On Disaster Information Gathering in a Complex Shanty Town Terrain

Gaurav Jain*§, Sarath Babu*§, Ranga Raj†‖, Kyle Benson†‖, B. S. Manoj*§ and Nalini Venkatasubramanian†‡
*Indian Institute of Space Science and Technology, Thiruvananthapuram, India 695547
†University of California Irvine, CA 92697
Email:§{gaurav.jain.in, sarath.babu.2014, bsmanoj}@ieee.org, ‖{ranga.raj, kebenson}@uci.edu, ‡nalini@ics.uci.edu

***Abstract*—Information gathering during a disaster management has a crucial role in designing the disaster response mechanism. Several factors such as geography, infrastructure, and population influence the information gathering process. The task is particularly complex when disasters strike a shanty town. A shanty town terrain is characterized by its high population density, considerable level of under-development, and poor infrastructure. Mobile Data Collection agents (MDCs) can be assigned with the task of data collection in the aftermath of a disaster. In this paper, we study the difficulty of data gathering process using two movement models, *Path Type Based Movement* and *Path Memory Based Movement* in combination with data hand-off strategies *No Hand-off, Superior-Only Hand-off* and *Superior-Peer Hand-off*. We use the metrics such as percentage data collected, percentage way coverage, and the number of inter-MDC meetings for analyzing the performance of MDCs in the data gathering process. The low values of data collected and way coverage show the difficulty in obtaining disaster-data from a complex shanty town terrain.**

***Index Terms*—Disaster, information gathering, DTN, movement models, hand-off.**

I. INTRODUCTION

Disasters are natural or man-made events which cause extreme ruin to the people and nations. Major disasters include earthquakes, floods, typhoons, terrorist attacks, forest fires etc. In 2013 itself, 296 events resulted in an economic loss of USD192 billion and human fatalities of around 21,250. Among them the most disastrous one was Super Typhoon Haiyan in Philippines, which left behind nearly 8000 people dead or missing with an economic loss of USD22 billion. Flooding in India and Nepal, in June 2013 led to 6748 deaths with an economic loss of USD4 billion [1]. Dealing with such kind of extreme situations, the authorities need a good level of information regarding the location and the nature of disaster. Efficient planning and execution of a disaster response mechanism is required to minimize the losses resulting from these situations.

Because disasters are usually unexpected, the response from authorities takes a little time to start up with the rescue operations. In order to proceed with their task, the information regarding region and the nature of disaster should be known as soon as possible. If the location is in a city or in a well known place, it is much easier to get the geographical information and prepare a plan according to them. However, the situation becomes more difficult if the location is a shanty town terrain.

A shanty town is characterized by its high population density, complex road networks, poor infrastructure, and high level of under-development. This makes the task of rescue and data gathering operations more challenging. Whenever an event occurs, the response agencies start its rescue operations and simultaneously perform the task of data collection from the affected region. The agents responsible such tasks are referred as mobile data collection agents (MDCs). They start from a depot and make a trip through the disaster affected region. During the trip, they collect maximum data and return back to the depot. A *depot* is a location where the disaster-related data is collected and processed for deciding further emergency-response activities. Usually it is a Command and Control Centre for the entire rescue operations.

Several sensors are assumed to be distributed in disaster-prone regions to sense and collect different environment parameters. In addition to this, some sensors may be air dropped in the aftermath of a disaster. As a consequence of which, the MDCs may not have the information about the geographical location of the sensors in the region. The task of MDCs is to gather information from these stationary sensors and handover the disaster data to the depot.

In this paper, we study the level of difficulty involved in the data gathering process from a complex shanty town using two basic movement decision approaches and data hand-off strategies followed by the MDCs during their task. To address the problem, we define a map-based mobility model, which takes into account the geographical factors for deciding the movement of an MDC. Map-based mobility model consists two basic types of movements, *Path Type Based Movement (PTBM)* and *Path Memory Based Movement (PMBM).*

Due to low-power wireless sensors, it may not be feasible to have a direct communication link between the sensor nodes and the depot. In such cases, routing of information from sensor nodes to the depot becomes an area of concern. High density of narrow roads makes the MDCs confined to remote areas for a long time. As a result of which the collected data gets delayed before reaching the depot. This makes the necessity of data hand-offs to other MDCs, which can deliver the data to the depot at the earliest. The wireless network interface installed on the MDCs is usually of short communication range due to the lack of network infrastructure and low energy requirements. Thus, we assume that the data hand-off from the MDCs to the depot takes place only when

