論文の内容の要旨

論文題目　PEDESTRIAN MOBILITY MODELS AND ITS APPLICATION TO MOBILE AD HOC NETWORKS
「歩行者モビリティモデルとそのモバイルアドホックネットワークへの応用」

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Mobile Ad Hoc Network (MANET) is compound by nodes that can communicate with each other by wireless links. The node can also relay (route) packets which destination node is not the node itself. The connection is then established by multi-hop wireless links. The nodes can also be battery powered, and of a small size. Then a node can be carried by a person and moves according to the person's movements. It is evident that a network of these characteristics will operate in a highly changing environment. The wireless links established between the nodes can easily switch on and off by either nodes movements or by the radio propagation phenomenon. Besides there is also the fact that the node is a small battery powered terminal resulting in limited battery life and reduced processing capacity by the small size and power consumption. In such environment is not acceptable for the network to be manually configured. Therefore, as a consequence, the network has to be self-configured and able to adapt to the constant changing environment where it operates.

MANET' flexibility imposes formidable technological challenges. One of the more important network characteristics is the nodes mobility, as explained before corresponds to the pedestrian mobility. There are a number of proposals aiming to emulate nodes mobility, however none of them (that we are aware at this moment) has been based on any kind of experimental observation. It means that those models are merely syntactic models and there is no probe about their realistic behavior.

This research starts based on a some simple questions such as: Are the models realistic enough?, are their assumptions true?, if not, are there better models possible?, can these models be used in other network tasks than just computer simulations?. We use real pedestrian data to answer some of these questions, and propose our original mobility model. The data was extracted by two different methods, the first one by an experiment conducted in the Tokyo big sight exhibition hall and the second by directly measure the movement of a pedestrian that carries a notebook PC connected to a Global Positioning System (GPS) receiver in order to periodically register the position.

The first model proposed assumes that a sequence of position points that constitute a trajectory should have a high correlation between consecutive sample points. This corresponds to the trend of a body in motion to keep moving in the same direction and the same speed, principle also known as inertia. We use an auto regressive process model of second order; the order of the autoregressive process was estimated directly from the data. To construct this model we use the data from the Tokyo big sight experiment that had the problem of short duration. With a longer trajectory the model parameter should change and to study that phenomenon we set up the second experiment with the GPS.

Assuming that the model parameters should change during a long trajectory, we proposes a more elaborate autoregressive model, this time the parameter of the autoregressive model will change in time to adapt the trajectory changes. To fit the model parameters to a particular trajectory the Least Square Lattice (LSL) filter was used. The LSL filter has: fast convergence, low error, a recursive and numerically stable calculation algorithm. The results on real tracked trajectories with the GPS showed that the method can quickly follow the trajectory changes, and also worked fine with the Tokyo big sight experimental data. With this model, a position prediction method was proposed, that showed low prediction error on different kind of trajectories.

The prediction method was used to propose a novel Geographical Routing protocol. Geographical routing protocols are those were the packet forwarding decision is taken only considering nodes geographical positions. In our proposal each node implements the prediction method itself. The nodes exchange hello packets with their neighbors (one hop) with current node position and an estimation of the future position calculated by the prediction method. The forwarding decision criteria include both current and estimated future position. The proposal has been tested by computer simulation and its results compared against the Greedy Perimeter Stateless Routing (GPSR) and Routing Protocol with Ellipsoid (RPE). The simulation results have showed that the proposal performs better in most of the simulated scenarios.

The LSL was also applied in the group mobility model. In this case the relative velocities of a moving group were modeled as an autoregressive process of order two, the velocity vector components (vertical and horizontal) were independently input to LSL filter. This time the LSL filter was used to justify the assumption that the relative velocities between nodes in a group can be modeled this way. The results after the LSL filter showed that the model parameters quickly converge to stability.