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DETECTION OF CROWD WITH HELP OF GPS AND ACCELEROMETER USING PARTICIPATORY SENSING

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ABSTRACT

In this paper, we have detected crowd with help of the most commonly found sensor in people mobile phones and that is Accelerometer. This is possible because we are using participatory sensing technique. Participatory sensing allows people to participate in collecting data. First, we will define different travel mode and specifically defining it within two mode, that wheel and non-wheel. Non-wheel data are localized with help of GPS that will help detecting crowd. Once the Data collection process is completed, analysis of data will be done by data mining techniques in data mining softwares WEKA and MATLAB. This research is basically focusing on detecting random and unexpected crowd on road that could somehow interrupt daily travelling people and may create obstacle for traffic system in management.

Keywords:- ITS, ATMS, Participatory sensing, mobile sensing, Acceleration based travel mode, Crowd detection

1. INTRODUCTION

Various researchers have developed different ITS architecture and model which are studied to get the insight of the main domain i.e., Intelligent Transportation System. Based on their implementation in different aspects of transportation management it has been sub-divided in four main branches i.e. ATIS, APTMS, ATMS and EMC [14].

- Advanced Traveler Information System (ATIS)
- Advanced Traffic Management System (ATMS)
- Advanced Public Transportation System (APTS), and
- Emergency Management System (EMS)

India, the second most populous country in the world, and a fast growing economy, is seeing terrible road congestion problems in its cities [3]. Road congestion problems ask for ATMS. Advanced Traffic Management System needs to manage the congestion problems occurring. The main causes to such problems are the non-lane system of transportation in India. Also increase in number of vehicles and people walking on road or their disputes sometimes or some rally may cause congestion which will lead to poor management of traffic or it will make it even worse to keep it in control. For some monitoring such situation there are some vision-based infrastructures implemented at intersection and at some of the commonly ad expectedly crowded places. The groups are identified or discovered by bottom up hierarchical clustering using a generalized, symmetric Hausdorff distance defined with respect to pair wise proximity and velocity [17]. To cut off the expenses the static sensors need we can make use of the sensors in mobile phones as there are increasing the number Sensors in smartphones with the increase of their usage. Sensors are actually the key factors of increase in development of interesting applications on the mobile phones, and the sensors make the mobile phone different from traditional computing devices like computer [2]. The idea of participatory sensing emerges with making usage of sensors in mobile phones for development. Participatory sensing includes communication, computation and database. Including people for data gaining in every way leads to mobile crowd sourcing, which further clarify the potential fusion of human and machine intelligence [8].As infrastructure based traffic management system which could detection crowd would be expensive, participatory sensing can be used instead. It will be an energy- efficient method to detect event by making use of the Minimum Cut theory and support vector machine (SVM)-based pattern recognition techniques [6]. For our purpose of detecting crowds that are specifically on road, we tend to use Accelerometer data of people mobile phones. The data collected shows different patterns when an individual is going through different travel modes. Also the position of the phones can be detected using Accelerometer which affects the activity recognition [13]. But we are by default considering the vertical position of the phone. From the data we get and the analysis we go through, we classify wheel and non-wheel data. After which non-wheel data is undergone further analysis in data mining software WEKA for crowd detection of walking people outcome.

2. RELATED WORK

There has been a fair amount of work in detecting and monitoring crowd but more with the traditional technique that is video camera based system. For example, Weina Ge et al, [17] automatically detect small groups of individuals who are traveling

together. These groups are discovered by bottom up hierarchical clustering using a generalized, symmetric Hausdorff distance defined with respect to pairwise proximity and velocity. This was the crowd detection with traditional method. The mobile sensing method in which sensors are in mobile phones are used. Introduction to new method of mobile sensing in which Wang, Yi, et al, [1] present a novel design framework for an Energy Efficient Mobile Sensing System (EEMSS). EEMSS uses hierarchical sensor management strategy to recognize user states as well as to detect state transitions. Also recognition of crowd behavior and their pattern analysis with graph clustering method is done [15] but that was by on-body sensors. It describes the individual moments and action recognition, basically mounted sensor on the body and checked what are the results when person is walking alone, in a pair or in a group. Whereas there comes an idea of using sensors in the mobile phones which will make it easy as we do not have to put sensors on body and we do carry our mobile almost everywhere.