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they return back to the depot. In addition, the sensors and the MDCs may not always be in contact. Due to this, there may not always exist an end-to-end path between the source (sensors) and the destination (depot). Therefore, we need to design appropriate Delay Tolerant Network (DTN) [4] solutions for effective response. Due to the absence of an end-to-end path between MDCs, they use a carry and forward mechanism in which the MDCs store the data until they find a suitable custodian to carry the data further. To address this problem, we define three data hand-off strategies, *No Hand-off, Superior-Only Hand-off* and *Superior-Peer Hand-off*.

The rest of the paper is organized as follows. In Section II, we discuss the related works existing in movement models and data forwarding in a DTN. The *Map-based Movement Model* is explored in Section III. Section IV describes three different data hand-off strategies for the MDCs. Section V provides the results and performance analysis of the movement models and hand-off strategies and Section VI concludes the paper.

II. RELATED WORK

Different methods can be used for collecting information from a disaster scenario. One of the important methods is by using an agent-based approach [3]. Agents are entities used to model human behaviour in different environments. They collect data from the environment, process it, and perform decision making. Agents are also able to interact with each other in order to have a collaborative approach in executing the task. Such properties make them suitable for the task of data gathering from a disaster scenario.

Mobility models followed by MDCs have significant impacts on the data gathering process. The movement of MDCs may get affected by the factors such as geographical constraints, obstacles in the path of movement or by the disaster itself. Several movement models are discussed in the literature. One of the most common movement model amongst them is the Random Waypoint mobility model [5]. The model uses randomness while selecting the paths and destination nodes. Whenever a node reaches a point, it randomly chooses a destination and a path and move towards that destination at random speed. Even though it is one of the most accepted model due to its simplicity, it lacks the ability to adapt to the real world constraints.

In a complex shanty town scenario, geographical constraints have a crucial role in deciding the MDC movement. Authors in [8] proposed a graph-based mobility model which takes into account the spatial parameters of a location by considering the region as a graph with vertices being the important buildings that people visit and edges being the ways that connect those buildings. A Pathway mobility model is discussed in [2] where some nodes are restricted only to pathways and their destinations are chosen at random. Authors in [9] propose a mobility model for ONE simulator [6] that models the impact of disaster on the transportation movement. It defines two main groups: *survivors* and the *rescue workers* participating in relief operations. In addition, authors in [9] provide detailed analysis about the behaviour of the different entities in the aftermath of a disaster. For our study on the difficulty of information gathering, we use two movement models derived from the Pathway model. We define a constraint based on the type of the path that an MDC can travel (Section III-A and III-B).

Apart from the mobility models to be followed by MDCs in a disaster scenario, it is important for them to take the gathered information back to the depot at the earliest. The possibility exists that, the MDCs may get trapped in remote locations due to randomness in their mobility model and high density of narrow roads. In such cases, it is necessary to hand-off their data to other MDCs, which come in contact with it, so that they can deliver it back to the depot. Different routing protocols exist in DTN to serve this purpose. One of the earliest and simple protocol is the *Epidemic Routing Protocol* (ERP) [10]. In ERP, an MDC hands over its data to other MDCs which comes in contact with it. ERP uses an assumption that, the more is the number of message copies in the network, the more is the probability that it gets delivered at the destination. Even though the protocol is simple, it adds more communication overhead in the network. For our study, we derive a protocol from epidemic by adding some constraints based on the type of paths that the MDCs can travel and the buffer clearing strategies they used.

In this paper, we discuss a network with sensors and mobile data collectors (MDCs). Mobile agents, also known as data mules, are deployed in the region for gathering data from the sensors, store and carry them forward until they either find a suitable custodian for carrying the message further or return to the depot [7]. To the best of our knowledge, there exists only very limited studies that reveal the complexities of information collection in shanty town emergency response. In this paper, we study the difficulty involved in the data gathering process in a complex shanty town terrain, Dharavi in India, using two different movement models with hand-off strategies.

