**International Journal of Information Security and Privacy**
Volume 14 • Issue 1 • January-March 2020

# Improving DV-Hop-Based Localization Algorithms in Wireless Sensor Networks by Considering Only Closest Anchors

Amanpreet Kaur, Jaypee Institute of Information Technology, Uttar Pradesh, India
Padam Kumar, Jaypee Institute of Information Technology, Uttar Pradesh, India
Govind P. Gupta, National Institute of Technology Raipur, Raipur, India

## ABSTRACT

Localization problem has gained a significant attention in the field of wireless sensor networks in order to support location-based services or information such as supporting geographic routing protocols, tracking events, targets, and providing security protection techniques. A number of variants of DV-Hop-based localization algorithms have been proposed and their performance is measured in terms of localization error. In all these algorithms, while determining the location of a non-anchor node, all the anchor nodes are taken into consideration. However, if only the anchors close to the node are considered, it will be possible to reduce the localization error significantly. This paper explores the effect of the close anchors in the performance of the DV-Hop-based localization algorithms and an improvement is proposed by considering only the closest anchors. The simulation results show that considering closest anchors for estimation of the location reduces localization error significantly as compared to considering all the anchors.

## KEYWORDS

Accuracy, Anchor, DV-Hop, Localization, Wireless Sensor Networks

## 1. INTRODUCTION

Wireless sensor network (WSN) is a wireless network that consists of low-priced, less energy tiny nodes called sensors along with a central server called base station. The sensor nodes examine the event and send the event information to the Base station via multi-hop communication (Liu, Nayak, & Stojmenovic, 2010). In location-based applications, location information of sensor node that has detected the event is also significant along with event information. Thus, Localization, a way to find the location of a sensor node, is a very important problem.

With respect to the hardware required for computing the coordinates of the node, the localization algorithms can be divided into two categories: range-based and range-free (He, Huang, Blum, Stankovic, & Abdelzaher, 2003). Range-based need expensive equipments to find distance estimates or angle estimates between nodes (Kunz & Tatham, 2012). Range-free algorithms derive location information using approximate distance estimates between nodes (Panwar & Kumar, 2012; Niculescu & Nath, 2003;

Zhang, Ji, & Shan, 2012). These algorithms estimate the location by using approximate distances from anchor nodes (Song & Tam, 2015). Here a sensor node which knows its location is called anchor node and sensor node which does not know its location is called non-anchor node (Alrajeh, Bashir,

DOI: 10.4018/IJISP.2020010101

& Shams, 2013; Nagpal, Shrobe, & Bachrach, 2003; Bahl & Padmanabhan, 2000). Due to hardware limitations, range-free algorithms like DV-Hop (Niculescu & Nath, 2003) achieve cost effectiveness but have low localization accuracy (Tomic & Mezei, 2016). The anchor nodes play an important role in deciding the location of non-anchor nodes in range-free algorithms. In these range-free algorithms, normally all the anchors in the network are required to determine the location of the non-anchor node. But rather than considering all anchor nodes, if only a few near anchors are considered then it is easier to locate a node with better precision. Thus it is more significant to study the influence of near anchors on DV-Hop based algorithms to improve their localization accuracy.

In this paper, most of the known DV-Hop based algorithms are surveyed and the effect of the closest anchors is explored. Improvement gained by considering only a few near anchors instead of all the anchors for finding the location of non-anchor nodes in their last phase has been evaluated. These improved algorithms have been compared with original algorithms to analyze the impact of the closest anchors on the localization error. It is observed that the closest anchors have a significant impact in reducing localization error of all these algorithms.

## 2. RELATED WORK

### 2.1. Original DV-Hop Algorithm

The Algorithm (Niculescu & Nath, 2003) was first proposed by Dragos Niculescu and Badri Nath in 2001. It is a distributed localization algorithm where each node tries to determine its location by knowing its number of hops from each anchor node. The algorithm works as: Given the network with n anchors, in the initial step, the anchor nodes broadcast their location information and hop value (initially equal to 0) to all other nodes in the network. Receiving non-anchor node increments the hop value by one and saves location information along with hop for every anchor in its hop count table. Thus, each non-anchor node *j* gets location information and the smallest number of hops ($hop_{ij}$) from every anchor i in the network in the first step. The second step enables all the non-anchor nodes to get approximate distance from every anchor node by multiplying $hop_{ij}$ from each anchor i with the average distance per hop ($Ahd_i$) computed by each anchor. Equation (1) is used by anchor *i* to compute $Ahd_i$ in this step.

$$Ahd_i = \frac{\sum_{j=1\, j\neq i}^{n} \sqrt{\left(x_i - x_j\right)^2 + \left(y_i - y_j\right)^2}}{\sum_{j=1 j\neq i}^{n} hop_{ij}} \tag{1}$$

Equation (2) is used by node j to find its distance from anchor *i*.

$$d_{ij} = Ahd_k \times hop_{ij} \tag{2}$$

where $Ahd_k$ *i*s the average hop distance of nearest anchor k from node *j*.

The last step enables all the non-anchor nodes to find their location by using least square method (Niculescu & Nath, 2003). The explanation of least square method is as follows:

If the x-coordinates and y- coordinates of a node UN and anchor $A_i$ are ($x_{un}$,$y_{un}$) and ($x_i$,$y_i$). Then, we get the following system of equations by Euclidean Distance formula: