Applying LVQ Techniques to Compress Historical Information in Sensor Networks

Song Lin, Dimitrios Gunopulos*, Stefano Lonardi†, Vana Kalogeraki*
Computer Science & Engineering Department
University of California, Riverside
{slin, dg, stelo, vana}@cs.ucr.edu

In the emerging area of wireless sensor networks, a typical challenge is to retrieve historical information from the sensor nodes. Due to the resource limitation of sensor nodes (CPU, memory, bandwidth, and energy), the collected information of sensor nodes has to be compressed quickly and precisely for transmission.

We propose a new technique，called Adaptive Learning Vector Quantization (*ALVQ*), to compress this historical information. Our technique is based on the following two observations: (1) In sensor networks, the historical information exhibits similar patterns over time, and (2) different measurements are intrinsically correlated.

The ALVQ framework

1. Create the codebook from training data set at the sensor. Apply *LVQ* (Learning Vector Quantization) learning process to adjust the codebook
2. Transmit the codebook to the base station
3. Let the sensor collect data and fill the local buffer
4. When the buffer is full, compute the codebook update and employ *2-level Piece-wise Linear Regression* technique to compress the codebook update
5. Compress the collected data with updated codebook
6. Transmit the compressed codebook update and the compressed data
7. Flush the buffer and go to step 3

Our algorithm works as follows: First, the codebook is obtained through a *LVQ* (Learning Vector Quantization), which adjusts the codebook to be nearer to the optimal codebook. Second, *ALVQ* compresses the codebook update data pieces and transfers the compressed information to the base station. Using 2-level piece-wise regression, *ALVQ* can compress the updates with high precision while saving more bandwidth for data transmission in order to increase the quality of the approximation.

In our experiments we used weather data to compare the performance of the *ALVQ* algorithm with the recently proposed *SBR* (Self Based Regression) technique. Our experimental results demonstrate that the *LVQ* learning process significantly improves the quality of the codebook, thus increasing the regression precision. In addition the use of two-level regression for transmitting the codebook updates further minimizes the required bandwidth. Overall the ALVQ technique can achieve the same precision with SBR while using 75% of the bandwidth.

---

* This work was supported in part by NSF Grant 0330481.
† This work was supported in part by NSF Grant DBI-0321756.