III. MAP-BASED MOBILITY MODEL

The movement models have significant impacts on the data collection and routing in a DTN scenario. The MDCs should take into account the factors such as geography and infrastructure in order to make the movement more beneficial. Movement of vehicles results in frequent link-breaks, which change the network topology. In the absence of any link, the MDC should store the data until it finds another suitable MDC to forward the data further. In scenarios where stationary sensors are placed, the movement of nodes should be in such a way that they should visit maximum number of sensors and collect maximum data from them and return back to the depot. Different movement models such as *BusMovement model, CarMovement model*, and *RandomWalkMovement* are defined in typical DTN environments [6]. They do not consider several factors such as type of roads or type of MDCs for deciding the node movement. In shanty towns, the roads and lanes are particularly narrow that we need to consider four-wheeler, two-wheeler or pedestrian MDCs for disaster information gathering. The mobility models should particularly provide options to consider these constraints. To address this problem, from

Pathway mobility model, we derive two different movement models: *Path Type Based Movement* model and *Path Memory Based Movement* model.

A. Path Type Based Movement Model (PTBM)

The type of the path a vehicle can travel is an important parameter while considering the movement. While reaching a road junction, MDCs should select a way from the set of available ways. The set consists of ways that are accessible by several classes of MDCs. For example, a four-wheeler can go through highways but not through a narrow road which can handle only two-wheeler MDCs and pedestrians. Similarly a two-wheeler cannot go through pedestrian ways. The PTBM model addresses this situation by choosing the appropriate path for the movement by classifying the paths according to its type. Whenever an MDC reaches a road junction, it obtains information regarding all the adjacent paths connected to that road junction. From the list, the MDC removes all the paths through which it cannot travel. From the remaining list it selects a path at random. Each path in the reduced list has equally likely probability of being chosen as the next path. Due to this, an MDC may subsequently select the same path and gets confined to the same area of movement for a long time. Algorithm 1 describes path selection of an MDC at a junction using PTBM approach.

Algorithm 1 Path Type Based Movement

```
Require: $available\_paths$: set of available paths at a junction;
  $mdc$: an MDC with attribute $path\_types$;
  RANDOM($X$): a function returns an element from set $X$ at random.
  $possible\_paths = \{\}$
  for each $path \in available\_paths$ do
    if $path.type \in mdc.path\_types$ then
      $possible\_paths = possible\_paths \cup \{path\}$
    end if
  end for
  $selected\_path$ = RANDOM($possible\_paths$)
```

B. Path Memory Based Movement Model (PMBM)

Due to the randomness in choosing a path from the set of available paths, there is a possibility that the MDCs will subsequently choose already traversed paths. Such repeated traversals make the MDCs confined to a particular area for a long time. This process may cause unnecessary wastage of resources and time. In addition, it may also happen that an MDC repeatedly arrives at a junction, yet some paths will never be traversed due to the randomness in way selection. We address the problem using a simple memory-based decision making approach for path selection. With this approach, each MDC keeps a record of the ways it traversed. While reaching a junction, the MDC collects information regarding all the available paths and discards those that have been already traversed by it. From the remaining paths, it chooses a path at random. Thus it tries to explore new paths and visit new sensors. If all the paths at an intersection are already traversed, then the MDC chooses its next path using the PTBM approach. Algorithm 2 describes the PMBM path selection procedure followed by an MDC at a road junction.

Algorithm 2 Path Memory Based Movement

```
Require: $available\_paths$: set of available paths at a junction;
  $mdc$: an MDC with attributes $path\_types$ and $paths\_traversed$;
  RANDOM($X$): function returns an element from set $X$ at random.
  $possible\_paths = \{\}$
  for each $path \in available\_paths$ do
    if $path.type \in mdc.path\_types$ then
      $possible\_paths = possible\_paths \cup \{path\}$
    end if
  end for
  $paths\_not\_traversed = \{\}$
  for each $path \in possible\_paths$ do
    if $path \notin mdc.paths\_traversed$ then
      $paths\_not\_traversed = paths\_not\_traversed \cup \{path\}$
    end if
  end for
  if $paths\_not\_traversed = \emptyset$ then
    $paths\_not\_traversed = possible\_paths$
  end if
  $selected\_path$ = RANDOM($paths\_not\_traversed$)
  $mdc.paths\_traversed = mdc.paths\_traversed \cup \{selected\_path\}$
```

IV. DATA HAND-OFF STRATEGIES

The two movement models described in Sections III-A and III-B try to address the problem concerned with the type of path selection for information collection in a shanty town terrain. Along with the movement of MDCs, the delivery of information gathered from the region plays a key role in the efficiency of a disaster response mechanism. Decisions made by the Command and Control Center depends more on the information available from the sensors. In this section, we define different data hand-off strategies for data gathering from a highly complex shanty town terrain.

