Building-CPS: Cyber-Physical System for Building Environment Monitoring

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design computation

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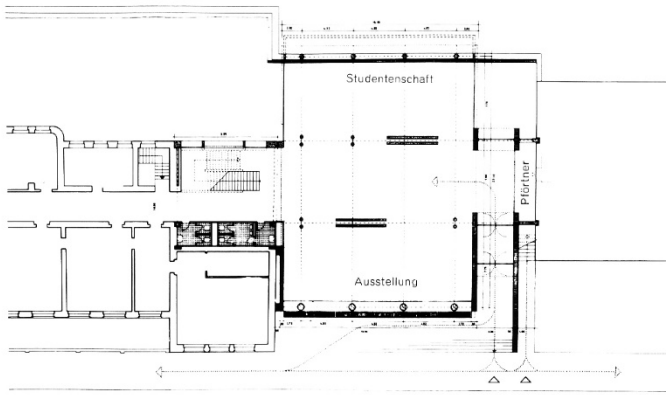
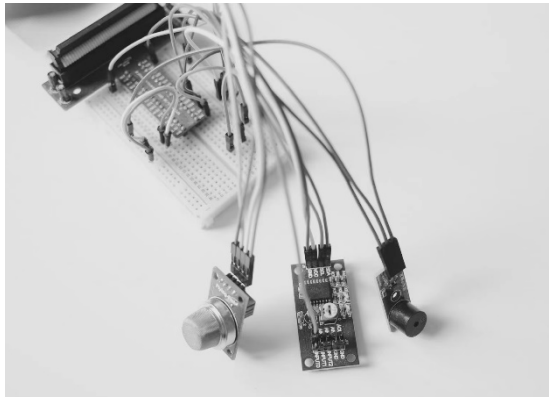
Background

building/city environment monitoring

- **Have you ever noticed that the uphill road/ cross roads will generate more pollutants?**



- **Better understanding of the exist building/city**

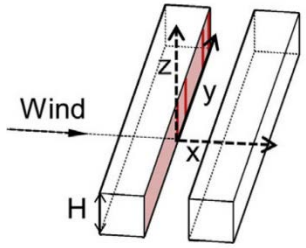


- **Distributed building/city database**

Current state

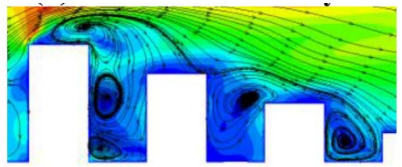
approaches applied to investigate the building/city environment

- **Mathematic analysis**



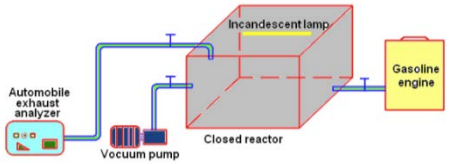
LES/RANS, Zheng, X., Montazeri, H., & Blocken, B. (2021)

- **Software simulation**



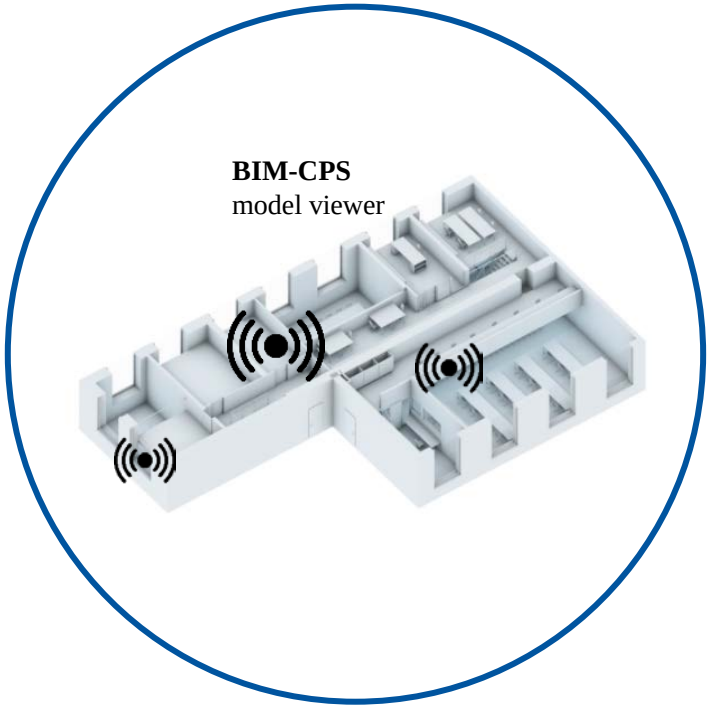
Zhan N.Y., Gao Z., Deng Y.F. (2018)

