Real-time Subsurface Sensing with Cognitive Networked Robotic System

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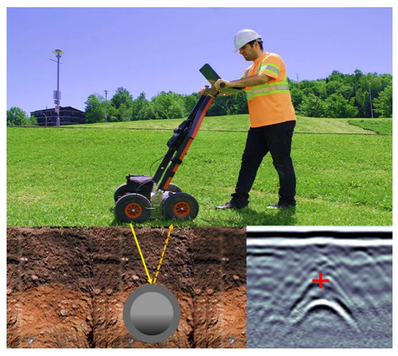
Challenge:

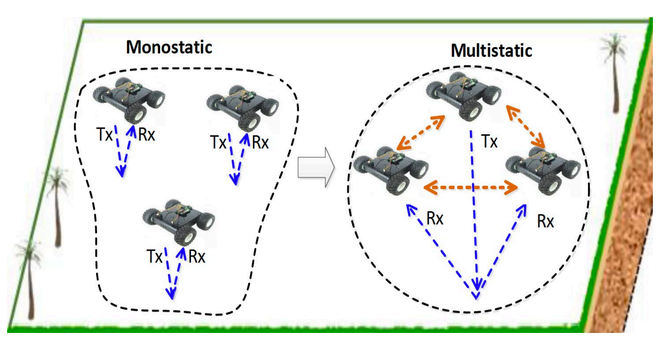
- Unknown/aged conditions and unknown locations of subsurface infrastructure raise profound concerns related to safety, health, and economic implications across multiple domains.
- Precise detection, localization, and assessment of subsurface infrastructure pose Formidable technical obstacles.
- Present methods are inadequate in terms of speed, sensitivity, accuracy, and human-machine interactions.





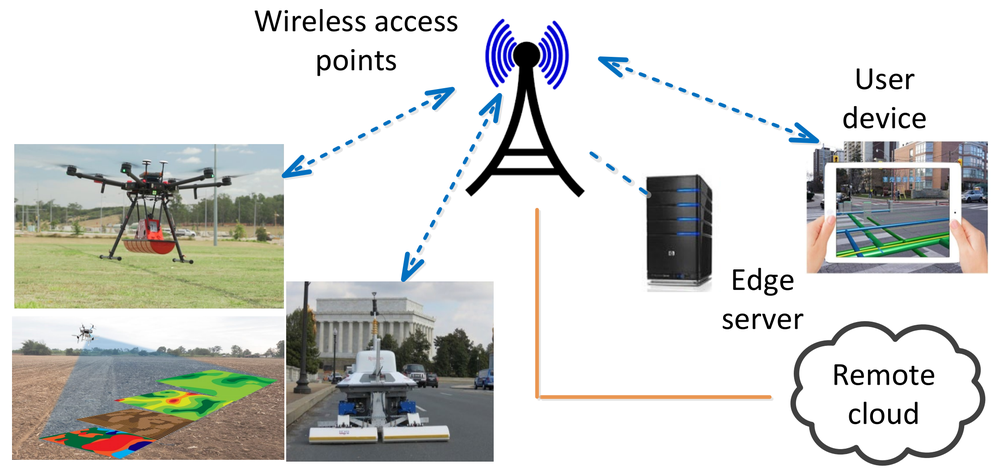
Solution:

