Medical Mobile GIS Tracking

Every healthcare provider, in order to make decisions, needs specific information from external sources made available to them more than fifty times a day. The challenge is obvious: better methods have to be found to get 'the right information to the right person at the right time.' Developments in integrating (geospatial) information technologies, including GPS, remote sensors, wireless networks, smart cameras and internet-linked communication systems, make it possible to achieve this aim. In the wake of these developments there is growing interest on both the medical and geomatics side in decision support using advanced (geospatial) technologies. The development of wireless devices to support location tracking and pattern analysis, furthermore, provides significant economic and exceptional technological opportunities.

Exciting Technologies

This recent growth in interest on the part of both users and researchers, together with recent advances in mobile GIS applications, makes easier than ever the development of novel applications and integration of exciting new technologies. Innovative wireless devices for remote monitoring are becoming more sophisticated and accessible, for example,

-Radio Frequency Identification Tags (RFID), compact hardware devices capable of tracking equipment and people

-Real-time Location Systems (RTLS) for continuous monitoring and real-time response in emergency

-Wireless Fidelity Networks (WiFi).

As a result, wireless devices are increasingly applied in the areas of risk assessment and disaster management, such as for weather tracking, tourism, emergency response, hazard handling and marine security.

RFID and WiFi

But the new technologies also provide many opportunities within a medical context. The development of advanced spatial-positioning and monitoring systems for medical monitoring and emergency response using RFID and Wi-Fi technologies is one research project being conducted at the University of Calgary. The research is being carried out by the SPARCS Lab (Spatial Analysis Research in Computational Science), in collaboration with the W21C initiative (the Medical Ward of the 21st Century, Foothills Hospital, Calgary), and should support real-time tracking of both medial personnel and patients in hospital settings. The research also aims at developing methods for data acquisition, representation and analysis. Patterns revealed are further studied to identify procedures and places where time involved in patient care and medical personnel responsibilities can be much more efficiently used, and to develop better policies for emergency response through evaluating system prototype as part of W21 C infrastructure.

Topology-based

The core of the methodology is based on geometric topology for data representation and pattern analysis. Once data has been collected from RFID devices, this needs to be analysed to identify common patterns and plan proper emergency response. In our application we use Voronoi diagrams; a fundamental data structure in computational geometry for the partitioning of a plane with n points into convex polygons, such that every point in a given polygon is closer to its generating point than to any other. This has been used in many applications, such as urban planning, collision detection, mobile-tracking and obstacle avoidance, and also provides a familiar "roadmap" in motion planning, having edges that provide a maximum clearance path among a set of disjoint polygonal obstacles. For instance, a Voronoi-diagram approach has been applied successfully for cluster analysis and optimal-path planning, avoiding hazardous zones within a marine environment (oil spills, shallow regions). In our application it is used for representation of location data, and to compute the distance to the nearest workstation, lab, sink etc. in connection with optimal-path determination to reduce response time and efficiently use resources in an emergency. Since multiple criteria are used, this computation can become very complex. Criteria include position in time of all system components, proximity of resources to target location, classification of overlapping paths and pattern analysis to compare expected and observed responses. The key advantage of Voronoi diagram is here the ability efficiently to process complex data and events and perform updates to the system in real-time.

New Frontier

It is clear that many modern healthcare emergency-response needs can be met using wireless technologies and mobile GIS. However, the research is just beginning, and many questions remain open, including those concerning technology performance and advantage evaluation. Problems needing to be resolved include cost of purchase, installation and servicing of the devices, including phasing out of outdated units, adaptation of system architecture to local conditions, and personnel training. The methodology too provides many interesting challenges; some of the issues to be addressed here are complex decision-making process, various trade-offs and prioritising events, multiple parameters for operation optimisation. Nevertheless, the first significant steps in the direction of improving quality of patient care and medical practice have been taken, thanks to amazing advances in mobile-tracking technologies. This opens the way for new discoveries and innovations that have the potential to improve quality of life for many Canadians in the near future.