- **Laboratory experiment**



Hu, Z., Xu, T., Liu, P., & Oeser, M. (2021)

- **Physical environment perception + software models**



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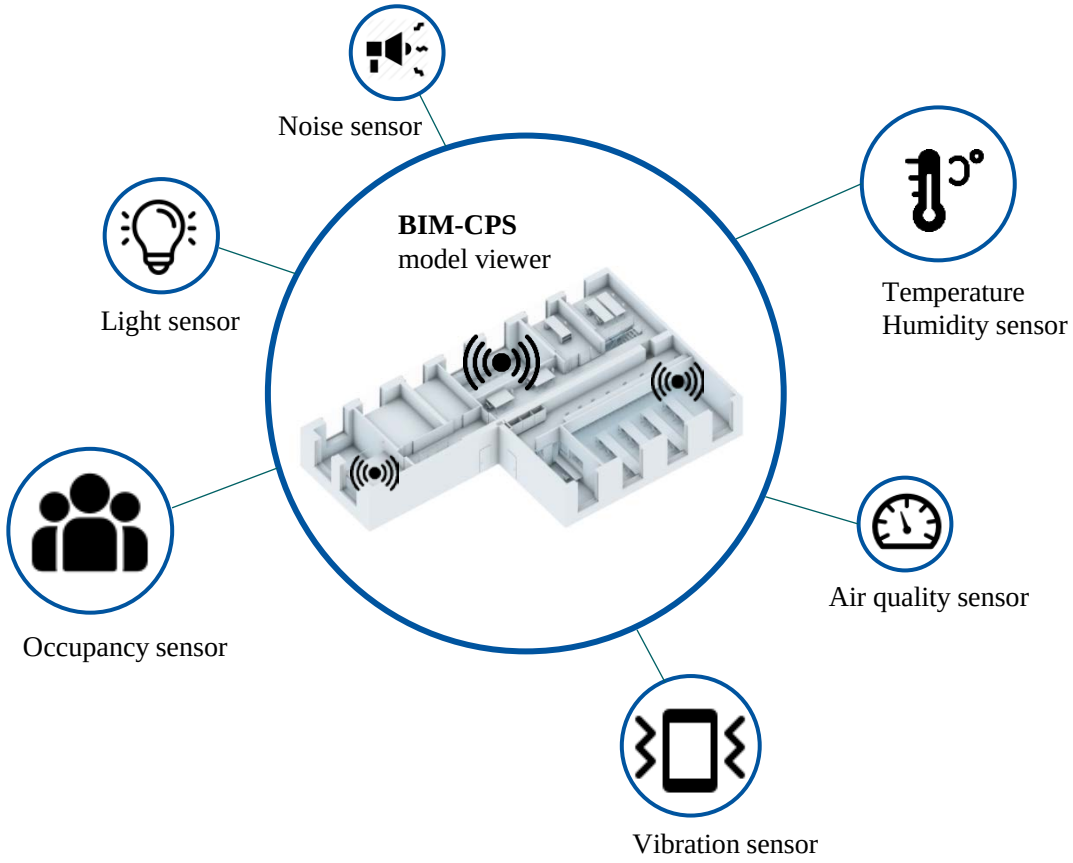