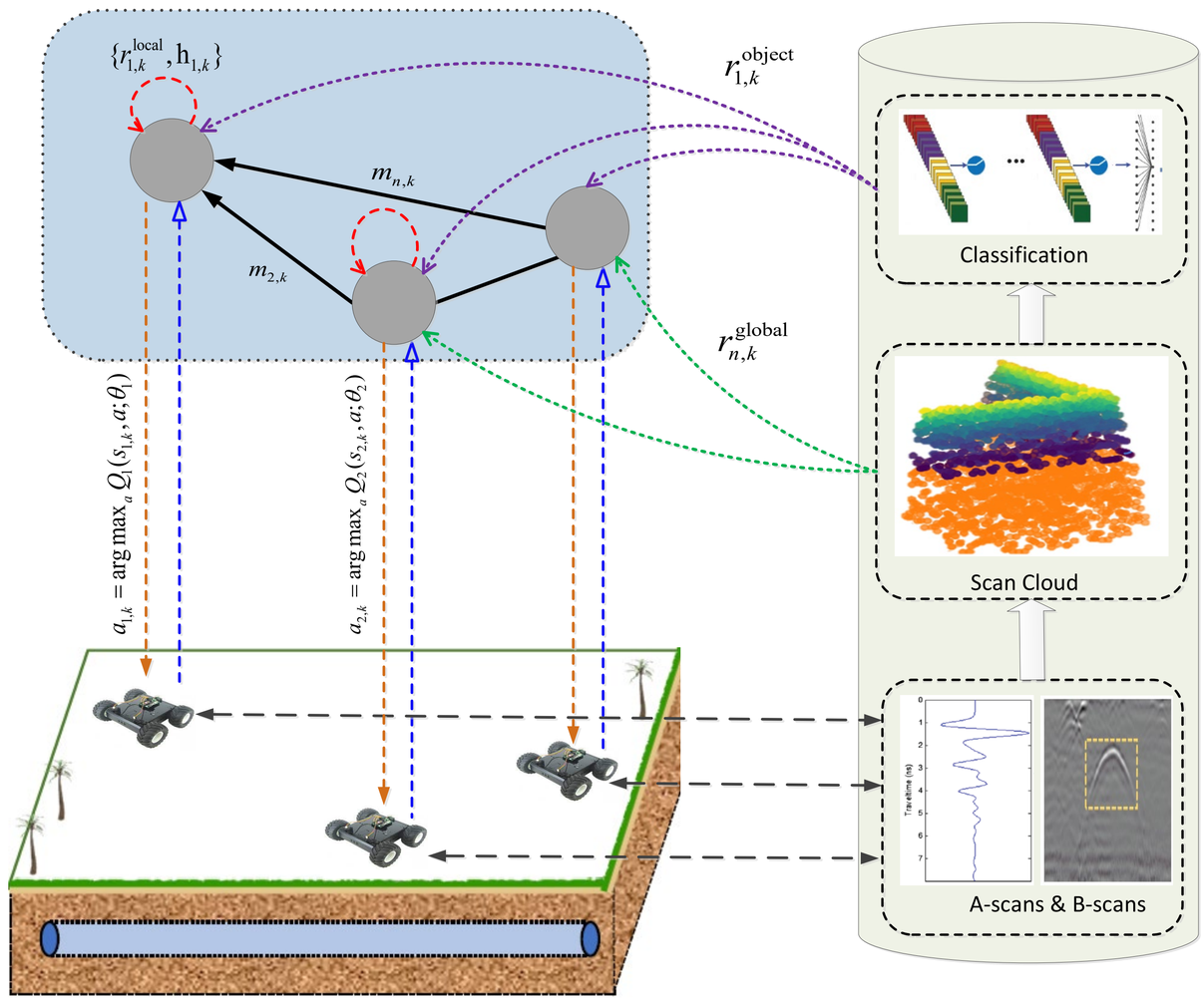
- Novel architecture of cognitive and agile ground penetrating radar (GPR) enabled by edge computing, AI, and adaptive hardware design
- Team of adaptive multistatic GPR agents coordinated by graph-based deep reinforcement learning algorithms by accounting for system failures and uncertainties
- Advanced data analytics for real-time object detection and 3D mapping
- Human-in-the-loop approach incorporating human expertise and feedback into the training and operation of GPR agents
- In-lab and field tests for validation

Scientific Impact:

- The fundamental principles of adaptive sensing and cognitive intelligence are transformative.
- The seamless integration of computational and physical elements and the research foci covering multiple core CPS areas provide insight into other CPS design and applications.





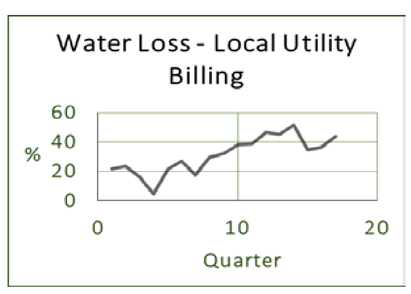
Broader Impact:

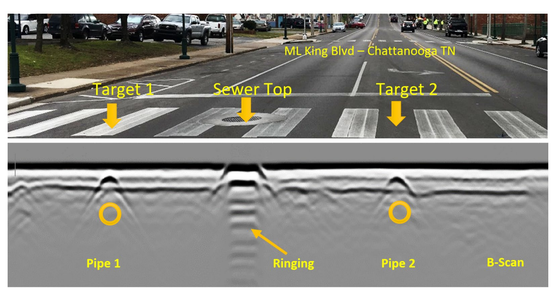
- Facilitating management and maintenance of underground utilities; improving their service, sustainability and resilience; reducing costs and waste
- Utility and construction industries, municipal utility officials are particularly interested in the project
- Partnerships with community for testing, result dissemination, and potential commercialization
- Incorporating research findings into teaching and curriculum, new CPS courses, outreach to K-12 schools

Performance Metrics:

- Dynamic adaptivity
- Autonomy
- Latency
- Sensitivity
- False alarm rate







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Award ID#: **2345852**
Start Date: 09/01/2024