3. PROPOSED FRAMEWORK

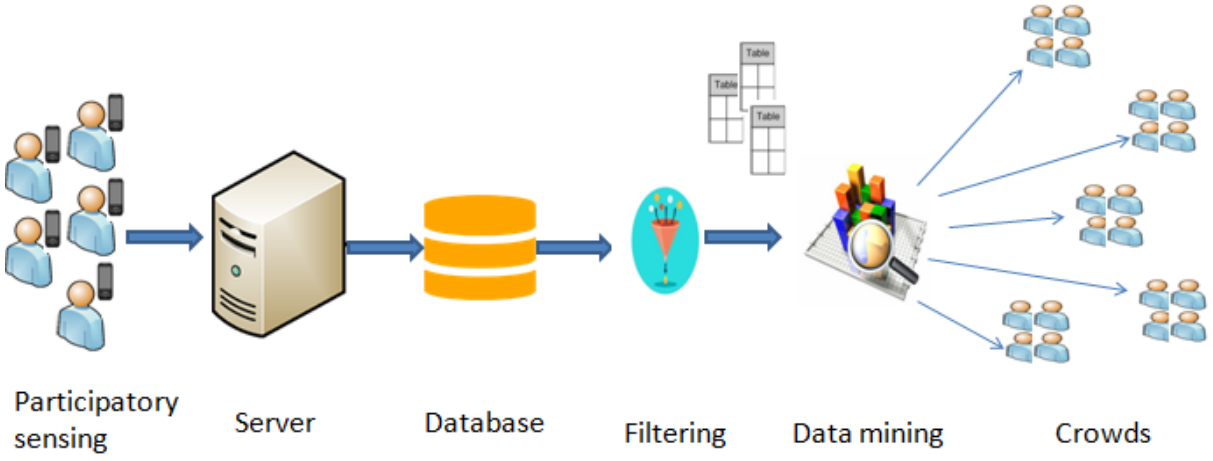

Fig.1. Proposed framework

Figure shows the proposed system that depicts three main parts. There are server, database and data mining. Proposed system starts from the technique of transportation that include the people involvement in the process. The technique is called participatory sensing. Participatory sensing make use of the mobile phones of people in getting data which will be stored in some particular form in database to be analyzed. After the analysis is done on the data is collected by data mining techniques provided by data mining softwares, WEKA and MATLAB. We are provided by the result of walking people on the road creating crowd.

(A) PARTICIPATORY SENSING: Participatory sensing is the process whereby individuals and communities use evermore-capable mobile phones and cloud services to collect and analyze systematic data for use in discovery. Sensing methods which are people-centric use smartphones for mobile sensing. Smartphones are very popular and has become important part of people life and they carry it almost everywhere. They are embedded with various sensors which could be used for many interesting applications. These emerging capabilities of mobile phone open the wide areas for it to be applied on. First, it covers wider area compare to any static sensing system. Static sensing system for example we say, video camera systems are way too expensive to be employed than using the sensors already available in smartphones.

(B) SERVER: The server here plays vital role by fetching the data of sensors of the mobile phones in which we have installed our application. We have created a server that will fetch the data every 1 minute which is collected every 5 second.

(C) DATABASE: The data that is collected is in some particular format. We have included date, time, IMEI number, Sensors, latitude, and longitude. Accelerometer data of every individual is collected with their latitude-longitude points.

(D) FILTERING: Basically, we are filtering the non-wheel data from wheel data. We want the people walking on the road or the side of the road. So, on the basis of the analysis and some feature of accelerometer, we concluded that the average of acceleration chance changes with travel mode. Based on the average, we have manually defined range of every mode that we have considered. We have done experiment with car, bus, scooter and walking.

(E) DATAMINING: Once the non-wheel data is filtered in MATLAB, k-mean clustering on the data will use the location points of walking people and will give the output in the form of clusters. Those clusters will shows the crowds.

(F) CROWDS: Crowds which is defined as the people gathered at some particular place with or without purpose. But when the crowd form on road that will ultimately affect the traffic system management. Daily traveling people suffer from traffic congestion. Crowd creating congestion is our main focus here.