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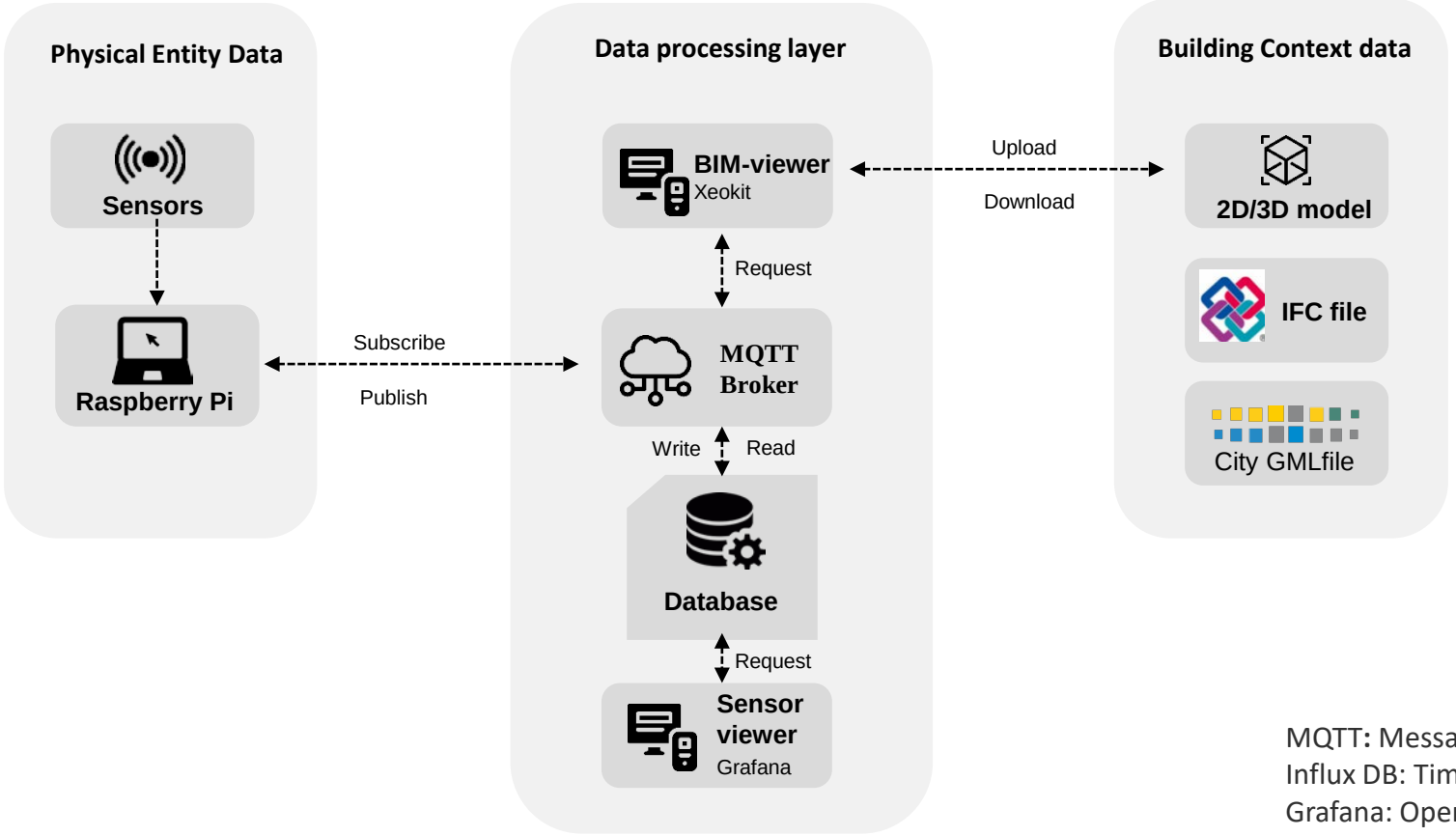
Methodology

Framework of the building environment monitoring system



MQTT: Message Queuing Telemetry Transport
Influx DB: Time series database
Grafana: Open observability platform
Xeokit: BIM online viewer

Methodology

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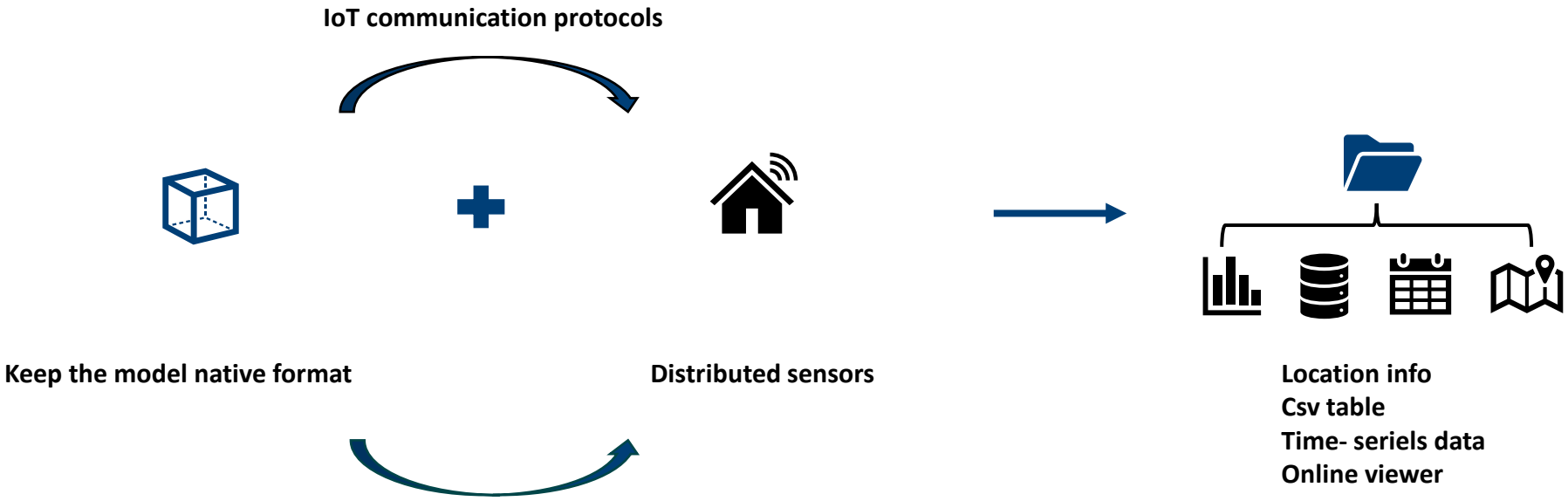

