and what actions remain to be taken. It summarizes as well gathered knowledge. Tasks are color coded the same way as events, and can be resized to reflect importance. They can also be reordered or even merged to reflect connections between tasks.

Spatial View

In the middle screen, the main resort areas are displayed. The operators can switch between casino, hotel, and conference area. Symbols next to the areas indicate major events in an area, also for those areas not displayed entirely. These events relate to the entities from the left screen (e.g. VIP present, suspect present, fraud ongoing, etc.). On the floor plans, guests, employees, VIPs, and suspects are color-grouped and can be interactively tracked with movement trajectories. This includes trajectories of persons that behave similarly, for example guest groups or otherwise connected people. Furthermore, an operator can interactively request the sight or communicate with security personnel, or detailed information on a person can be accessed. Important or suspicious persons are highlighted. The floor plan also allows interaction with equipment like WiFi-Hotspots to check who is logged in. Heatmaps display aggregated data such as revenue per casino table or guest density, if values differ from expected values in an unusual way.

4 CONCLUSION

We described a working environment enhanced by ambient lighting and sound supporting operators' overall situational awareness and allowing in-depth investigations of incidents and hypotheses. We believe that ambient lighting and sound will further increase the efficiency of the operators. However, this has to be proven by further studies.

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