A Hybrid Intelligent Information System for the Administration of Massive Mass of Hajjis

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Abstract: In this paper the development of a hybrid intelligent information system for the administration of massive Hajjis crow has been described. The main objective is to design an information system to manage the crowd during one of Hajj rituals, "Nafra" so as to avoid crowding disasters. The developed system incorporates data acquisition and processing via several thermal cameras deployed as sensors at strategic points on “Nafra” access roads. The sensors are linked to an analysis module, which in turn measures crowd flow and density in real time. The analysis results are fed into a fuzzy logic module to determine the priority of roads with respect to their widths and lengths. Then, the integrated decision support system generates decisions to the controllers in order for them to take the appropriate actions. Hybridization is done by integrating fuzzy logic, operations research and decision support to produce alternate decisions to the system controllers enable them to control the movement of the huge crowd. The paper illustrates different system components. It also describes the architecture of each component as well as the architecture of the entire system. A complete case study is illustrated with real snap shots of system screens in order to prove the system methodology. The results show solid decisions that help the authorities manage the huge pilgrim crowds. The system can contribute to provide complete safety for crowds during the “Nafra” event that attracts millions each year.
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1. Introduction

According to the Islamic faith, every able Muslim who can afford to do so must make the pilgrimage to Mecca, the holy city in Saudi Arabia, at least once in his or her lifetime. Known as the Hajj, the pilgrimage involves a number of sacred rituals, and represents a profound personal and spiritual journey for Muslims. This annual Hajj occasion brings around 3.0 Million Muslims of all countries, colors, and races in a unique opportunity of worshipping Allah collectively in large gathering at one place.

Over the years, overcrowding and difficulties in crowd control have resulted in a number of accidents and fatalities during the Hajj. Despite many efforts and improvements for roads and footbridges, ensuring the safety of pilgrims continues to challenge especially with the annual increase of the number of pilgrims. The challenge has attracted many researchers who provided several methodologies for crowd monitoring and estimation of its density. However, even with the crowd control techniques, there are still many incidents during the Hajj, as pilgrims are trampled in a crush, or ramps collapse under the weight, causing hundreds of deaths.

The main objective of this paper is to provide an integrated intelligent crowd management system allows for close monitoring and control of crowd movements of pilgrims and protection against accidents caused by overcrowding, and preserving a level of comfort during the movement to keep the sanctity of emotions at its best.

The presented system incorporates data acquisition through the use of several thermal cameras deployed at critical points on the target route. The thermal videos will be fed into an analyzer to calculate the density of the crowd in each road in the target route. The crowd analysis will be fed into a fuzzy logic module along with pre-stored information about roads geometry to devise the status of each road individually. Then, the intelligent decision support system is triggered. It incorporates an operations research module that determines the pilgrims mass per minutes for each available road due to road parameters and possible time remains. It also incorporates a capacity weighted approach based on roads priority. The decision support system will generate different alternatives showing the closed roads, road priorities, and which group should move through which road. The alternatives will be used by the authorities to take the necessary actions.

The system architecture is illustrated along with the information flow diagram as well as a detailed description of different system components. A complete case study is illustrated that traces the systems with a real example. The results show solid decisions that help the authorities manage the huge pilgrim crowds.

This paper is divided into six sections. The first section is this introduction. The second section defines the problem under discussion. The third section surveys some related work. The fourth section illustrates different system components. The fifth section, discusses a complete case study. And the last section concludes the work and discusses the future of the research.

Problem Definition

After the sunset of the ninth day of "Dhul-Hijjah" pilgrims go from "Arafat" to "Muzdalifa" during "Nafra". The "Nafra" process includes the movement of 3.0 Million Hajjis before sunrise using certain limited roads. Khozium *et al.* (2012) showed a map with plotted pedestrians' roads on the "Nafra" route. Figure 1 shows a view of pilgrims during the "Nafra".

Figure 1: A View of Hajjis During "Nafra"

Ben-Mahmoud *et al.* (2010) have shown that the number of pilgrims will dramatically increase in the next few years to reach almost 3.75 million Muslims. Moreover, managing millions of people gathered from diverse countries around the globe is not only a matter of placement them in the correct route. The gathered troops are different in nationalities and so in customs. Pilgrims coming from Gulf area prefer to move by cars or buses; pilgrims coming from India, Pakistan and Bangladesh prefer to move by walking together, and pilgrims that belong to Shi'a also prefer to stay together. This makes the challenge more difficult in order to manage the moving of different troops together.

To control pilgrims, the Kingdom Ministry of Hajj has established six establishments to provide services for pilgrims plus GCC and interior establishment. These six establishments are:

- National "Tawafa" Establishment for South Asian Pilgrims
- National "Tawafa" Establishment for Pilgrims of the Non-Arab African countries
- National "Tawafa" Establishment for South East Asian Pilgrims
- National "Tawafa" Establishment for Pilgrims of the Arabian Countries
- National "Tawafa" Establishment for Pilgrims of Iran
- National "Tawafa" Establishment for Pilgrims of Turkey and Muslims of Europe, Americas and Australia.