4. METHODOLOGY

We are using participatory sensing technique to collect data. We have developed an application which includes the following information.

- Date
- Time
- IMEI number
- Acceleration
- Latitude-Longitude

The application developed works in background once it gets installed in mobile phone. It collects data at the time interval of 5 seconds. This interval can be changed as per our need. These data will be uploaded to our server in every one minute.

4.1 DATA ANAYLSIS AND RESULT

We wanted to cut off the extra processing over the location data. Also wanted the congestion cause to be detected is to be the people on road. Vehicle making congestion problem is other scenario. Sometimes people causing congestion to traffic system not only causes delay only, sometimes it may goes to the security and safety level to be maintained. The crowd could be an unauthorized rally or some disputes that turn into something big that might need to be resolved for the sake of people and transportation infrastructure safety.

We had installed our application into 10 person's mobile phones. All went through the four travel modes, by bus, car, scooter and walk. We observed Acceleration pattern of all modes differ from each other. But we do find similar pattern of Acceleration of all 10 people of same mode. We calculated the average of change in Acceleration and created a range in which particular mode falls.

Travel mode	Average range
Car	2.7 - 3.04
Bus	0 - 2.7
Scooter	3.02 - 4.83
Walk	4.83-6.01

Table I. Travel mode and their average acceleration range

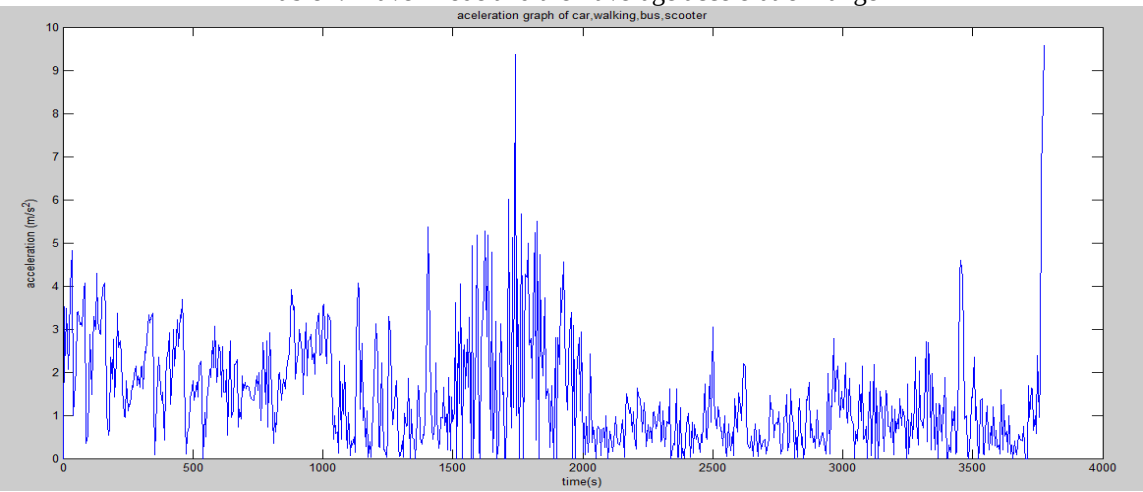

Fig.2. Acceleration of car, walking, bus and scooter

Using this, we write a script in MATLAB that filters the walking data. Also a graph is created in MATLAB that clearly shows how all four differs

