IC2018

An Ocean Target Detection Mechanism in IoT Environment

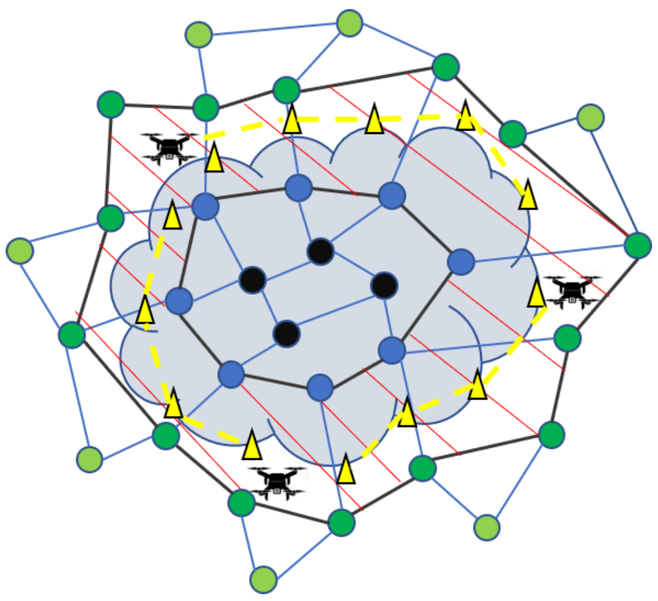
Yaqiang Zhang[1,2], Xiangbo Kong[1], Lin Meng[1], Zhangbing Zhou[2] and Hiroyuki Tomiyama[1],
[1]Graduate School of Science and Engineering, Ritsumeikan University
[2]School of Information Engineering, China University of Geosciences

Background and System

- Toxic target like crude oil leak will cause great damage to human and marine environment.
- With the development of IoT system, devices like UAV can be deployed to detect and track continuous target.

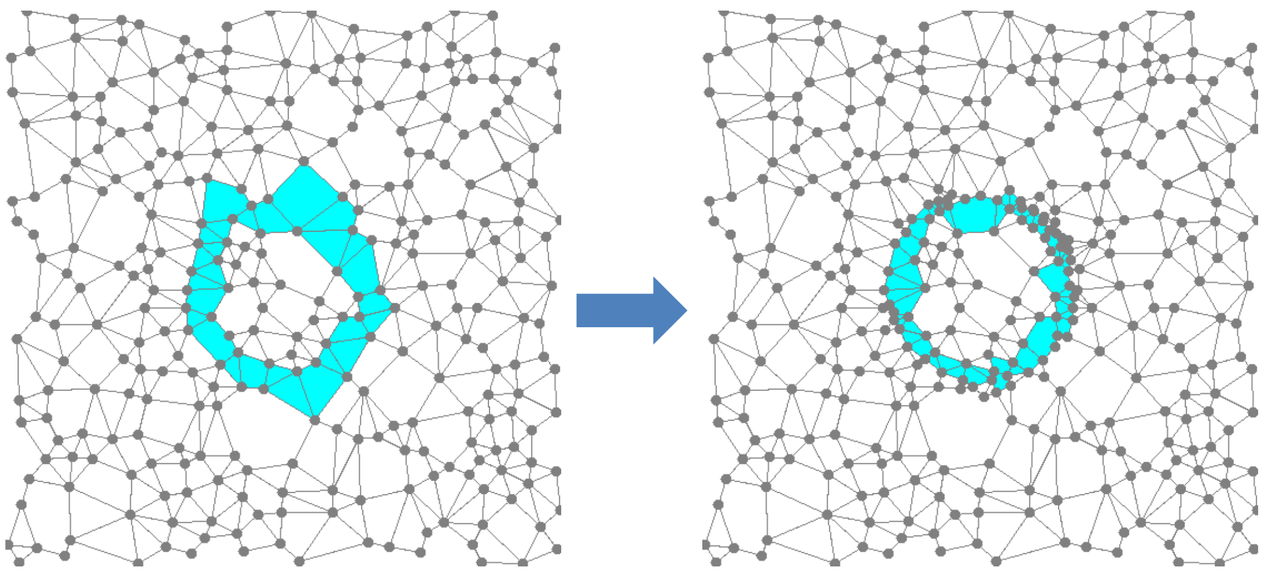
✓ A heuristic algorithm based mechanism is proposed for routing mobile IoT devices like UAV in order to track the boundary region of marine pollutant.

