2-Hop Neighborhood Information for Cover Set Selection in Mission-Critical Surveillance in Wireless Image Sensor Networks

M. DIOP, C. PHAM, O. THIARE

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CONTEXT

Sink
• Sentry sensor
○ Normal sensor
On Event Detection

- Criticality-based scheduling of image sensor’s activity
- A cover set for $V$ is a subset of nodes which covers its FoV area

**Contributions**

- A cover set selection approach which
  - Determines the most relevant cover sets to be activated
  - Uses on 2-hop neighborhood knowledge
  - Defines metrics to probabilistically determine the likelihood of multipath transmissions required

- T-GPSR wherein routing decisions are also based on 2-hop information
2-Hop Information

\[ F_2(v, u) = \{ k | d(k, \text{Sink}) < d(u, \text{Sink}), u \in F(v), k \in N(u) \} \]

\[ F(v) = \{ u | d(u, \text{Sink}) < d(v, \text{Sink}), u \in N(v) \} \]

Multipath & Number of Images

- **Multipath is a common feature in wireless ad-hoc networks**
- **Multipath can be used for reliability, load-balancing, mitigating congestion thus packet losses**
- **As more images need to be sent, a high number of paths towards the sink is desirable**
\[ R_{2-hop}(C_{oi}(v)) = \frac{1}{|C_{oi}(v)|} \sum_{w=1}^{\text{NbOptimal Paths}(w)} \frac{|C_{oi}(v)|}{|F_2(w)|} \]

- \( R_{2-hop} \) measures the likelihood of a given cover set to find as many needed 2-hop paths as required by the capture rate or \# images.

**Unshared Relay Nodes Likelihood**

- 2-hop potential forwarders may have few relay nodes themselves.
- A cover set with many unshared relay nodes per 2-hop forwarder has better efficiency.

\[ R_{relay}(C_{oi}(v)) = \frac{1}{|C_{oi}(v)|} \sum_{w=1}^{\frac{|F(w)|}{|F_2(w)|}} \]

- The \( \frac{|F(w)|}{|F_2(w)|} \) ratio expresses the likelihood that a 2-hop forwarder has several unshared relay nodes.
Cover-set’s Transmission Quality Factor

◆ Each cover set is then associated to a Transmission Quality (TQ)

◆ TQ is used to score and classify cover sets at a sentry node

\[ TQ(Co_i(v)) = \alpha \times R_{2-hop}(Co_i(v)) + \beta \times R_{relay}(Co_i(v)) \]

◆ \(\alpha + \beta = 1\)

T-GPSR

◆ GPSR is a geographic routing protocol

◆ We extended GPSR with 2-hop neighborhood information

◆ Whenever a source node \(v\) needs to forward a data packet, it chooses the closest potential 2-hop forwarder to the sink in \(F_2(v)\)
EVALUATION & SIMULATION

◆ 400 SENSORS IN AN 400M * 400M AREA

◆ SENSOR NODES HAVE AN 60° ANGLE OF VIEW, A DEPTH OF VIEW OF 25M AND A COMMUNICATION RANGE OF 30M

◆ SCENARIO 1: FIRST ACTIVE COVER SET IS CHOSEN

◆ SCENARIO 2: 2-HOP SELECTION AND GPSR ARE USED

◆ SCENARIO 3: 2-HOP SELECTION AND T-GPSR ARE USED

IMAGE QUALITY

◆ 320*320 PIXELS
◆ 205 PKTS
◆ IMAGE ENCODING METHOD (CRAN)

◆ ORIGINAL IMAGE &
◆ RECEIVED IMAGES WITH VARIOUS PACKET LOSS RATIOS
**Image Statistic at the Sink**

![Graph showing packet loss ratio, received image, usable image, and complete image for different scenarios.]

- **An image with more than 60% pkt losses is said unusable**

**Image Delivery Latency**

![Graph showing average latency for different scenarios.]

- **The image transmission time at the source node takes 0.94s**
CONCLUSION

◆ We proposed an optimized cover set selection approach based on 2-hop neighborhood information to determine the most relevant cover sets to be activated.

◆ We extended GPSR for image transmission wherein routing decisions are also based on 2-hop knowledge.

◆ Simulations have shown that our proposal reduces the packet loss ratio to provide better received image quality at the sink.

◆ Future work: cover set mutual exclusion to better control simultaneous image transmission.

THANK YOU FOR YOUR ATTENTION