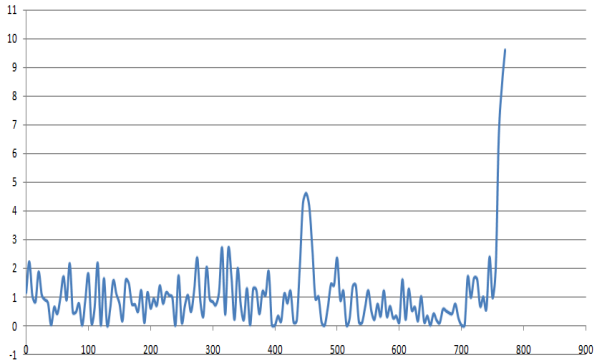

Fig.3. Scooter acceleration to time graph

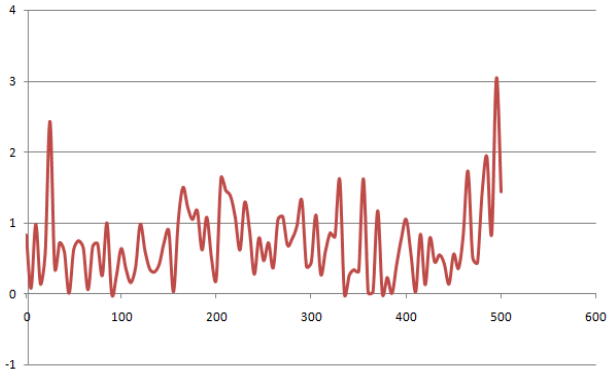

Fig.4.Bus acceleration to time graph

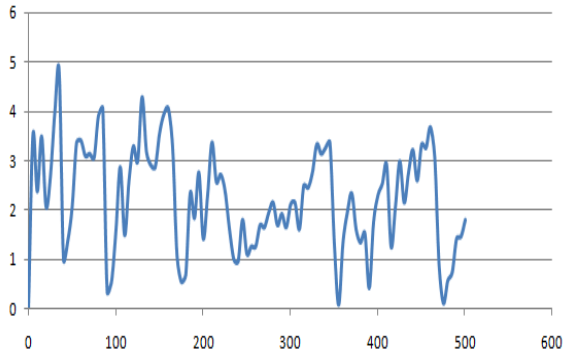

Fig.5. Car acceleration to time graph

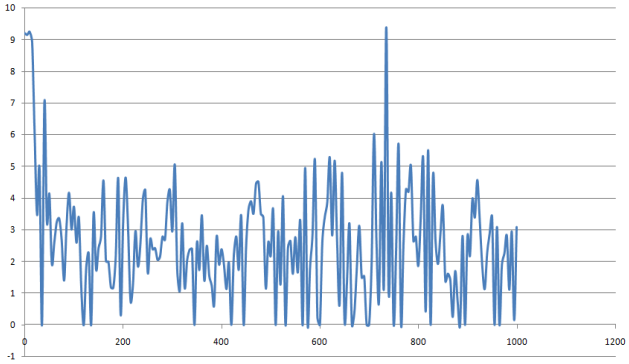

Fig.6. Walk acceleration to time graph

The above figures show the individual patterns that each mode makes of acceleration. It is by far clear that acceleration changes according to the travel mode. Once the walking data is filtered, their latitude-longitudes are used for localization. Here comes WEKA, it is data mining software that provides us the number of data mining techniques. We have applied k-mean clustering to the latitude-longitude points. The algorithm used is k-mean clustering, it take input as all latitude-longitude points of GPS of walking people only and then randomly select the center points. And now the points around the center point form a cluster along with the center. We experimented with the 10 persons and this is how the result shows.