Each establishment has around 100 offices; each office is responsible for around 5000 hajj and consists of a manager and a group of personnel. These establishments are responsible to provide accommodation, transportation and other services to pilgrims. These service providers are the main stakeholders of the intended system; they will be the controllers and users. Each establishment is responsible for half million hajj divides them into one hundred groups according to nationality, race and religious group. The establishment is responsible for moving these groups through different roads in the "Nafra" route.

In the following text the author assumes that each establishment is responsible for twenty groups of Hajjis over one hundred who will move by walking using the pedestrians' "Nafra" roads. Each one has 4000 Hajjis; total will be 80,000 Hajjis. Each of these groups is going to move as one block of Hajjis.

Related Work

Generically, crowd can be defined as a large number of people gathered together with or without orderly arrangement. Crowd management is defined as the systematic planning for, and supervision of, the orderly movement and assembly of people. Crowd management involves the assessment of the people handling capabilities of a space prior to use (Fruin, 1993).

Most major crowd disasters can be prevented by simple crowd management strategies. The primary crowd management objectives are the avoidance of critical crowd densities and the triggering of rapid group movement (Fruin, 1993). Helbing *et al.* (2007) showed that as crowd density rose, they identified the start of stop-and-go waves similar to those found in road traffic jams. This was followed by transition to a much more chaotic state, with outbreaks of panic as individuals lost control. This phenomenon – known as crowd turbulence – can trigger disasters. In the following paragraphs, some crowd control and management systems have been studied.

Sirmacek and Reinartz (2011) have introduced a novel approach to detect crowded areas automatically from very high resolution satellite images. Although resolutions of those images are not enough to see each person with sharp details, they can still notice a change of color components in the place where a person exists. Therefore, they developed an algorithm which is based on local feature extraction from input images. They have tested their algorithm on panchromatic Worldview-2 satellite image dataset, and also compared with an algorithm result obtained from an airborne image of the same test area. The presented results indicate possible usage of the algorithm in real-life events.

Deshpande and Gupta (2010) have proposed a computer based system combining fuzzy logic and Graphical Information System (G.I.S) to monitor and avoid the crowding disasters. They have proposed two-step mode. The first step is pre-disaster planning incorporating the determination of sensitive locations and space management, evacuation paths using (G.I.S) and management related arrangements. The second step is real time analysis of crowds to detect a possible emergency. Their system contains two modules. The first is a fuzzy inference system to determine crowding situations and plan of action. The fuzzy interface depends on the number of pixels and shape of objects to determine the crowd density. It also uses object characterization from the image to determine the speed of the crowd. The second is the determination of the shortest evacuation path for the current area under surveillance. The shortest path is determined with the help of G.I.S. and the overall crowding situation. Their proposed system follows certain steps: acquiring basic information, formation of evacuation network, and calculation and decision.

Al-Habaibeh *et al.* (2009) have described a novel application of low-cost infrared system for estimating people's density using infrared thermography. They have conducted their experiments inside Madina Mosque in Saudi Arabia. They designed a fusion of three sensors low-cost infrared sensor, light intensity sensor and temperature sensor. By taking one shot every one minute they have been able to predict the people density by plotting the number of warm infrared pixels which are found to be very representative to the density of people in the mosque. Because of the air condition inside the mosque, the temperature sensor has no use in their experiment which leaves a question about its role in the fusion system. In addition, the change in light intensity has caused significant source of error in their experiments. The obtained results did not give an indication about the critical crowd density level; however they only showed that in different prayer times, people are increasing in the mosque.

The use of still images has been extended to analyzing the work from multiple cameras using information fusion. Andersson *et al.* (2009) have presented a useful tool for estimating behaviors of a crowd derived from distributed and heterogeneous sensors. Their tool doesn't need to identify specific persons or decide their exact positions in the scene but it aims to become aware of that something abnormal has occurred. The concept is used for automatically alerting operators when abnormal behaviors occur, or are about to occur. Yang *et al.* (2003) estimated the number of people directly from groups of image sensors. For each sensor, foreground objects are segmented from the background, and the resulting silhouettes are combined over the sensor network. A geometric algorithm is then introduced to limit the number and possible locations of people using silhouettes extracted by each sensor.

Mahalingam *et al.* (2009) have presented a simplified method for tracking people in crowded scene from a video sequence. The method is based on computing the Minimum Mean Square Error (MMSE) between frames of the video sequence to identify people in subsequent frames. They have succeeded to handle small occlusions, varied lighting conditions and camera motions. Pini *et al.* (2004) have presented a system for crowd detection from a moving platform. The system uses slices in the spatiotemporal domain to detect inward motion as well as intersections between multiple moving objects. The system calculates probability distribution functions for left and right inward motion and uses these probability distribution functions to deduce a decision about inward motion or crowd detection. The system has succeeded to automatically detect scenes that contain crowd consisting of multiple pedestrians moving in opposite directions, even at a large distance

Schubert and *et al.* (2008) presented a decision support system for crowd control. Decision support is provided by suggesting a control strategy needed to control a specific disturbance situation. Control strategies consist of deployment of several police barriers with specific positions and strengths needed to control the disturbance. The control strategies are derived for a set of pre-stored example situations by using genetic algorithms where successive trial strategies are evaluated using stochastic agent-based simulation. The optimal control strategy for the current situation is constructed by the best linear combination of pre-stored example situations. The optimal strategy is given as the same linear combination of associated strategies. So, their system is using a decision making algorithm where a current situation is compared to all simulated situations. A linear combination of control strategies, whose corresponding weighted superposition of simulated situations most closely resembles the current situation, is given as the required decision.

System Components

Figure 2 shows the information flow between different system components. The flow goes with the arrow's direction through thermal cameras, video sequence analyzer, road selection module, fuzzy module, operations research (OR) module, decision support system module, and establishment status module.

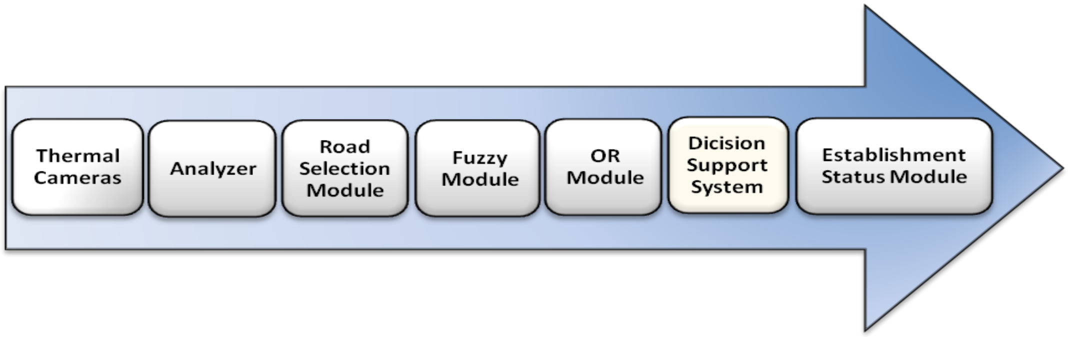
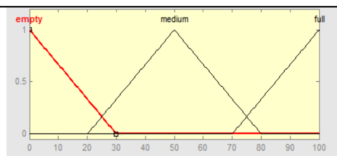
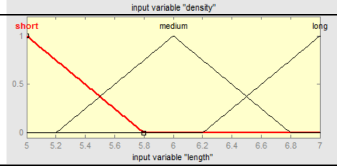
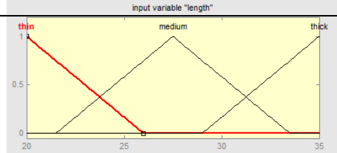
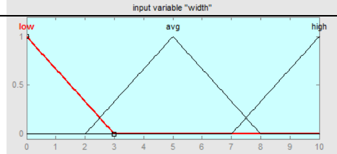


Figure 2: Information Flow Diagram

The thermography module (Abuarafah *et al.* 2012) uses a set of FLIR E60bx thermal camera deployed over an elevation about 10m above each pedestrian road in the route. The cameras will be connected to a controller. The controller collects different video sequences about each road in certain period of time and feeds the second module which is the video sequence analyzer with the collected video sequences and the necessary calibration information such as human temperature. The video sequence analyzer module calculates the crowd density in real-time in pre-defined steps; every step includes a specific number of frames pre-defined in system configuration. The less number of frames in the step will result in increasing the accuracy of calculating the average crowd ratio. The module will indicate the crowd density percentage in different colors. In addition the module infers the movement behavior from whether it is accelerating or decelerating. The road selection module will reject the closed roads, and marks other roads with critical or open road according to the crowd density that comes from the analysis module. The module then feeds the output to the next module.

The next module is the fuzzy logic module (Ross, 2010). This module manipulates the output of the analyzer in integration with road parameters such as road length and width to formulate the status of each road individually. The fuzzy logic module prioritizes the roads according to three parameters the crowd density on the road, the road length, and the road width. So, suppose that the crowd density is normalized among several roads; then the priority of them is arranged according to the shortest and widest one. The roads will be assigned a discrete number from 0 (lowest) to 10 (highest) to describe its priority.
Table 1summarizes the fuzzy module.

Table1: Fuzzy Module Rules

Input	Density 0 - 100%		**Fuzzy Rules** 1. If (density is empty) and (length is short) and (width is thick) then (priority is high) 2. If (density is full) and (length is long) and (width is thin) then (priority is low) 3. If (density is medium) and (length is short) and (width is thick) then (priority is high) 4. If (density is empty) then (priority is high) 5. If (density is full) then (priority is low) 6. If (density is medium) and (length is medium) and (width is medium) then (priority is average) 7. If (density is medium) and (length is long) and (width is thin) then (priority is low)
	Length 5.0 – 7.0 km		
	Width 20 - 35 m		
Output	Priority 0 - 10		

The output of the fuzzy module is fed to the operations research module which determines pilgrims mass per minute for each available road due to road parameters and possible time remains.

The decision support component along with establishment status module works in a new approach which can be named capacity weighted using priority approach (CWP).This new technique uses the capacity of the establishment which depends on the remaining number of Hajjis and the priority of the roads for each establishment to achieve balance among the remaining Hajjis in the entire establishments. The approach is done in the following steps.

1. A matrix is constructed with its columns represent the available establishments and its roads represent the available roads in the “Nafra” route;
2. The matrix is initialized with the roads sorted according to their distance from the corresponding establishment, the closer the road from the establishment the higher rank it takes in the matrix.
3. Table 1 shows an initial matrix assuming that there are six available establishments and four available roads in the “Nafra” route. For example, road number 4 is the nearest road to establishment number 1 then road number 3, road number 2, and road number 1 is the farthest one;
4. From the road analysis module, the closed roads are excluded from the matrix. For illustration, road number four is assumed to be closed;
5. From the fuzzy logic module, roads with priority less than 5 are excluded from the matrix. For illustration, road number three is assumed to be excluded.
6. Table 2 shows the matrix after the exclusion of the roads Rd_4 because it is closed and Rd_3 because it has the low priority;
7. The weight WX for the capacity or remaining groups of each establishment is generated with respect to the priority of the roads as follows:

$$(W_x)_R = G_x \times \left(1 - \left((R-1) \times C\right)\right)$$

Where: W is the weight, x is the establishment number, G_x is the number of remaining groups in the establishment x, R is the row index in the matrix, and C is a coefficient factor = 0.2. For example to calculate the weight for establishment number three in row number 2, the weight is equal to

$$(W_3)_2 = G_3 \times \left(1 - \left((2-1) \times 0.2\right)\right) = 0.8G_2$$

Table 3 shows the calculated weights associated with roads in the matrix;

8. The maximum weight for all the cells is selected. This means that the road associated to this weight will be assigned to the corresponding establishment. Then the next maximum weight in matrix is selected and the road associated to this number is assigned to the corresponding establishment, and so on until all groups are done. If two or more equal weights are found the left most one will go first.

Table 1: Establishment/ Road Initial Matrix

Est_1	Est_2	Est_3	Est_4	Est_5	Est_6
Rd_4	Rd_4	Rd_3	Rd_3	Rd_1	Rd_3
Rd_3	Rd_3	Rd_2	Rd_2	Rd_2	Rd_2
Rd_2	Rd_2	Rd_1	Rd_1	Rd_3	Rd_1
Rd_1	Rd_1	Rd_4	Rd_4	Rd_4	Rd_4

Table 2: Establishment/ Road Matrix after Removing Closed and Low Priority Roads

Est_1	Est_2	Est_3	Est_4	Est_5	Est_6
				Rd_1	
		Rd_2	Rd_2	Rd_2	Rd_2
Rd_2	Rd_2	Rd_1	Rd_1		Rd_1
Rd_1	Rd_1				

Table 3: Calculated Weight for each Road

Est_1	Est_2	Est_3	Est_4	Est_5	Est_6
				($1.0G_5$)Rd_1	
		($0.8G_3$)Rd_2	**($0.8G_4$)**Rd_2	**($0.8G_5$)**Rd_2	**($0.8G_6$)**Rd_2
($0.6G_1$)Rd_2	**($0.6G_2$)**Rd_2	**($0.6G_3$)**Rd_1	**($0.6G_4$)**Rd_1		**($0.6G_6$)**Rd_1
($0.4G_1$)Rd_1	**($0.4G_2$)**Rd_1				

Case Study

In order to prove that the system generates the correct decisions to move Hajj groups, this section discusses a full case study with real numbers and snap shots of the system during its run. The following is the case study assumptions:

The establishment under the study will be establishment number three i.e. x = 3;

Period of time will be 10 minutes which is quite enough to pass easily one group (4 thousand persons) through the neck of each road. So, the time interval between different thermal video shots will be 10 minutes;

There are four pedestrians' roads Rd1, Rd2, Rd3 and Rd4 under study;

Due to the location of establishment (3), the roads are sorted nearest to farthest as Rd3, Rd2, Rd1 and Rd4.

