Mobile Ad-Hoc Network Based Child Monitoring with DSDV Routing
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Abstract—This paper proposes Mobile Ad-Hoc Network Based Child Monitoring with DSDV routing. The aim of this paper is to reduce child abduction in general or maternity hospital, which is important in Indonesia because of many cases of child abduction, appeared in those hospitals. The method of child tracking and monitoring of this paper is using Mobile Ad-Hoc Network with DSDV routing to substitute GPS tracking which was limited especially inside a building. The system using Triangulation Estimation method to determine approximation of child or patient position in certain area. The simulation demonstration showed that it gives good performance to track child or patient but compromised when number of nodes in certain area is increased.

Index Terms—MANET, Tracking System, DSDV, Triangular Estimation

I. INTRODUCTION

According to Indonesia Police HQ records, there were 344 child abduction cases in 2010 and 68 cases in 2011. Another source from Komisi Nasional Perlindungan Anak (National Child Protection Committee) mentioned child abduction has been reported that there were 114 cases since January 2012 by MNC TV [1] and 111 reported cases in 2010 reported by Kompas [2]. Between January and July 2011 there were 34 child abduction cases and at the same period in 2012, Komisi Nasional Perlindungan Anak [3] recorded 39 missing child cases and 15 reported missing in maternity hospital, which causes serious public concerns. With more new modus operandi of child abduction and today era that allows a child to be more active and free which gives parents and families more difficulties to supervise them.

This paper proposes a child tracking using Mobile Ad-Hoc Network (MANET) [4]. Therefore, the aim of this paper is to develop a child tracking using in-building infrastructure due to limitation of Global Positioning System (GPS) infrastructure for tracking objects inside a building in which the GPS is very dependent on Satellite. As mentioned by [5] that GPS lost its accuracy and increased errors due to multipath fading, which occurred when a signal bounces off a building or terrain before reaching the receivers antenna. This is supported by Hightower et al. [6] that receiver of GPS devices usually cannot detect GPS Satellite.

MANET has high degree of flexibility which does not work under permanent topology in which every node in the network communicates directly with other nodes in a peer-to-peer fashion [7]. With this feature, it can be deployed on a field without permanent communication infrastructure. Some examples of this infrastructure are first it can be constructed by some devices using WiFi Network cards [8], second it will not be effected during disasters and blackouts [9], and third it can be deployed on the war field.

To determine and tracking location of a child inside the building that employs the system then the concept is the child tagged by using wearable wristband that has sensor node such as Pluto mote [10] and by using Triangulation Estimation [11] method to determine location of the child.

This paper consist of methodology which discussed the approach of child tracking using MANET with DSDV routing in section II followed by result which demonstrated the NS-3 simulation of child tracking using the method in section III and the conclusion is in section IV.

II. METHODOLOGY

Mobile Ad-Hoc Network (MANET) [7] had been a popular subject in network research around 1990s with appereance of inexpensive 802.11 wifi network which common in mobile computer today. It can be deployed with minimal configuration and fast deployment makes suitable for emergency situation. Figure 1 depict typical representation of MANET.

![Nodes within the communication range of each other](image)

Figure 1. A typical of MANET [7]

There are two classification of routing protocol in MANET which are first proactive protocol, reactive proto-
col, and hybrid protocol. Proactive protocol was designed as a same manner of wired network. It stores routing information all the time to every node in the network and maintained the route entries to all destination including the node that not send the packet [7]. Each node in the network that employs proactive protocol communicates with one another and each of it in the routing table, which updated every second, describes its position in the network. This reduces delay and route establishment time of the network. Besides the advantages of proactive protocol in which the formation of network is quickly established with small delay, proactive protocol also has shortcomings at a time where the network is filled with routing table update packets to all nodes in the network. This is the best protocol when quality of network service is required with high traffic exchange [7]. The example of this kind of the protocols are DSDV [12], and OLSR [13].

Different approach is reactive protocol [7] or source on-demand protocol [14] in which a route is established between the sender and the receiver when the sender needs for connection to destination. The route is determined using route discovery process in the network by sender. Usually, request message floods in a network relayed by a node until it reach a destination is one of the method to discover a route. The process is completed when the desired route is found or all possible permutations already examined. When the route has been found then the path is managed by a route management procedure until the destination cannot be accessed by all paths from the source or the path is not required anymore [15]. There are some examples of the protocol are DSR [16], AODV [17], and TORA [18]. The last classification is Hybrid routing protocol that combine between proactive and reactive protocol [7].

DSDV was chosen because it can provide the best performance when applied to a confined space and have relatively low mobility, such as a nursery area in a hospital. The works of the DSDV protocol is to make the node as a special router which periodically provide interconnection information seen by the node to another node. This protocol is a modification of the Bellman-Ford routing technique used by RIP to fit the needs of ad-hoc networks that require self-starting mechanism and dynamic network [12]. In this paper, MANET was simulated behaviorally by making a scenario of child monitoring with NS-3 [19]. NS-3 supports topology, nodes and protocol simulation. Other feature of NS-3 is function addition in its core. Each object in NS-3 has a set of attributes which are name, type, and initial name.

Siddhu Warrier [20] proposed Visitor Tracking System named VTS to track a visitors in a building that informs visitors that they approaches a certain restricted or dangerously area. The systems estimate the location of mobile nodes and provide information on the location and direction of each node to central node with help of sensor nodes. DSDV and ZRP were used as its protocol. The application determines the location of a node by locating the signal strength of the received radio signal. DSDV routing algorithm is used to convey information in the form of packets from the sensor nodes to the sink node. Siddhu works is a most related work of this paper.