In real situations the constraints associated with MDCs and paths are important because the area that each MDC covers depends on the type of the vehicle. That is, a two-wheeler MDC can travel easily through the narrow lanes while a four-wheeler can cover only the highways. Pedestrians can cover narrow roads, lanes, and foot-ways to gather information, but they are limited in their speed. The possibility of a two-wheeler MDC to get trapped in a set of narrow lanes of a remote area is high, resulting in the MDCs taking a long time to return back to the depot. At the same time, the possibility is very less in case of four-wheeler nodes because density of highways is usually very less and they have relatively high speed. Taking these factors into consideration we define three data hand-off strategies, discussed in the following sections.

A. No Hand-off

No Hand-off is the basic case as far as data hand-off between MDCs is concerned. As the name implies, here, no data hand-off takes place between two MDCs or between two stationary sensor nodes. The only responsibility of an MDC is

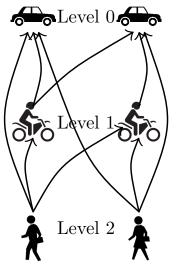

Fig. 1: Superior-Only Hand-off

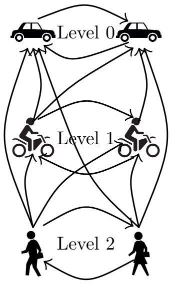

Fig. 2: Superior-Peer Hand-off

to make a trip through the region as per the defined movement model and collect the data from the visited sensors. Whenever an MDC comes in the communication range of a sensor, the sensor sends the information regarding the messages, which it has in its buffer, to the MDC. Using the received information, MDC requests the sensor to send those messages which are not available in its buffer. Meeting of two MDCs is insignificant in this strategy. The performance of *No Hand-off* case is discussed in Section IV-A.

B. Superior-Only Hand-off (SOH)

As per the movement models, there is a possibility that the two-wheeler MDCs may get confined to a remote location for a long time so that it cannot transfer the data to the depot at the earliest. In order to speed up the data movement, we define *Superior-Only Hand-off* strategy. The MDCs are arranged in a hierarchical order according to the path types they can travel and the time they take to reach the depot back. The scenario under consideration requires the four-wheeler MDCs at the root position, level 0, and two-wheeler MDCs as its children at level 1 (Figures 1 and 2). Pedestrians come in level 2 as the children of two-wheeler MDCs as they can travel through all the paths that a two-wheeler and a four-wheeler MDCs can travel. In a hierarchy, a node at level M is referred as a *superior* to another node, residing at level L, only if $M < L$. As per SOH strategy, each MDC hands over its data only to their superiors. That is, the information flow is only in the *bottom-to-top* direction. After the data gets transferred, MDC at the lower level, the sender, clears its buffer in order to accommodate new messages. The information flow in SOH strategy is depicted in Figure 1.

C. Superior-Peer Hand-off (SPH)

In order to improve the performance of information collection, we propose *Superior-Peer Hand-off* strategy. SPH utilizes the hierarchical approach similar to that of SOH. A node at level M is a *peer* of another node, residing at level L, only if $L = M$. Here, as the name implies, an MDC hands over its messages not only to the superiors but also to its peers. Figure 2 shows the information flow in SPH strategy. A two-wheeler MDC can now transfer the data to a four-wheeler as well as to a two-wheeler MDC, but not to a pedestrian node residing at a lower level. Similarly a four-wheeler can transfer its data to a four-wheeler. By adopting this variation, SPH has a slightly different buffer clearing strategy. Whenever an MDC hands over the data to its superior, it clears its buffer same as in SOH strategy. The data hand-off takes place between two peers does not result in any clearing of buffer, i.e., when a two-wheeler hands over its data to a four-wheeler, two-wheeler clears its buffer because four-wheeler has more confidence in reaching the depot early. When a two-wheeler hands over its data to a two-wheeler, it keeps its buffer the same because, two-wheeler nodes are at the same confidence level in reaching back to the depot.