Figure 3 shows a snapshot of the system including position of the four cameras and the position of the six establishments with 20 croups for each one. The right panel shows a video for each road and over each road its density is written in the main panel.

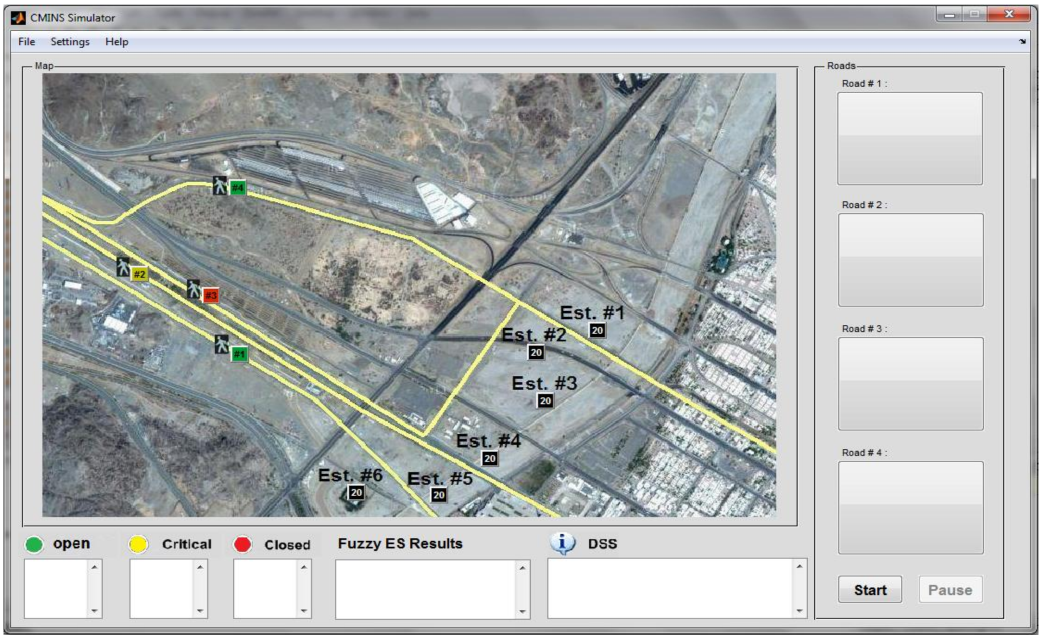


Figure 3: Initial System Screen

Figure 4 shows the system screen after the first period (10 minutes):

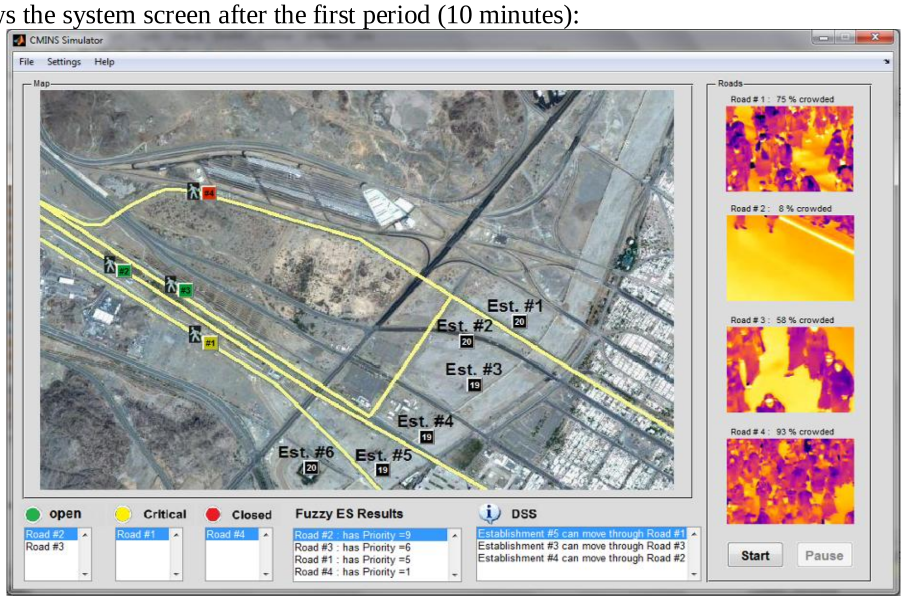


Figure 4: System Screen after the First (10 Minutes) Period

Video sequences from the thermal camera are generated for each road;

Crowd density of each road is calculated through the analyzer which equals to 75%, 8%, 58%, and 93% for roads Rd1, Rd2, Rd3 and Rd4 respectively;

From the road selection module, the roads Rd2, Rd3 are open, Rd1 is critical and Rd4 is rejected because it is closed;

From the fuzzy module, roads Rd1, Rd2 and Rd3 have priority greater than or equal to 5;

For establishment number three the roads can be sorted nearest to farthest as Rd3, Rd2, Rd1 and Rd4;

From the OR module, the valid roads for establishment number three are sorted from the best to the worst by assigning weight for each road considering the location and the remaining groups. The result will be this order Rd2, Rd3 and Rd1;

From the decision support system, Rd3 will be assigned for establishment 3 after analyzing all roads for all establishments;

One group from establishment 3 will move through Rd3, the remaining group will be 19.

