

Indoor Location Tracking Based on a Discrete Event Model

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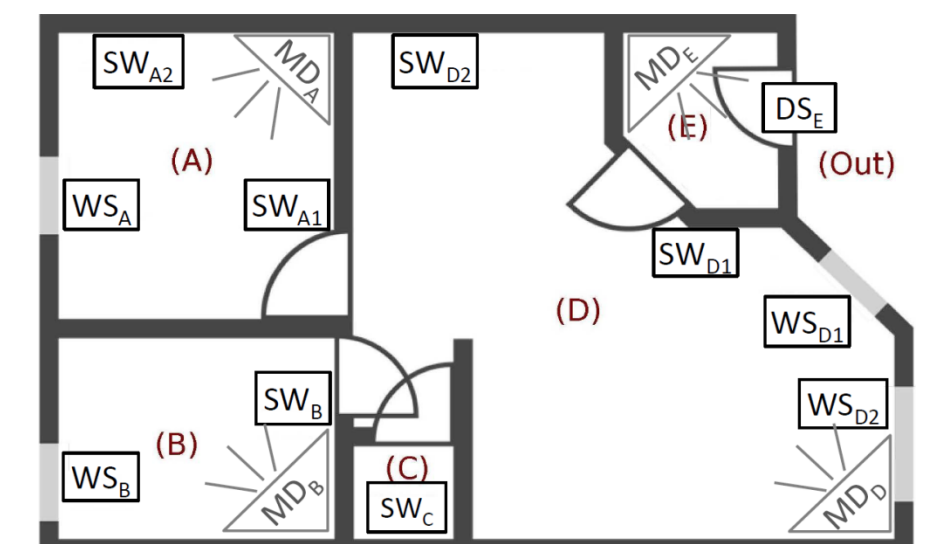
Introduction

Location Tracking for Ambient Assisted Living

- A new approach is proposed
 - For single inhabitant location tracking
 - For houses instrumented with binary and non invasive sensors
 - Using finite automaton to model the instrumented house
 - Using a model-based location tracking algorithm