V. PERFORMANCE ANALYSIS

In order to evaluate the performance of the movement models and the data hand-off strategies, we developed a Python-based DTN simulator discussed in Section V-A with a given configuration. We choose Dharavi, a shanty town in Mumbai and one of the largest slums in the world, as the location for the simulation. Dharavi is characterized by its high population density and poor infrastructure with a highly complex set of road network. The simulator exploits complex road network characteristics of Dharavi, by classifying each road according to its type so that it can adapt to the mobility models discussed in Sections III-A and III-B.

A. DTN Simulator

We developed a Python-based DTN simulator for analyzing the performance of the movement models and data hand-off strategies discussed in the previous sections. The simulator takes into account the geographical factors of a region, such as different types of roads, for simulating the movement of MDCs. The simulator loads the map of Dharavi terrain in order to study various data gathering strategies. The map environment of the location, where the disaster occurred, is given in the form of an XML file, exported from *openstreetmap.org*, with an *.osm* extension. The simulator provides a graphical user interface for the movement of mobile nodes and a report module to track all the MDC parameters. Figure 3 shows a snapshot of the simulator with five four-wheeler MDCs, 20 two-wheeler MDCs, and 20 sensors distributed in the Dharavi map environment.

The objects referred using letters F, T, and S in Figure 3, represent four-wheeler MDCs, two-wheeler MDCs, and the sensors respectively. The road network in the region is divided into three classes: highways, two-wheeler ways and pedestrian ways. Highways are capable of accommodating all types of MDCs such as four-wheeler, two-wheeler, and pedestrians. Two wheeler ways can handle two-wheeler MDCs and pedestrians, but not four-wheeler MDCs. The pedestrian ways can accommodate only the pedestrians.

Whenever an event occurs, mobile agents can be assigned with this road network, which results in a scenario similar as that of a DTN, in order to gather the information. Each node, both mobile and stationary, is assigned with a buffer of infinite size and is assumed to have a blue-tooth interface with a transmission range of 10m. For analysis, we are assumed

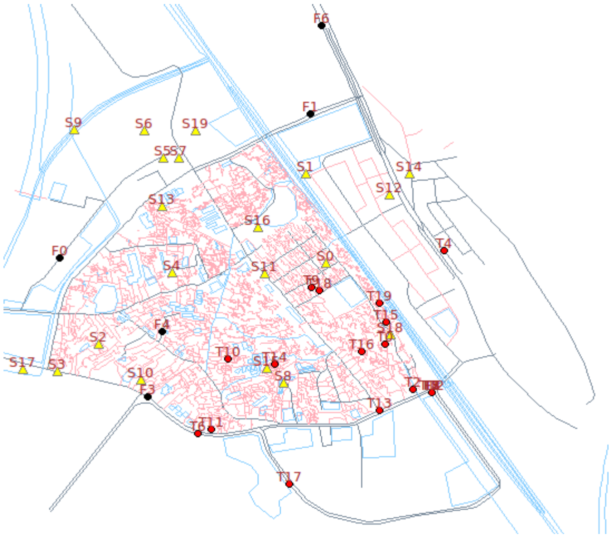

Fig. 3: Snapshot of DTN simulator for Dharavi environment

to have 50 sensors which are placed in random geographical points. For *No Hand-off* strategy, we use maximum 10 four-wheeler and 10 two-wheeler MDCs. For SOH and SPH, we use four combinations of four-wheeler and two-wheeler MDCs. Each of them is represented in the form mHnT where m and n are the number of four-wheeler and two-wheeler MDCs, respectively. For example, 2H4T represents two four-wheeler and four two-wheeler nodes are assigned the job of MDCs. The four-wheeler and two-wheeler MDCs are assumed to be moving at a speed of 60 kmph and 30 kmph, respectively. We excluded pedestrians from our study because of their inability to reach the depot at the earliest as compared to the two-wheeler and four-wheeler MDCs.

For performance analysis we use different metrics such as *percentage data collected, way coverage*, and *number of inter-MDC meetings*. We used the results from first three hours, on the reason that initial time period after the disaster is crucial in data gathering process. However, for analysis with respect to number of MDCs, we allow each MDCs to complete their trip. The performance of different data hand-off strategies and movement models is discussed in the following sections.