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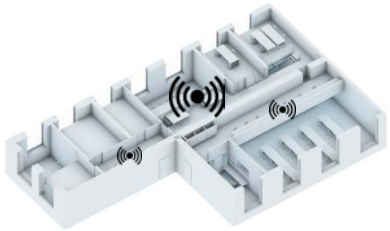
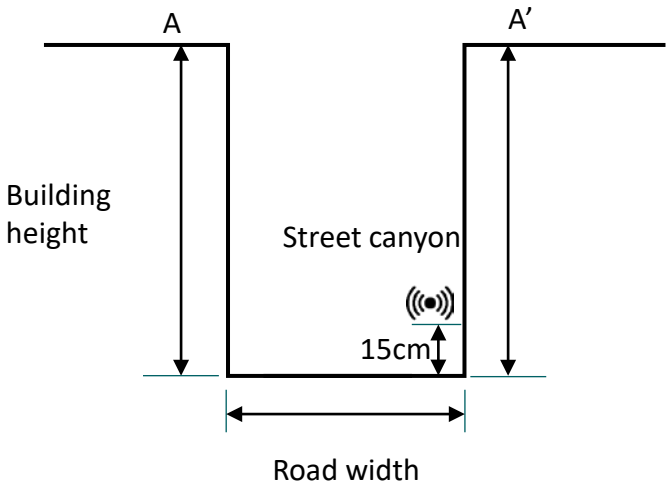


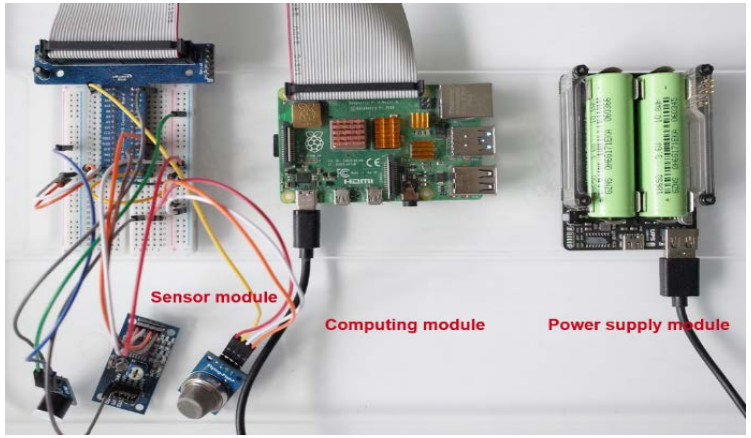
Case study

Real time pollutant gas monitoring in city area

Economical and replicable custom set up

- Pollutants are mainly composed of HC, CO, CO2, Nox
- Gas sensor: mq7, mq139 sensor; vibration sensor
- Sensor module, computing module, power supple module
- Measured at a height of 15 cm from the ground