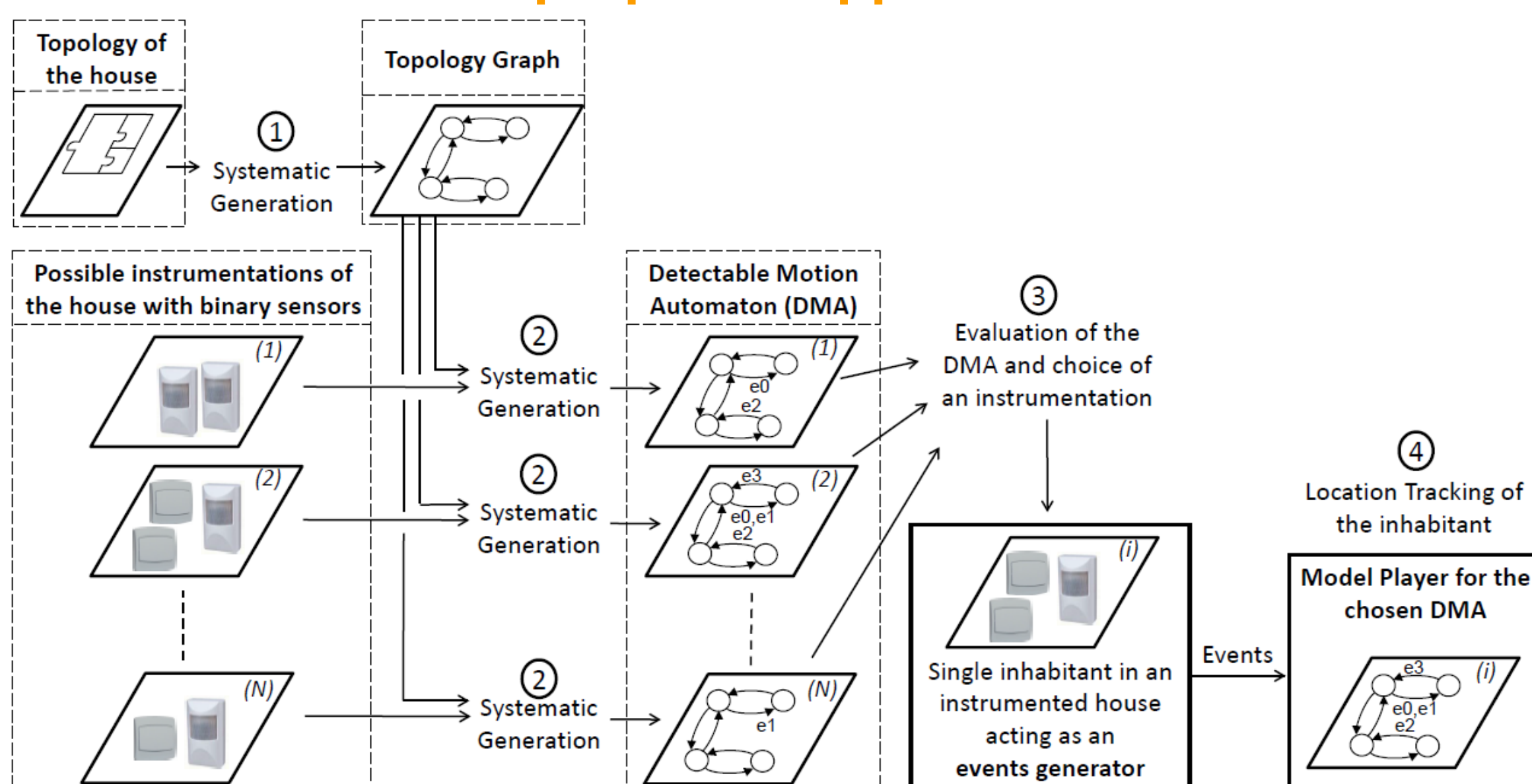
A case study

- Apartment in Kaiserslautern (Germany)
- Topology: 5 rooms (A,B,C,D and E)
- Instrumentation: 15 sensors
 - Door Sensor (DS)
 - Windows Sensors (WS)
 - Switches (SW)
 - Motion Detectors (MD)