B. No Hand-off

1) Data collected Vs No. of MDCs: Figure 4 shows the percentage data collected with respect to the number of MDCs. We allow each MDCs to complete their trip in order to collect maximum information. On an average each MDC takes nearly three hours to complete their trip in the given Dharavi shanty town terrain. 10 two-wheeler MDCs takes nearly 12 hours to complete their trip. The two-wheeler MDCs perform better than the four-wheeler MDCs in all cases, because only two-wheeler MDCs can visit the sensors located at remote locations where highways are almost absent. An increase in the number of MDCs results in an increase in the percentage of information collection. The percentage data collected shows an increase from 8 to 23.2 (in PMBM) and 4 to 22 (in PTBM) with an increase in the number of two-wheeler MDCs from 1 to 10. Even though there is an increase in percentage data collection from 1.28 to 5.3 (in PMBM) and 1.7 to 6.2 (in PTBM) in case of four-wheeler MDCs, the increase in data collection is not uniform throughout due to very low density of highways. Even with 10 MDCs, the percentage data collected is only about 25%. This low amount of data collected is due to the complexity of the terrain in the Dharavi shanty town which we used for simulations.

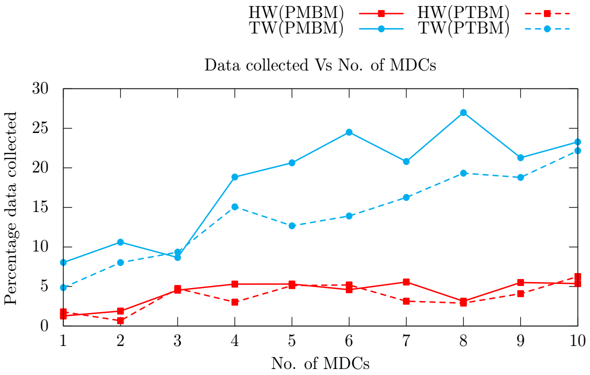

Fig. 4: Data collected Vs No. of MDCs

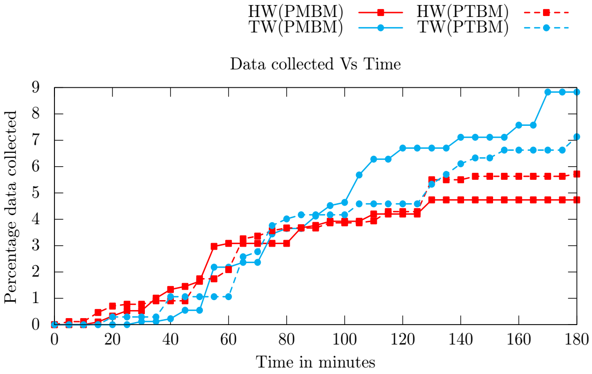

Fig. 5: Data collected Vs Time

2) Data collected Vs Time: Figure 5 represents percentage data collected with respect to time for 10 four-wheeler MDCs and 10 two-wheeler MDCs. Within three hours, two-wheeler MDCs are able to collect 9% of data as compared to 5% by four-wheeler MDCs. The low percentage, even below 10 percent, of data collection is due to the complexity of the Dharavi shanty town terrain that we considered for simulations. The PMBM approach performs better than PTBM. The data collected by four-wheeler MDCs is between 5 to 6% in either case. However, the two-wheeler MDCs show performance improvement of about 15% when simple memory-based decision making is introduced. Therefore, in a shanty town disaster response, memory based approaches may be essential for gathering efficient emergency-response information.

3) Way coverage Vs No. of MDCs: Figure 6 shows the percentage road coverage with respect to the number of MDCs, allowing each MDCs to complete their trip. With an increase in

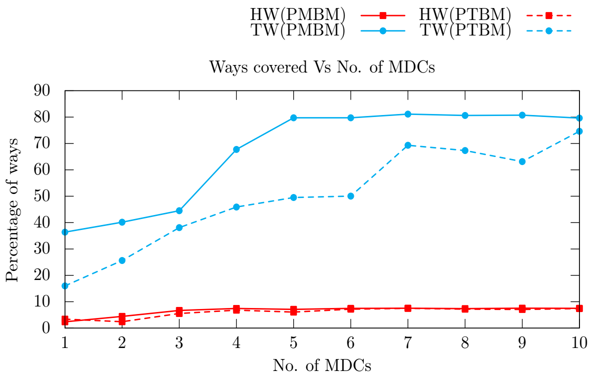

Fig. 6: Percentage way coverage Vs No. of MDCs

the number of MDCs, the road coverage also increases. The four-wheeler MDCs cover only 7.49% of ways because the density of highways are significantly less as compared to two-wheeler roads. Only four four-wheeler MDCs are required to achieve this coverage. Even with large number of two-wheeler ways, 80% of the ways can be covered with just five two-wheeler nodes. However, this may take a long time because some two-wheeler MDCs took nearly 20 hours to complete their journey. As far as the movement model is concerned, the graph clearly shows the impact of the introduction of memory in MDCs for efficient path selection.

