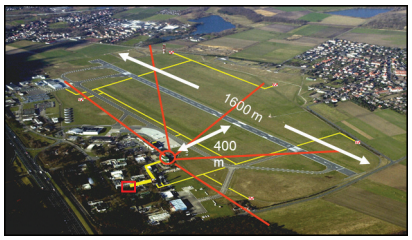
Deutsches Zentrum
für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

Handout

Remote Tower Operation and the Remote Airport Traffic Control Center

Braunschweig Research Airport with main runway in east–west direction. Red lines indicate camera segments of a 180° video panorama system; red circle: camera location; red square: visualisation system; yellow lines: fiber-optic high speed data network, with thick line indicating 600 m Gbit link for panorama video transmission.



RTO sensor system for 180°-video panorama consisting of four remotely controlled high resolution panorama cameras and pan-tilt zoom (PTZ) visible and thermal imaging cameras on top. Braunschweig control tower in the background.

180° Video panorama system with additional PTZ camera display above. Pen touch input display below contains electronic flight strips and PTZ control.

Remote Tower Operation (RTO) describes the goal of remote controlling small airports and movement areas of large airports which are not directly visible from the control tower. Results of tower work and task analyses showed the importance of the direct far view out of the tower windows for establishing the controllers' situation awareness under present day work conditions. This finding provided the motivation for developing a digital high resolution augmented vision video panorama as main component of the RTO Human Machine Interface (HMI) that replaces the direct far view out of the tower windows.

An experimental RTO-system for initial field testing was realized at the Braunschweig research airport within the DLR project RapTOR (2005-2008). A PC-cluster for image processing and compression at the camera position allows for storing panorama and zoom data (roughly 40 GByte of data per hour). This feature provides the possibility of complete panorama replay. The live video panorama with synchronized video stream from four high resolution cameras and the remotely controlled PTZ-camera are displayed on five high resolution monitors or alternatively on backprojection screens. Interaction of the operator with the panorama system (cameras, weather station, stereo microphone) is performed via pen touch-input display. Field tests with expert and non-expert observers proved the visual resolution to match the theoretically expected value of ca. 1/30° which is about half as good as the human eye.

Features Beyond Conventional Control Towers

The digitally reconstructed panoramic out-of-windows view allows for several automation features which are not available within the conventional control tower environment. Besides image processing based automatic movement detection, augmented vision is of particular interest: flight data or real-time aircraft positions obtained from approach radar, via transponder from a multilateration system or from GPS / Satellite navigation may be integrated at the display coordinate of the respective aircraft. Under reduced visibility this Augmented Tower Vision (ATV) feature allows for localizing the a/c near the correct geographical position. In addition contours of the movement areas may be superimposed on the reconstructed panorama for guiding the operators attention during darkness or bad weather. Position data, e.g. from movement detection allow for aircraft tracking by means of the zoom camera.

Remote Tower Center (RTC)

The RTO technology allows the realization of a Remote Tower Center (RTC) which combines several RTO workplaces for two or more remotely controlled airports from a central location, each airport equipped with its own high resolution camera system. Together with the live video stream all local airport data like approach radar, weather and radio communication with pilots are transmitted to the RTC workplace. RTC together with the RTO specific automation tools allows for new and more efficient control tower work organization.

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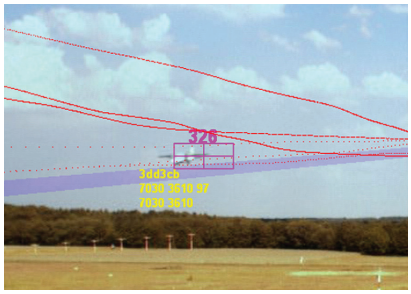
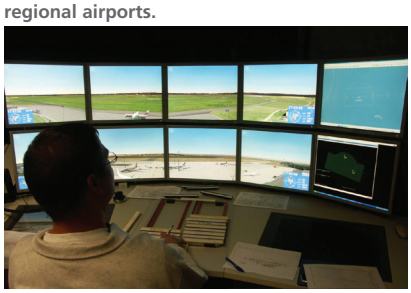
Screenshot showing augmented vision features with DLR test aircraft during approach. With highlighted 3°-glide path (violet), transponder code and multilateration position at aircraft location (yellow), numbered square at A/C position from automatic movement detection (image processing), and superimposed GPS trajectories from previous approaches (red).



Remote Tower (RTO) simulator console with backprojection videopanorama attached to the DLR tower simulator.

Simulation experiment in an RTC environment with two simultaneously controlled regional airports.



Validation of New Procedures

Validation of specific operational procedures, matched to the new RTC work environment requires a special RTO/RTC simulator. This is in order to iteratively optimise the work situation within a process of participative design, i.e. with repeated feedback by tower controllers as domain experts. A high fidelity RTO/RTC simulator environment was realized as component of the DLR tower simulator. It provides the possibility to create reproducible traffic scenarios of different complexity. Within the DLR project RAiCe several simulation phases with controllers from different regional and international airports have shown the principle feasability of remote control, even with a single operator responsible for two airports.

Tests under Real World Conditions

Within a cooperation between DLR and the German air navigation service provider DFS validation experiments under passive mode conditions are prepared within an extended experimental testbed. For this purpose, besides the Braunschweig research airport a regional DFS-controlled airport is equipped with a second video panorama system for providing more realistic operational conditions. It also serves for verifying the long distance high-bandwidth live video stream transmission. In parallel additional simulation experiments are prepared addressing the workload in a two-airport environment.