Figure 5 shows the system screen during the second period the system has directed establishment 3 to move through road 2 instead of road 3. The remaining groups will be 18 groups.

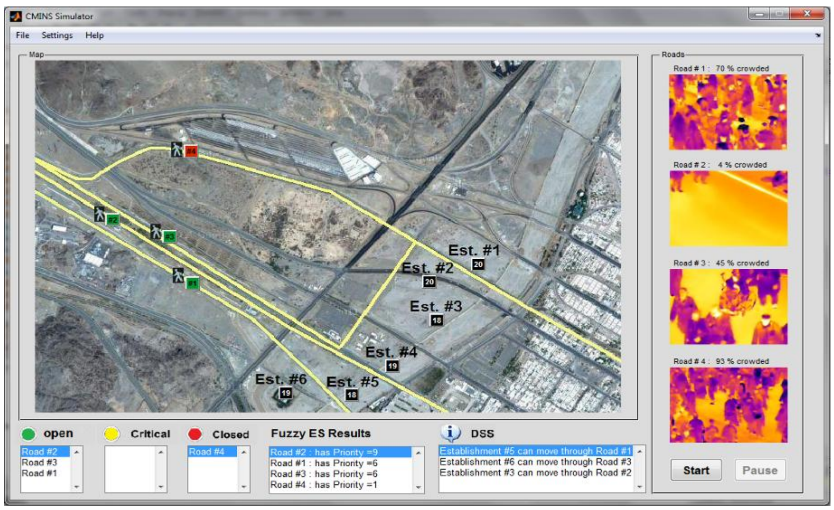


Figure 5: System Screen after the Second (10 Minutes) Period

In the third period no suitable road is available for establishment 3. Then the remaining groups are still 18 groups. Figure 6 shows a snap shot of the system after the third period. Notice that, DSS generates no decision for establishment 3.

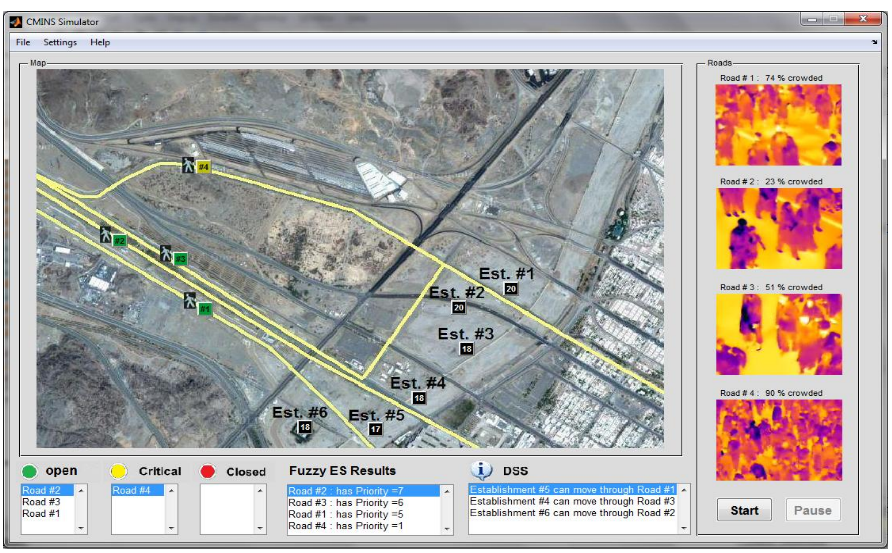


Figure 6: System Screen after the Third (10 Minutes) Period

In the fourth period the DSS has directed establishment 3 to move through road 3, then the groups has been reduced to 17 groups. Figure 7 shows DSS for establishment 3 and number of groups becomes 17.

Figure 7: System Screen after the Fourth (10 Minutes) Period

In the last period the groups of establishment 3 has been reduced to be zero. See Figure 8.