- Static IoT sensors are firstly deployed in the interested ocean network region and separated into different groups according to their reading.
- The gray region is the scope of the marine pollutant.
- Black nodes: a sensor whose reading is exceed the threshold of toxic target and all of its neighbor nodes are event nodes.
- Blue nodes: a sensor whose reading is exceed the threshold of toxic target and some of its neighbor nodes are event nodes while others are not.
- Green nodes: a sensor whose reading is under the threshold of toxic target and some of its neighbor nodes are event nodes while others are not.
- Light green nodes: a sensor whose reading is under the threshold of toxic target and all of its neighbor nodes are normal nodes.



- The yellow dotted line is the predicted boundary line on which all positions are equal to threshold according to interpolated results.
- Yellow triangular marks are stops selected on the predicted boundary line and there is a proper distance between each stop.
- A suitable number of UAV are deployed to traverse stops and genetic algorithm (GA) is applied to route for Multi-UAV in order to optimize the time and energy consumption of UAV.

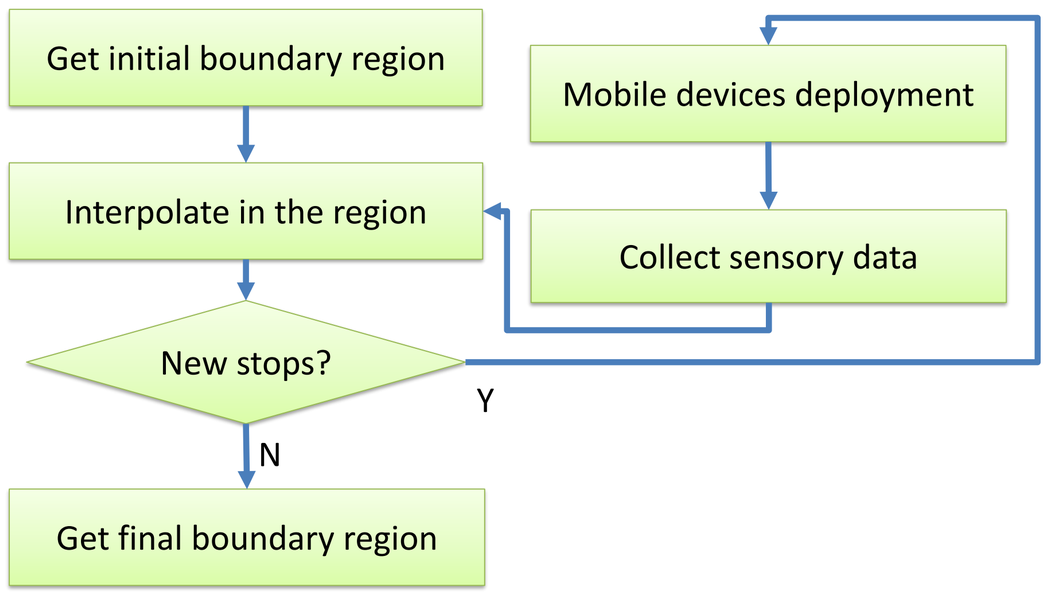
Target boundary region detection



Initial boundary region

Final boundary region

Procedure



- Interested network region is divided by static IoT sensor nodes and an initial boundary region is generated.
- According to the sensory data gathered by static IoT sensor nodes, sensing holes that don't have sensory data are interpolated and find a predicted boundary line.
- Some stops are selected on predicted boundary line if there are.
- Multi-UAV are applied to traverse selected stops and get sensory data on stops.
- A new boundary region is generated according to new data and repeat above steps until there are no new stops.

Experimental Results

Changes in boundary region with different number of static sensors.

- Through continuous iteration, the scope of the target boundary region is gradually narrowed and kept stable.
- In different scale of static sensors deployment, the size of the target boundary region varies greatly. When static IoT node deployment is more densely, the result is more accurate.

Conclusions

- The proposed mechanism can effectively detect and track the ocean target boundary region.
- The experimental data shows that the scope of target boundary region is shrunken and it reflects the actual situation of toxic target.
- The GA based mechanism for routing UAV can effectively balance the energy and time consumption.

Reference

[1] L. Shu, M. Mukherjee, and X. Wu, "Toxic gas boundary area detection in large-scale petrochemical plants with industrial wireless sensor networks," IEEE Communications Magazine, vol.54, no. 10, pp. 22–28, 2016.
[2] R. Roman, J. Lopez, and M. Mambo, "Mobile edge computing, Fog et al.: A survey and analysis of security threats and challenges," Future Generation Computer Systems, 2016.
[3] J.-H. Kim, K.-B. Kim, S. H. Chauhdary, W. Yang, and M.-S. Park, "DEMOCO: Energy-efficient detection and monitoring for continuous objects in wireless sensor networks," IEICE Transactions on Communications, vol. E91-B, no. 11, pp. 3648–3656, 2008.