



MYTC

Creating Safe Communities through Information Technology
Training in Home Land Security Applications



Detroit Public SCHOOLS
Accountability + Added Value = Achievement

EvacMYTC: A Real-time Inside Building Evacuation Management Toolset

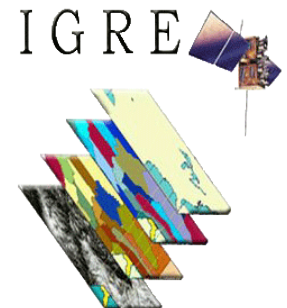
Dr. Yichun Xie

Institute for Geo-spatial Research and Education (IGRE)

Eastern Michigan University

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Background: The NSF Project - MYTC

"Detroit ITEST Project: *Mayor's Youth Technology Corps* - Creating Safe Communities through Information Technology Training in Homeland Security Applications" is a project funded by NSF ITEST Program.

This award (award # DRL-0737589) is supporting a three-year program (from January 1, 2008 to December 31, 2010) to develop a collaborative project between Eastern Michigan University (EMU), the Detroit Public Schools (DPS), the City of Detroit Homeland Security and Emergency Management (CDHSEM), and the Environmental System Research Institute, Inc (ESRI) to provide career training for homeland related agencies in Detroit.

EvacMYTC: 2D/3D Critical Infrastructure Emergency Management Toolset

The capstone of the GIS applications of the MYTC project is to train students to use a 2D/3D Critical Infrastructure Emergency Management Toolset to prepare first responder plans for selected school buildings or city critical facilities as learning exercises or as internship experiences. Simulations in a real-case application for evacuation planning and emergency response options will enable students to process complex problem solving and to learn critical thinking skills. This 2D/3D Critical Infrastructure Emergency Management Toolset (**EvacMYTC**) has been fully developed. This toolset involves geometry, trigonometry, computer-aided drafting and design, visualization, database management, and network analysis. A typical use of **EvacMYTC** in case of **fire** inside a multiple-story building includes the following orders.

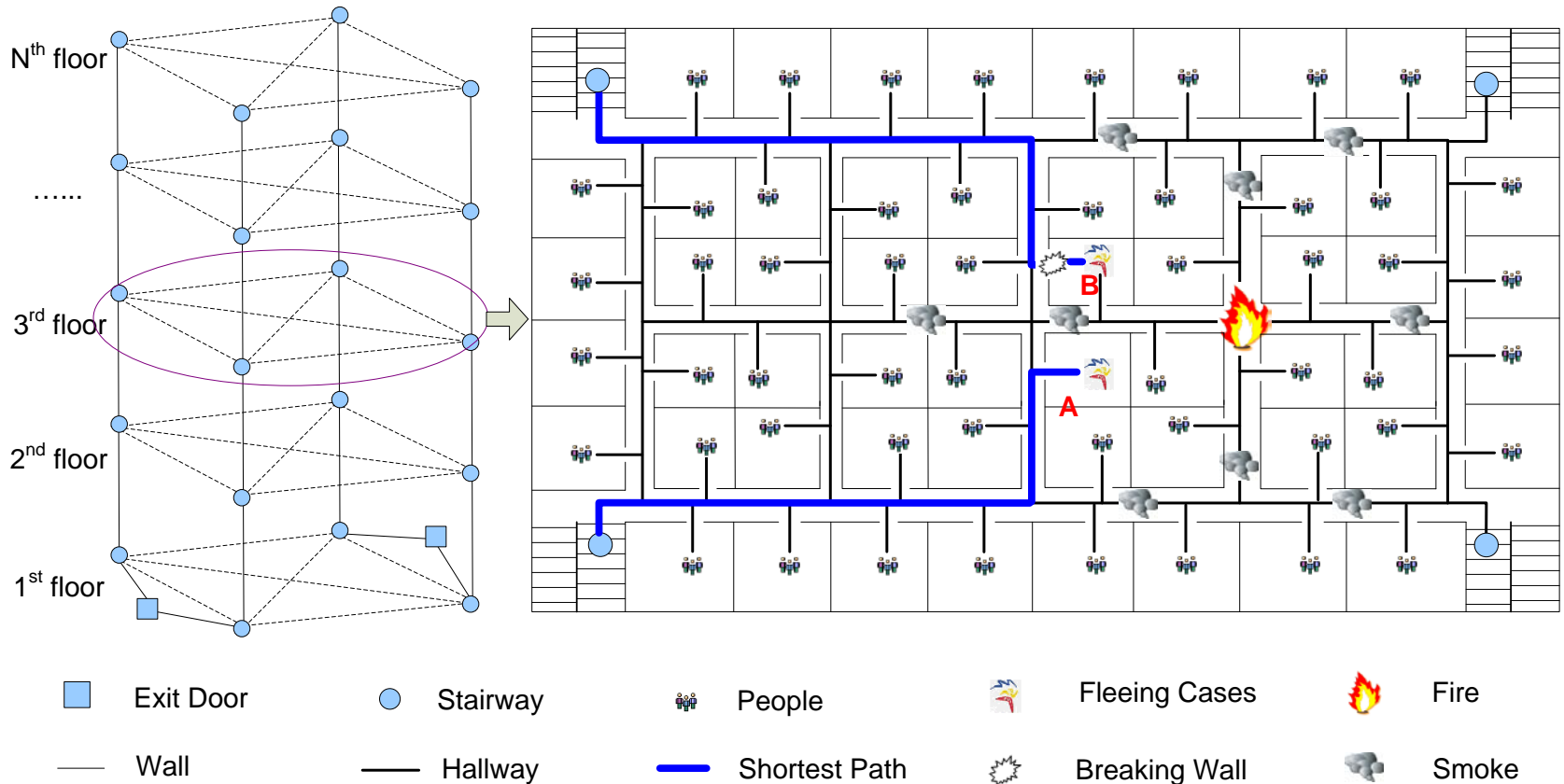
- Someone dialed 911 and reported a fire in a building located at [address, building]
- 911 System received the call and searches the database to find the closest fire department, and police department (**Find the closest facility**)
- 911 System directs fire trucks to take the shortest path reaching the scene (**Find the fast route**)
- **EvacMYTC** assists Firefighters to know the structure of the building (**CAD Drawings, and 3D rendering**)
- **EvacMYTC** helps Firefighters to find where are exits and entrances (**Searching Geodatabase**)
- **EvacMYTC** assists Firefighters to identify where are the peoples in the building (**Incident Spots**)
- Firefighters using the system to identify whether there are chemical materials or other hazardous materials inside the building, and where they are (**Identify Barriers**)
- Firefighters using the system to plan routes for getting into the building, and reaching the incident spot to rescue people and get them out (**Fast Route**).
- Update the data based on what is happening inside the building (**Real-time Evacuation Planning**)
- Estimate response time
- Send people to the closest hospital (**Find closest hospital**)