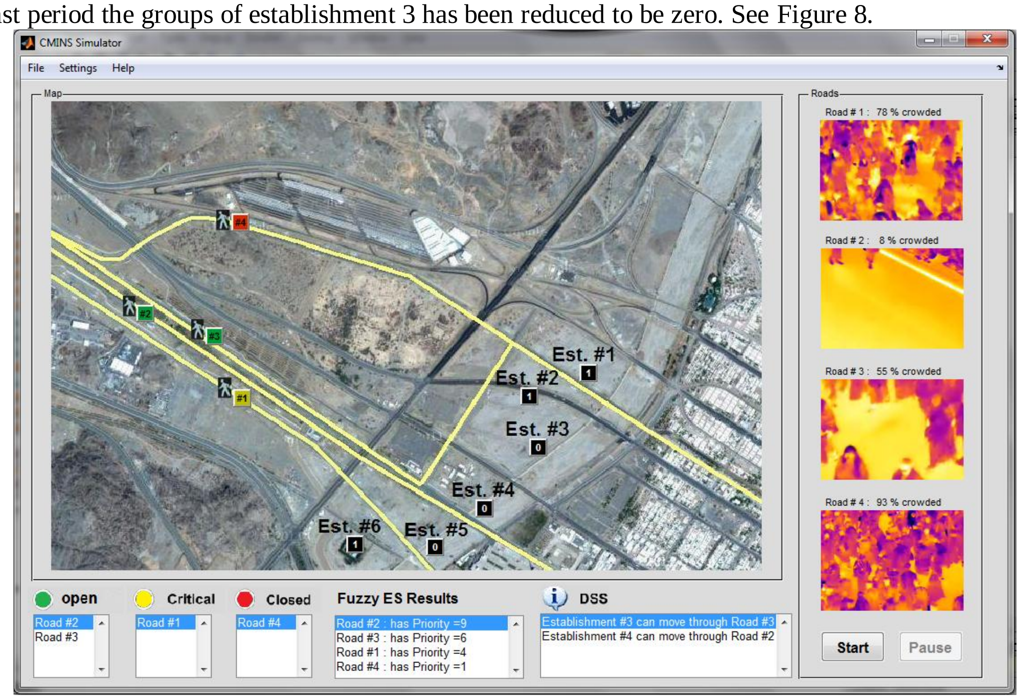


Figure 8: System Screen after the Last (10 Minutes) Period

Table 5 shows a summary of the case study. Four periods are shown in the main columns in addition to the last period. Different steps during the running of the system are shown on different rows; the steps follow the information flow direction as illustrated above.

Table 4: A Summary of the Case Study

Period = 10 Minutes	First period				Second period				Third period				Fourth period				Last period			
Roads Density %	R1	R2	R3	R4	R1	R2	R3	R4	R1	R2	R3	R4	R1	R2	R3	R4	R1	R2	R3	R4
	75	8	58	93	70	4	45	93	74	23	51	90	74	23	36	90	76	8	55	93
Roads selected by density <= 90	R2	R3		R1(c)	R2	R3	R1		R2	R3	R1	R4 (c)	R2	R3	R1	R4 (c)	R2	R3	R1 (c)	
Fuzzy priority	R1 5	R2 9	R3 6	R4 1	R1 6	R2 9	R3 6	R4 1	R1 5	R2 7	R3 6	R4 1	R1 5	R2 7	R3 6	R4 1	R1 4	R2 9	R3 6	R4 1
Roads priority due to fuzzy =<5	R2	R3		R1	R2	R1	R3		R2	R3	R1		R2	R3	R1		R2	R3		
Roads priority for Est.3 setup	R3	R2	R1	R4	R3	R2	R1	R4	R3	R2	R1	R4	R3	R2	R1	R4	R3	R2	R1	R4
Roads selected by DSS For Est.3	R3				R2				-------				R3				R3			
Groups remained in Est.3	19				18				18				17				0			

The case study shows solid decisions generated by the system. For example, Rd4 is rejected in the first period because it is closed by the massive crowd. Rd_3 is assigned to establishment number 3 after sorting the remaining roads according to their priorities. Also, the case study shows accurate assignments of roads to other establishments. By noticing the remaining roads in the last period, almost all establishments have drained their groups through the decided roads by the system. Thus, this can ensure safe moving of the massive mass of Hajjis as well as balancing of their distribution so that nobody waits too long time. In addition, by moving groups as solid units, the system ensures that different customs among Hajjis are respected.

Conclusion

In this paper, a hybrid intelligent decision support system for the administration of massive mass of Hajjis has been introduced. Hybridization is done by integrating fuzzy logic, operations research and decision support to produce alternate decision to the system controllers enable them to administrate the movement of the massive mass of Hajjis in a way that ensures safety with compromised time of moving of the groups as well as respect the customs among Hajjis.

New tech. has been proposed named capacity weighted priority. The technique shows solid generations of decisions during the movement of Hajjis. The technique is based on matrix calculations which keep its running cost minimal. A complete case study is discussed that proves the use of the CWP approach. Solid decisions have been generated by the system which will help authorities to administrate and control the massive crowd during the "Nafra" event.

For future research the decisions that are generated by the system need to be measured with respect to their success to move different Hajj troupes. An adaptation module needs to be added to system to avoid decisions that have low success ranks. Adaptability will improve the decisions generated by the system and increase its usefulness to the controllers.