Coarse-gained tracking [11] is a tracking method that uses two or more sensor nodes along the path of movement of the target node. The coordinates of the target node is determined by averaging the coordinates of the location of the sensor nodes to be able to detect the target node, logically sensor node is a node that is closest to the target. With this approach, the density of sensor nodes in the area affects the accuracy of the approximate location of the target.

Triangulation Estimation is an approach that uses trigonometric method to determine an unidentified location by using two angles and distance between them [11]. The method uses two reference nodes and two sensor nodes placed on guideline of x-axis and y-axis respectively as shown in figure 2. Reference nodes R₁ and R₂ create a guideline of x-axis and R₁ and R₃ create a guideline of y-axis. It should be mentioned that reference node R₁ is being shared both of x-axis and y-axis to form both guidelines. Two angles α₁, α₂ between x-axis and y-axis guidelines shown in figure 2 are measured to the line constructed by the target node and the reference node. The T₁ location coordinate (x, y) can be determined by using R₁,R₂,R₃ combinations to find x and R₁,R₂ combinations to find y based on [11],

\[ x = \frac{d_{xy} \sin(\alpha_{y1}) \sin(\alpha_{y2})}{\sin(\alpha_{x1} + \alpha_{x2})} \]  \hspace{1cm} (1)

\[ y = \frac{d_{xy} \sin(\alpha_{x1}) \sin(\alpha_{x2})}{\sin(\alpha_{x1} + \alpha_{x2})} \]  \hspace{1cm} (2)

Trigonometric identity can be used to form the expression

Figure 2. Triangulation Estimation method to determine unknown location of target node T₁ [11]
The system used three types of nodes which are Patient or Child Node (PN) as $T_1$, Infrastructure Node (IN) and Monitor Node (MN) as reference nodes $R_1, R_2, R_3$. PN is a moving node when IN and MN are stationary nodes which placed in a certain position. PN is a device used by the patient, in this case child patients, in a hospital which is lightweight and efficient in terms of energy consumption such as Pluto mote [10]. IN nodes are stationary and placed in a room or area. Their energy sources can be obtained from batteries or directly from the power source and can be recharged. MN is a central storage, processing, and analysis of data from the PN and IN. This node is specifically calculate the location of PN based on existing information from PN and IN.

Patient or Child Node (PN) is a simplest node compared with two other nodes. The node periodically receive Ping packets sent by IN and MN. When Ping packets is received by PN, and PN is not connected to another node then a link is created between the PN with a node which Ping packet has sent. PN then replying by sending Reply Ping to the node that sent the ping packet. The node should be IN or MN. PN store two data which are a node connected to PN, and PN signal strength between node connected to PN. Signal strength is estimated to have a range between 0 dBm to -25 dBm. PN also listen Ping packets from other nodes (IN or MN). If Ping packets are received from a new node which have a lower signal strength than the nodes that connected by PN, then PN connected by itself with the new node and start sending packets Ring (Reply Ping) to a new node.

Infrastructure Node (IN) broadcast Ping packets periodically to determine the location of PN around. If IN is receiving packet Ring (Reply Ping) from PN, then PN add the information into its table. Else if the package Ring is not received within the time specified constraint, then the PN is removed from IN table. IN also send PI (Patient Information) packets, which are a table that lists the PN information connected with each PN, to MN periodically. Monitoring Node (MN) is the most complex node between two other nodes because this node can function together with IN if no PN is connected directly to the MN. MN maintains information to all PNs that is connected to the IN and signal strength between the PN and IN. The information is used to describe the location of each node on the monitor which can be used to track a location of children (PN). Figure 3 shows the Infrastructure Node (IN) and the Monitoring Node (MN) do a broadcast Ping packets periodically to track Patient Node (PN) location.

When Patient Node (PN) has been found nearby IN then it replies with Reply Ping. PN does not reply to the whole Ping packet received, but only replies with a strongest Ping packet. In this case PN1 only reply to IN1. This signal strength parameter is kept within PN to be used when signal strength between PN and IN becomes weaker then PN will move to other IN or MN. IN stores information about the connected PN which called Patient Information (PI). In this case, IN1 stores information PN1 as nodes connected with Signal Strength = 4 as shown in figure 4.

### III. Result

The simulation was conducted by open-plan space or without any hindrance situation. It had five stationary node depicted in figure 5. Node 0 had a role as Monitoring Node which located at coordinate $(0,0)$. Node 1 until 4 had a role as Infrastructure Node or Sensor Node to take any signal from moving node. The remaining node became Patient Node or PN which are mobile.

Figure 5 to figure 9 shows broadcast process performed by each node. Every four sensor nodes node initiate a broadcast to the central node and all other nodes. Each node records destination path that may be achieved, which leads to the next destination node. Each node exchanged...
information on a regular basis by doing a broadcast to neighborhood nodes.

Figure 10 shows the process of updating the routing table when the simulation was in progress. Updates on the DSDV routing protocol can be time-driven (periodic) or event-driven (driven by a specific phenomenon). Each node exchanges information with its neighbouring nodes periodically to obtain the latest information routing table.

Figure 14 and figure 15 shows how Ping packets were sent by sensor nodes or patients node to neighbour nodes and replied by mobile node or patients node who had
received Ping packets by using Reply Ping to sensor node and neighbour node. Figure 15 shows the approximation coordinate of patient's nodes $T_{28}$ and $T_{16}$ from the simulation. Their coordinates were $(-25, -40)$ and $(50, 45)$ respectively.

**IV. CONCLUSIONS**

This paper has demonstrated MANET with DSDV routing to track children or patient in a general or maternity hospital. It shown good capability in simulation to track child or patient inside a building but it will be compromised when number of nodes in certain area is increased. The position approximation coordinate of a child or patient is determined by using Triangulation Estimation method.

**REFERENCES**


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