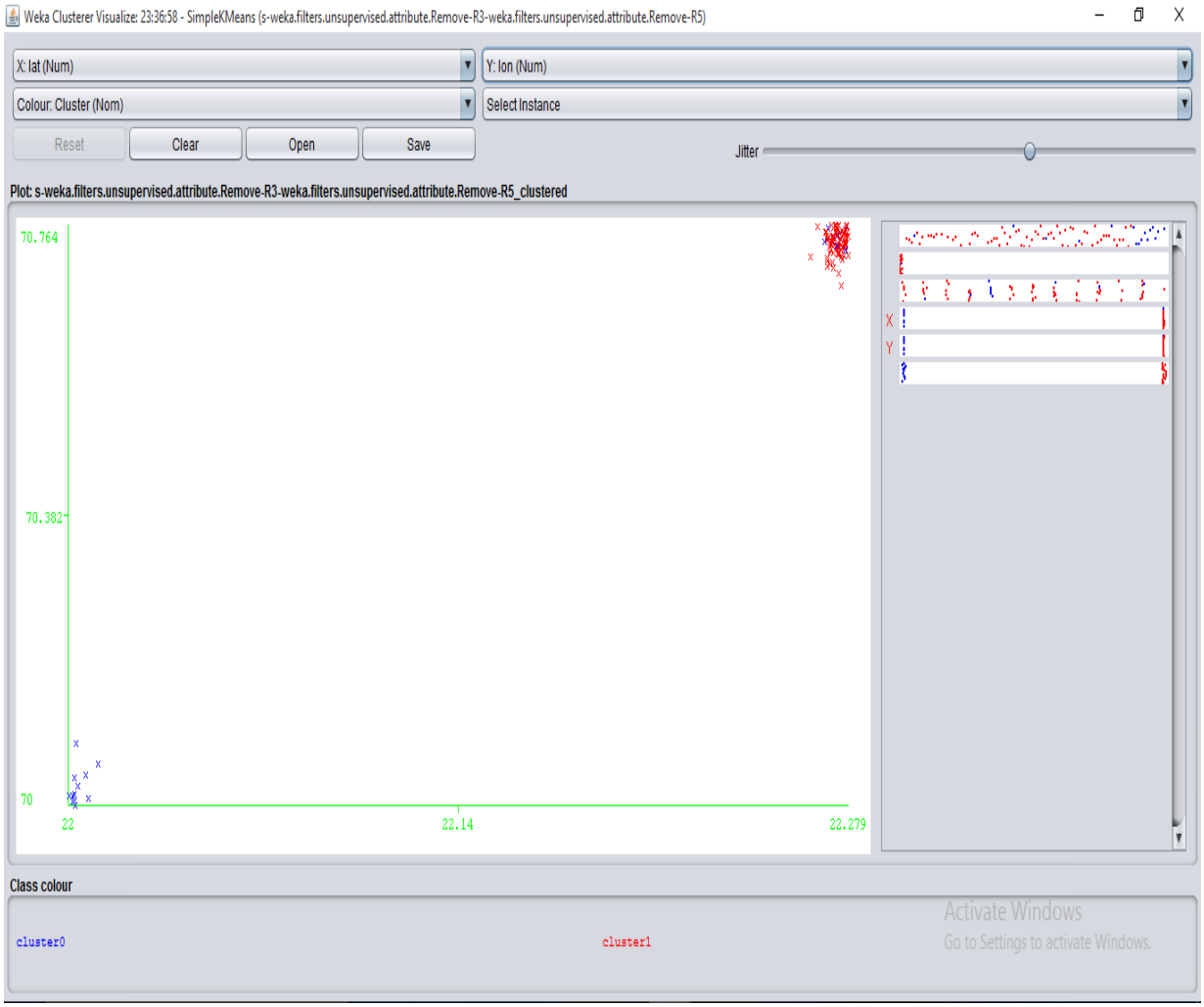

Fig.7. Cluster formation in WEKA

It is clearly seen that, it forms two clusters. Because of the lack of the more number of persons results shows two small clusters. But the experiments with the larger number of persons will result in more number of clusters. Or we can say, it will depict more crowds.

5. CONCLUSION

So, far most of the crowd detection and analysis processes acquired the vision based techniques more. Relying on videos cameras is somewhat obvious from such. Although, it provides very accurate outcomes but the drawback that it holds is limited area coverage. Sensors can contribute to this area very conveniently and can be considered as an alternate way to do the things we want to do with video cameras but with the wider coverage. Starting from on-body sensors [10] to using the sensors in today's mobile phones that rich in providing facilities has increased. With the advancement of increase in number of sensors in mobile phone and in increase in usage of mobile phone, researchers and practioners uses it for more activities like detecting transportation modes [19] or for recognition of pedestrian movements [20].

This paper provides current crowd analysis methods that include usage of sensors, if specifically said then Accelerometer and GPS for crowd detection using participatory sensing. Accelerometer data of an individual mobile phone will differ as per their travel mode. We have encountered the changes in pattern of Accelerometer data as we changes the travel mode. Also some other sensors can do the same like barometer sensor is sensitive enough to measure the altitude changes while vehicle is moving that gives specific analysis on travel mode detection [16]. But the reason that leads us to use Accelerometer is that it is commonly available in nearly every mobile phone. Localization in our case is precisely outdoor places mainly road areas. As GSM-based localization is more available but is not as accurate as GPS. Also GPS coverage is available only 4.5% of the time for a device carried in users' pockets or purse during a typical day [4] but for the precision we needed , we have used GPS.