EvacMYTC: The Technical Innovations

- EvacMYTC is capable of constructing an evacuation network model from CAD drawings of a building, and extracting structural features (such as rooms, doors, fire extinguishers, fire alarms, fire alarm control panels, and exits/entrances) as nodes and other features (such as corridors and stairways) as paths that connect these nodes.
- EvacMYTC builds a 3D inside building network from these nodes and paths to represent navigable spaces that are attributed with the number of evacuees in each location and the evacuation capacity of the paths.
- EvacMYTC can be used to prepare an optimized evacuation plan before events and to make real-time adjustment at emergencies when circumstances are changing constantly. The toolset also highlights potential congestion spots by simulating the movement of evacuees inside the building.
- First responders can predict possible locations of evacuees at any given time during an evacuation. Therefore, the responders can adjust evacuation routes in real time and save more lives.

EvacMYTC: The 3D Database Structure

The 3D data model of EvacMYTC builds on three elements (Fig. 1): (1) typical bus-routing algorithm; (2) Interior Building Mapping Framework; and the concept of combinatorial 3D data model. Therefore, the EvacMYTC's 3D model is called the inter-linked multi-layered transportation network (ILMLTN).



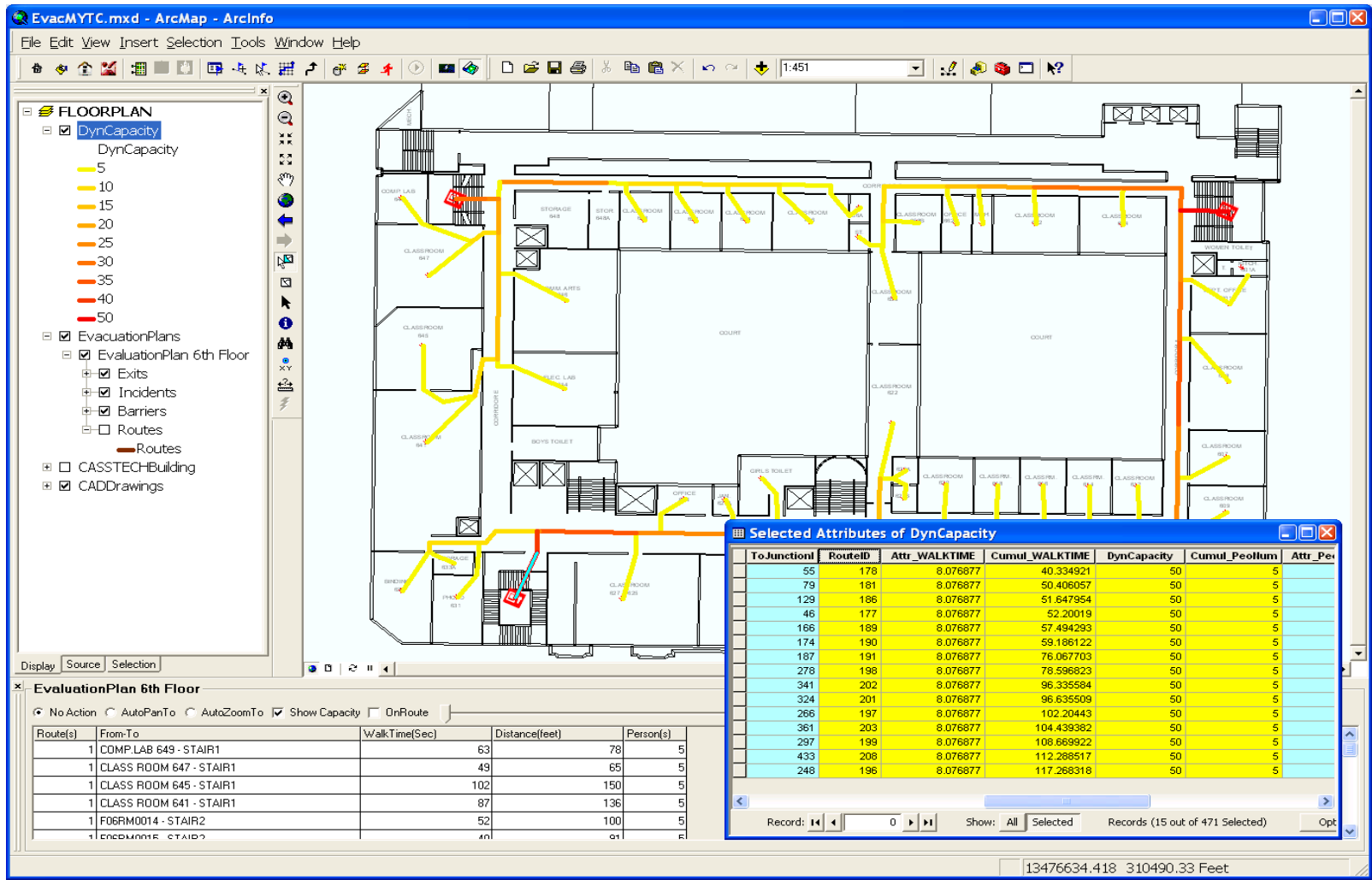
EvacMYTC: Real-time Planning Tools