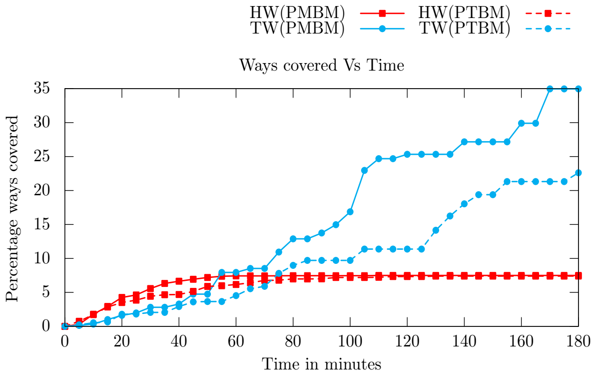

Fig. 7: Way coverage Vs Time

4) Way coverage Vs Time: Figure 7 shows the way coverage for 10 four-wheeler and 10 two-wheeler MDCs. It is interesting to note that four-wheeler MDCs cover the entire highways within an hour by using PMBM as compared to PTBM, which takes nearly two hours. The performance of two-wheeler MDCs is low as compared to that of four-wheeler MDCs. Two-wheeler MDCs ended up with 35% using PMBM as compared to nearly 20% with PTBM. In the context of way coverage, PMBM performs much better compared to PTBM. Coverage of 35% by two-wheeler MDCs shows that more than half of the area left uncovered. This is due to the high density of two-wheeler ways as compared to that of highways. However, this result also shows the challenge in the shanty town emergency-response, the time consumed in gathering the necessary emergency-response information.

C. Superior-Only Hand-off

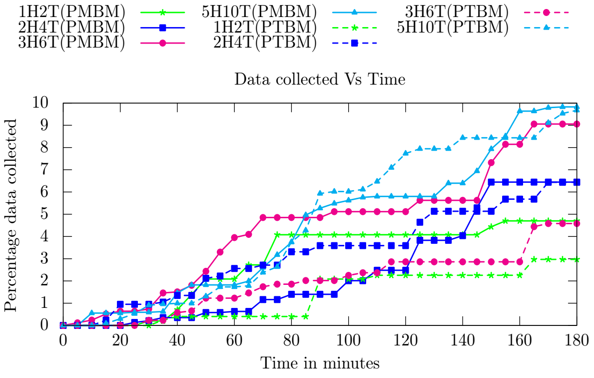

Fig. 8: Data collected Vs Time

1) Data collected Vs Time: Figure 8 shows the percentage data collected using SOH with four different MDC combinations and two different movement models. At the end of three hours, the 5H10T combination collects 10% data. As far as the movement model is concerned, the PMBM performs much better at the end of three hours. Clear dominance of PMBM can be observed in 1H2T and 3H6T combination. Both movement models interchange their dominance in 5H10T combination while PTBM outperforms PMBM for the first two hours in 2H4T.

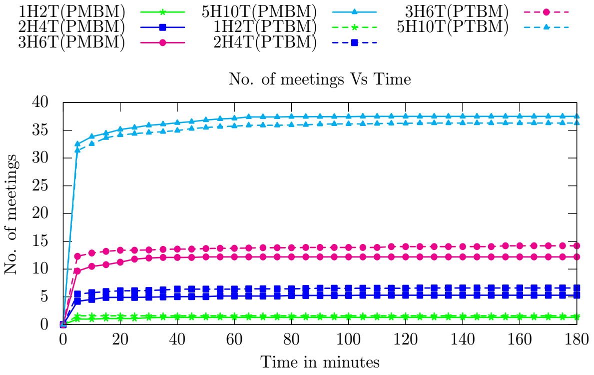

Fig. 9: No. of inter-node meetings Vs Time

2) No. of inter-MDC meetings Vs Time: The number of meetings that a two-wheeler made with a four-wheeler with respect to time is plotted in Figure 9. A meeting in SOH happens only when a node comes in contact with any of its superiors because the data hand-off takes place only to a superior. From Figure 9, it is clear that as the number of MDCs increases the number of meetings also increases. 5H10T has the maximum number of meetings at 36. Figure 9 shows that the movement model has less impact on the number of inter-node meetings. Except in 5H10T, PTBM outperforms PMBM.