Systematic generation of a model for location tracking

Overview of the proposed approach

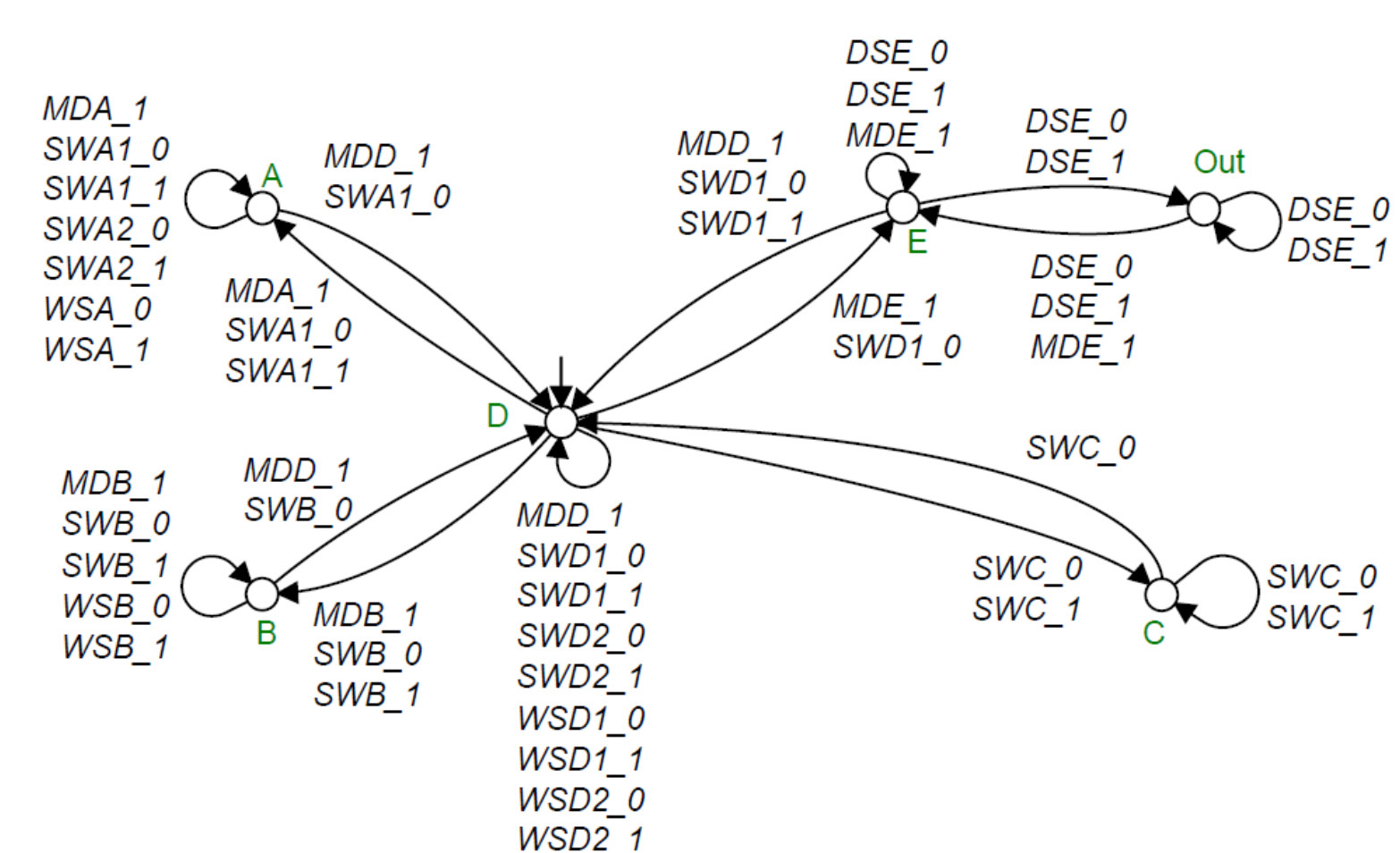


- Based only on the topology of the house (rooms and paths between rooms), a topology graph is built
- Starting from the topology and each possible instrumentation, a Detectable Motion Automaton (DMA) is systematically generated
- The best instrumentation is chosen
- Location tracking is performed online

Finite automaton formalism

- A finite automaton (FA) is a quadruplet $\langle Q, \Sigma, T, Q_0 \rangle$ with
 - Q a set of states ($Q = \{A, B, C, D, E, \text{Out}\}$ for the case study),
 - Σ a set of input events, (for instance the event MD_{D-1} is the rising edge of the motion detector MD_D)
 - $T \subseteq Q \times \Sigma \times Q$ a transition relation between states labeled with input events,
 - $Q_0 \subseteq Q$ a set of initial states ($Q_0 = \{D\}$ for the case study).

Detectable Motion Automaton for the case study



Location tracking based on finite automata

Model-based single inhabitant location tracking algorithm

Require: $Det_{DMA} = \langle Q_D, \Sigma, \delta_D, Q_{0D} \rangle$
(the deterministic FA equivalent to the DMA)

- Initialization of the monitoring:
Current state $S = \text{Initial state } \{Q_{0D}\}$
- while** Monitor is active **do**
- Wait for a new event e
- New event e is observed
- $S' = \delta_D(S, e)$
- Update current state $S = S'$
- end while**

Example for a typical day of the case study

- At 10:00:00, the location tracker is started, current location S is initialized as being $\{D\}$ (D is the initial state). $S = \{D\}$
- At 10:00:10, the event MD_{D-1} is observed. Update: $S = \{D\}$
- At 10:00:52, MD_{A-1} is observed. Update: $S = \{A\}$
- At 10:01:43, SW_{A1-0} is observed. Update: $S = \{A, D\}$, the current location is inaccurate
- At 10:02:11, WS_{D1-1} is observed, Update: $S = \{D\}$, the location is accurate again
- etc...

Conclusion and future work

Conclusion

- A formalism to model instrumented houses: finite automata
- A systematic approach for model building
- A model-based location tracking algorithm

Future Work

- Inactivity monitoring based on location tracking
- Multiple inhabitants location tracking

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