EvacMYTC integrates routing functionalities with tracking module and provides interface to input dynamic changes into the system. Thus, the commander can update or re-create evacuation routes.

3D visualization	3D rendering of building to show evacuation routes, exits, assembly locations on the map,	Data Communication
Real-time simulation and decision making support	Incident locations, current locations of occupants, inside-building condition, available evacuation routes and exits	
Evacuation plan development	Evacuation routes, exits, assembly locations	
Inside building 3D network construction	Extracting (from the floor blueprint) rooms, corridors, doors, elevators, exists, stairways; Adding data about hazard material locations, assembly locations (inside or outside) shelter-in-places, occupants' locations	
Inside building resources maintenance	Database management for occupant's information (age, gender, disability, location); AutoCAD blueprints, facilities, equipments, hazard materials and their locations	
Data Communication Module: communicate data concerning surrounding features and with other agencies		

EvacMYTC: Real-time Evacuation Management

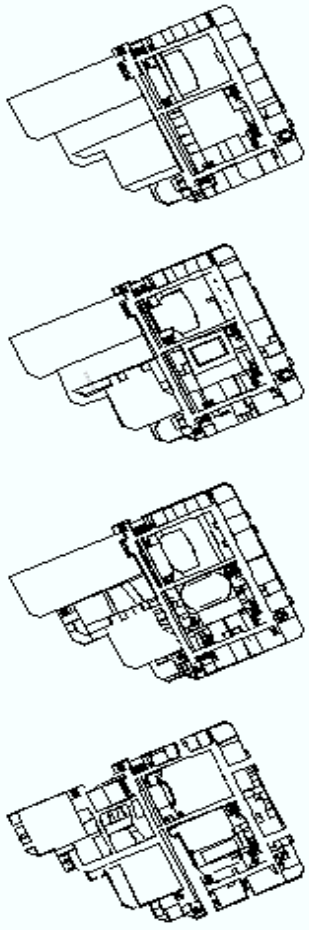
EvacMYTC includes a simulation tool to predict the locations of occupants at given times. This tool estimates the number of occupants on each segment of evacuation routes. Figure 4 demonstrates the evacuation routes and the number of occupants moving along the path at specific times during evacuation.