REFERENCES

[1] Wang, Yi, et al. "A framework of energy efficient mobile sensing for automatic user state recognition." *Proceedings of the 7th international conference on Mobile systems, applications, and services*. ACM, 2009.
[2] Liu, Ming. "A study of mobile sensing using smartphones." *International journal of distributed sensor networks* (2013).
[3] Qureshi, Kashif Naseer, and Abdul Hanan Abdullah. "A survey on intelligent transportation systems." *Middle-East Journal of Scientific Research* 15.5 (2013): 629-642.
[4] Varshavsky, Alex, et al. "Are GSM phones THE solution for localization?." *Mobile Computing Systems and Applications, 2006. WMCSA'06. Proceedings. 7th IEEE Workshop on*. IEEE, 2006.
[5] Zhan, Beibei, et al. "Crowd analysis: a survey." *Machine Vision and Applications* 19.5-6 (2008): 345-357.
[6] Liu, Chi Harold, et al. "Energy-efficient event detection by participatory sensing under budget constraints." *IEEE Systems Journal* (2016).
[7] Herrera, Juan C., et al. "Evaluation of traffic data obtained via GPS-enabled mobile phones: The Mobile Century field experiment." *Transportation Research Part C: Emerging Technologies* 18.4 (2010): 568-583.
[8] Guo, Bin, et al. "From participatory sensing to mobile crowd sensing." *Pervasive Computing and Communications Workshops (PERCOM Workshops), 2014 IEEE International Conference on*. IEEE, 2014.
[9] Sen, Rijurekha, and Bhaskaran Raman. "Intelligent Transport Systems for Indian Cities." *NSDR*. 2012.
[10] Mannini, Andrea, and Angelo Maria Sabatini. "Machine learning methods for classifying human physical activity from on-body accelerometers." *Sensors* 10.2 (2010): 1154-1175.
[11] Guo, Bin, et al. "Mobile crowd sensing and computing: The review of an emerging human-powered sensing paradigm." *ACM Computing Surveys (CSUR)* 48.1 (2015): 7.
[12] Coskun, Doruk, Ozlem Durmaz Incel, and Atay Ozgovde. "Phone position/placement detection using accelerometer: Impact on activity recognition." *Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP), 2015 IEEE Tenth International Conference on*. IEEE, 2015.
[13] Tilak, Sameer. "Real-world deployments of participatory sensing applications: Current trends and future directions." *ISRN Sensor Networks* 2013 (2013).
[14] Singh, Bhupendra, and Ankit Gupta. "Recent trends in intelligent transportation systems: a review." *Journal of Transport Literature* 9.2 (2015): 30-34.
[15] Roggen, Daniel, et al. "Recognition of crowd behavior from mobile sensors with pattern analysis and graph clustering methods." *arXiv preprint arXiv:1109.1664* (2011).
[16] Dimri, Anuj, et al. "RoadSphygmo: Using barometer for traffic congestion detection." *Communication Systems and Networks (COMSNETS), 2016 8th International Conference on*. IEEE, 2016.
[17] Ge, Weina, Robert T. Collins, and R. Barry Ruback. "Vision-based analysis of small groups in pedestrian crowds." *IEEE Transactions on Pattern Analysis and Machine Intelligence* 34.5 (2012): 1003-1016.
[18] Thiagarajan, Arvind, et al. "VTrack: accurate, energy-aware road traffic delay estimation using mobile phones." *Proceedings of the 7th ACM Conference on Embedded Networked Sensor Systems*. ACM, 2009.
[19] Reddy, Sasank, et al. "Using mobile phones to determine transportation modes." *ACM Transactions on Sensor Networks (TOSN)* 6.2 (2010): 13.
[20] Kjærgaard, Mikkel Baun, et al. "Detecting pedestrian flocks by fusion of multi-modal sensors in mobile phones." *Proceedings of the 2012 ACM Conference on Ubiquitous Computing*. ACM, 2012.