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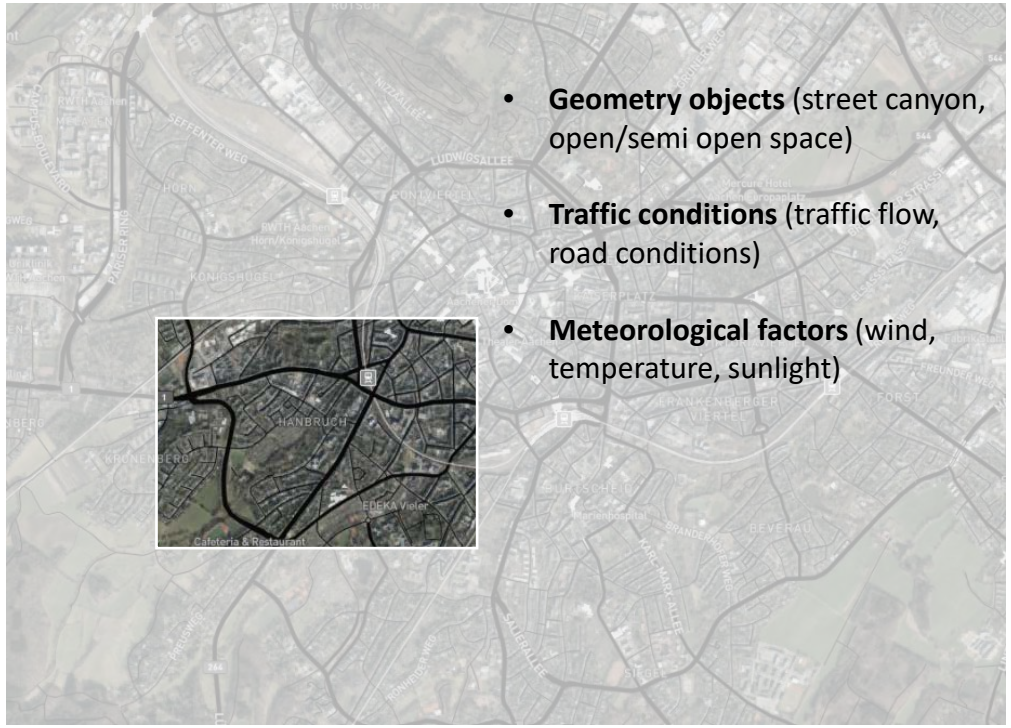


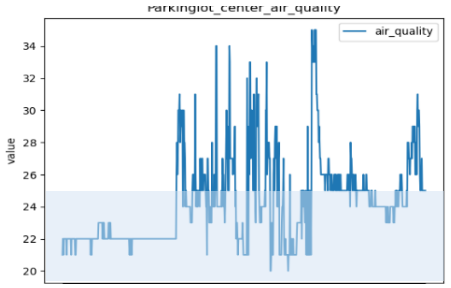
- **Geometry objects** (street canyon, open/semi open space)
- **Traffic conditions** (traffic flow, road conditions)
- **Meteorological factors** (wind, temperature, sunlight)

City Aachen/Germany

City GML model of the selected area

Case study

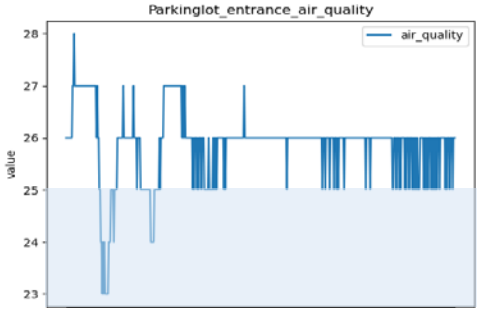
Real time pollutant gas monitoring in city area



- **parking lot center**

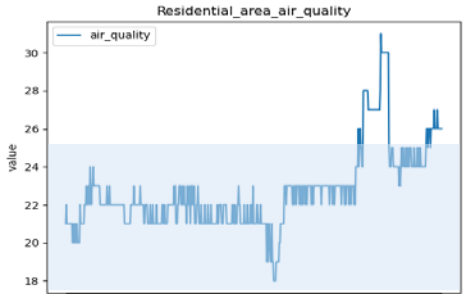
- Safe zone

- **uphill road, crossroads**



- **parking lot entrance**

- **City GML model of the selected area**



- **residential area**

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Conclusions

- Reproducible, economical IoT framework to aquire massive building/city physical environment data set
- Integrate physical data with building information through communication protocols
- Better understanding of exist building

- Accuracy of open space on-site monitoring data
- Long time- low energy monitoring device set up

Future research

- **Information semantic preprocessing, data automatic extraction**
  - Heterogeneous data query, editing
  - Simulation and sensor data coupling…
- **Micro sensor sensing performance**
  - sensor perception
  - localization
  - SLAM…
- **Long range, low energy sensor data transmission**
  - LoRa WAN
  - BLE…

Thanks for your attention!

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