Predictive Communications

Chaoju Wang, Fahad Almaraghi, Hanxiao Lu, Yuting Zhang, Qiyuan Huang

School of Informatics Computing & Cyber Systems, Northern Arizona University

Project Information

Description: Develop a system for Predictive routing algorithm which enables a delay-optimal communication through incorporating network topology prediction into the Dijkstra's shortest path algorithm. In this work, we extend the proposed solution to jointly optimize the end-to-end latency and total transmission power.

Purpose:

- Improve current conventional routing techniques
- Further increase our understanding in Autonomous Robotics
- Various applications in Medical, Civilization, and Military
- Further increase our understanding of Internet of things Concept

Method: Using mainly a distributed Lidar Localization system working in conjunction with a wifi network and five car robots, we are able to create the infrastructure needed to operate the predictive routing algorithm.

Subsystems

Localization system: In our project, we implemented two different localization methods. One is centralized, and the other is distributed.

For the centralized one, we used a QR code/reader system to localize the robots. The basic idea is taking photos at a specific rate from above all 5 robots which have a huge QR code on their top. We were able to recognize the location of each QR code therefore localizing the cars.

We use lidar as the distributed system. The invisible light which is transmitted by the robots and reflects back from objects. The robots can get the distance by calculating the time of flight of the laser (TOF). After the robots get the distance between them and the reference points, we set the robot so it can get the position by applying gps type tri-angle positioning algorithm.

Communication system: Since the GUI system is Matlab based, there are some constraints to what the application can do (e.g; no multi threading), therefore we implemented a database to store information, in which the GUI can take the uploaded data from the robots and incorporate it into the algorithm using our router (Wi-Fi).

There are three tables in the database. The first one is called USER. USER stores the basic information of robot cars, camera robot, and the server. Table PATH stores the path information of the package which will be used by the algorithm later. The last one is the COMMAND which can hold the command so the user can execute.

In our design, each robot will continually scan the COMMAND and execute commands which are assigned to them. GUI only needs to set the initial constants into database so no multi-thread task is involved.

GUI system:

Localization system provides positions to database, then database store these information and sends them to GUI. GUI can use position information to show the user the five platforms.The Predictive algorithm then uses the database information to calculate optimal paths and shows the user these paths through the user interface.

Platform system:

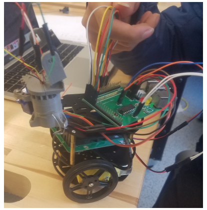

Fig.Platform

We used two wheels robot car as the carrier. Each wheel is driven by a separate motor.The robot car is divided into three layers.Two motors were placed at the bottom layer.A battery pack (power supply system) is placed in the middle layer.

The top layer places Raspberry pi and lidar.As shown in Fig.Platform, the front of top is the lidar system.Each layer is connected to the data line through holes in the layer.The size of the whole car is about one cubic decimeter.

Final Results

Fig. 2: shows the effect of the number of nodes in the efficiency of the method proposed. It is observable that as number of nodes in the network increases, the optimal algorithm exhibits a higher performance improvement in terms of delay and power utilization compared to the conventional algorithm.
Fig 3: shows that as we increase the waiting time for each node, topology changes are more severe and we obtain higher gains by predicting network topology. Therefore, substantial benefits can be obtained for queued networks with heavy traffic mode.
Fig.4: shows the optimal method improves compared to the conventional, for higher node velocities the network topology is evolving rapidly ,the proposed algorithm shows a better performance.

Simulation results confirm an improvement of about 10% for moderate network sizes. The performance gain increases for larger networks, larger average waiting time and higher node velocities.

Graphs

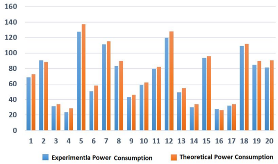

Figure 1: Shows results of Power consumption between Predicted consumption and Actual Consumption

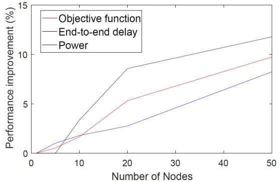

Figure 2: Shows Performance improvement vs the Number of nodes in the system.

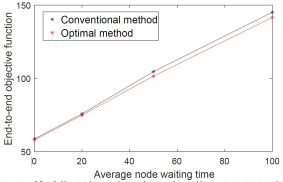

Figure 3: Objective function for the proposed and the conventional based on the average node waiting time

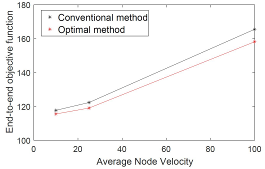

Figure 4: Objective function for the proposed and the conventional based on the average node velocity

Acknowledgments

Professor Abolfazl Razi
Professor Kyle Winfree
Arnau Sugranes
Northern Arizona University School of Informatics Computing & Cyber Systems