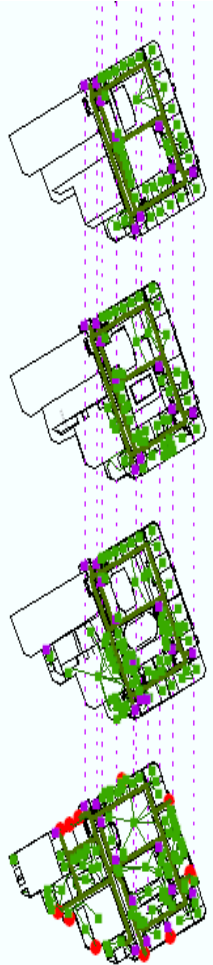
EvacuMYTC: GIS-based Visualization

EvacuMYTC is implemented as an extension to ArcGIS, which has full power of GIS visualization. It visualizes building structures and evacuation routes in three ways:

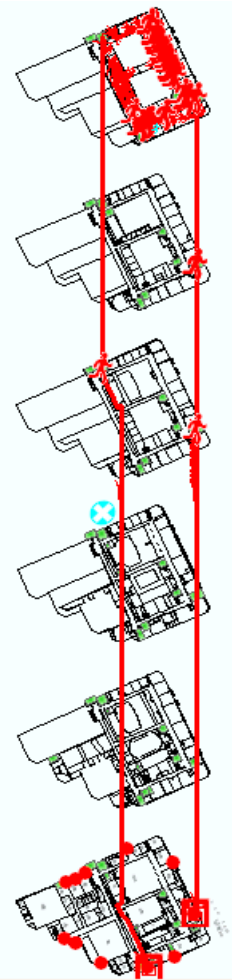
- (1) using 2D maps to draw building blueprints;
- (2) unfolding the building to 2.5D by using ceiling height as the third dimension for the network model visualization; and
- (3) rendering the entire building and evacuation routes and exits in true 3D through calling ArcScene. In this way, the first responders or commanders can view the building as a whole entity with multiple floors connected by vertical paths instead of separate individual floors.
- (4) Three different visualizations are presented in Figure 5.



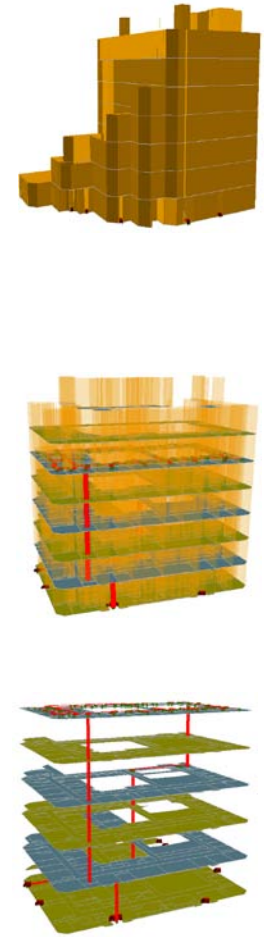
Blueprints



Blueprints with network model



Evacuation routes



3D view of building and routes

EvacMYTC: Summary and Discussion

- As GIS-based real-time inside building evacuation toolset, EvacMYTC is built on the interlinked multi-layered network algorithm to solve 3D routing problems inside tall and critical buildings. EvacMYTC can be used to both preparedness and response phases of emergency management.
- In term of preparedness, it helps building managers gather information about buildings and construct 3D network model for pre-event evacuation planning. It also provides tools for the managers to evaluate and readjust the evacuation routes.
- For response, EvacMYTC has a user-friendly user interface, allowing first responders and field commanders to enter dynamic changes or emerging events into the system. It also simulates the movement of the occupants and predicts the locations of them at any given time. With this critical information in real time, the commander or the responder can adjust evacuation routes on the basis of real situation or to avoid potential congestion spots so as to have much smoother evacuation. Therefore, they can make intelligent decisions quickly.
- EvacMYTC has been tested in high school buildings in Detroit Public Schools. More tests are necessary before it can be released for handling real-time onsite emergency response. The communication module needs to be improved, especially the communication with inside occupants during an evacuation process.

Questions:

Many Thanks!

Email: yxie@emich.edu; Phone: (734) 487-7588