D. Superior-Peer Hand-off

1) Data collected Vs Time: In SPH, 5H10T has achieved a data collection of 12% as compared to nearly 10% in SOH

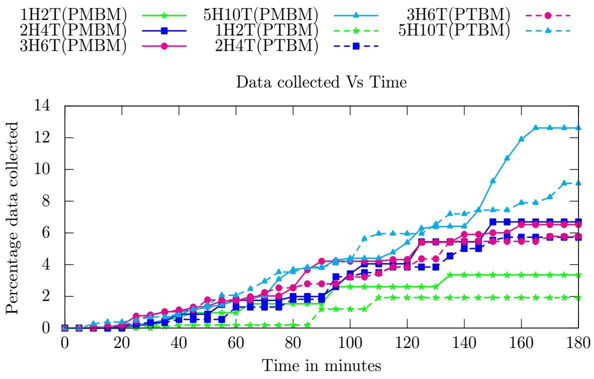

Fig. 10: Data collected Vs Time

using PMBM (Figure 10). Other combinations have nearly the same values as compared to the SOH approach. The increase is due to the increased number of inter-MDC contacts. Here, the data hand-off takes place between peers, which is prohibited in the SOH approach. With the introduction of memory, the MDCs explore new paths, which are not already traversed, thereby visiting more sensors. Ultimately it leads to more data collection. It is important to observe that even after three hours of information gathering, Dharavi shanty town allows only 10-12% data collection. This shows the difficulty involved in data gathering from highly complex disaster-affected regions similar to Dharavi.

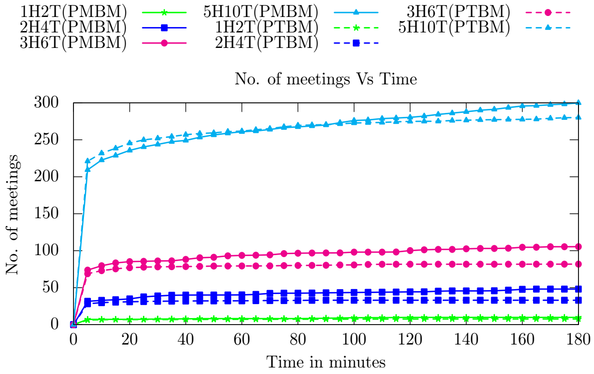

Fig. 11: No. of inter-node meetings Vs Time

2) No. of meetings Vs Time: Figure 11 shows the real impact of permitting the data hand-off between the peer MDCs. Here a meeting implies an MDC's contact with its peer or its superior. The number of meetings increases in a large scale and reaches 300 in 5H10T as compared to just 35 in SOH. As far as the movement is concerned, PMBM performs slightly better, contrary to what we observed in SOH. But the difference between the two is not up to a significant level.

VI. CONCLUSION

Information gathering in a disaster scenario is a challenging task as far as the time required for data collection is concerned. The process becomes more difficult if the region is a shanty town characterized by high population density and poor infrastructure. Complex road networks and geographical constraints make the process more complex and time consuming. The ultimate objective is to collect maximum amount of data from the sensors and provide it back to the depot as early as possible in order to make further decisions on the rescue operations. In this paper we studied the level of difficulty involved in the data gathering process using MDCs in Dharavi, the largest shanty town in Mumbai, India. We used two movement approaches namely *Path Type Based Movement* and *Path Memory Based Movement* to decide the movement of MDCs. Along with movement models, we also defined three hand-off strategies using a hierarchical approach, to provide the data to the depot at the earliest. The data hand-off strategies include *No Hand-off*, *Superior-Only Hand-off* and *Superior-Peer Hand-off*. *Superior-Peer Hand-off* has domination on way coverage while each of them have equal domination in percentage data collected. Even if we take the best of all combinations of movement models and data hand-off strategies, the maximum data collection achieved is only 14%, which reveals the complexity of information gathering during disasters in shanty towns.

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