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References

Abuarafah, A. G., Khozium, M. O., and AbdRabou, E. (2012). Real-time Crowd Monitoring using Infrared Thermal Video Sequences. *Journal of American Science*, 8(3): 133-140.

Al-Habaibeh, A., Yaseen, S., Parkin, R. M., Otham, F., & Albar, O. (2009). The Design of a Novel Sensor Fusion Model for Monitoring People's Density in Public Places Using Infrared Thermography. *Key Engineering Materials, 419-420*: 377-380.

Andersson, Maria, & Rydell, Joakim. (2009). Estimation of crowd behavior using sensor networks and sensor fusion. *Fusion, 2009. FUSION'09.*, 396-403.

Ben-Mahmoud, C., Abou Chalbak, M., & Plumb, C., Moore, K. (2010, June). Holy Cities: Saudi's Unique Real Estate Markets. In *on.point Jones Lang LaSalle IP, INC.* Retrieved from http://www.joneslanglasalle-mena.com/MENA/EN-GB/Pages/Home.aspx.

Deshpande, N. P., and Gupta, R., (2010). Crowd management using fuzzy logic and G.I.S. *WIT*

Transactions on Information and Communcation Technologies, 43:325-334.

Fruin, J. (1993). The causes and prevention of crowd disasters. *Engineering for crowd safety. Elsevier, New York*, 1-10.

Helbing, D., Johansson, A., Al-Abideen, H. Z., (2007). The Dynamics of Crowd Disasters: An Emprical Study. *Physical Review E 75*: 046109.

Khozium, M. O., Abuarafah, A. G., & AbdRabou, E. (2012). A Proposed Computer-Based System Architecture for Crowd Management of Pilgrims using Thermography. *Life Science Journal* 9(2): 377-383. http://www.lifesciencesite.com.

Mahalingam, G., Kambhamettu, C., & Aguirre, B. (2009). Crowd Analysis from Video. *2009 NSF Engineering Research and Innovation Conference*. Hawaii.

National "Tawafa" Establishment for South Asian Pilgrims. http://www.hujjaj-southasia.com/info/

National "Tawafa" Establishment for Pilgrims of the Non-Arab African countries. http://www.africa-sa.com/template/africa/default.aspx

National "Tawafa" Establishment for South East Asian Pilgrims. http://www.sea.com.sa/

National "Tawafa" Establishment for Pilgrims of the Arabian Countries. http://www.arbhaj.com/

National "Tawafa" Establishment for Pilgrims of Iran. http://www.mhi-est.com

National "Tawafa" Establishment for Pilgrims of Turkey and Muslims of Europe, Americas and Australia. http://www.mhteaae.com.sa

Pini, R., Ofer, M., Shai, A., & Amnon, S. (2004). Crowd detection in video sequences. *IEEE Intelligent Vehicles Symposium, 2004*: 66-71.

Ross, T. J., (2010). *Fuzzy Logic with Engineering Applications*. 3rd Ed., John Wiley & Sons, Ltd.

Schubert, J., Ferrara, L., Hörling, P. and Walter, J. (2008). A decision support system for crowd control. *In Proceedings of the 13th International Command and Control Research Technology Symposium, Seattle, USA*. Paper 005, 1−19.

Sirmacek, B., &Reinartz,P. (2011). Automatic crowd analysis from very high resolution satellite images.*Proceedings of Photogrammetry and Image Analysis Conference*. Munich, Germany.

Still, K., G. Crowd Safety in the Complex and Built Environment. *Crowd Disasters*. Retrieved Sep. 19, 2011, from http://www.gkstill.com/CrowdDisasters.html.

Yang, D. B., González-Baños, H. H., & Guibas, L. J. (2003). Counting people in crowds with a real-time network of simple image sensors. *Computer Vision, 2003. Proceedings. Ninth IEEE International Conference on* (pp. 122–129).

Biography

Mohamed O. Khozium completed his PhD from Cairo University (EGYPT) in 2005 in information system area; he is currently associate professor at the department of engineering, community college, Umm Al-Qura University, Makkah, Saudi Arabia.

He received the B.S. degree in aviation science from Air academy, EGYPT, in 1975, first M.S. degree in aviation science (in laser applications) from Air war studies institute, Egyptian air force, in 1994, high diploma and second M.S. degree in computer science and information systems from the university of Cairo, Egypt. Many studies in electronic warfare from USA and France, Ph.D. in information systems from the university of Cairo, Egypt.

Dr. khozium has published many articles in international journals and conferences in the area of electronic warfare, expert systems, information security and software engineering, he participated in organizing many international conferences, he is an active reviewer for numerous international.

Dr.khozium has been awarded "doing duties honestly and faithfully award" and "excellent duty medal from the first level" from the president of Arab Republic of Egypt, 1996, 2006 respectfully.

Dr.khozium is an active member in many international computing and electronic warfare associations including ACM and AOC.