Optimizing process of Healthcare Assistance at Road Side using Particle Swarm optimization and Person Accident Behaviour

Amreen Khan1, Dr. M.M. Raghuwanshi2, Dr. Prashant Borkar3

1Ph. D Scholar at G.H. Raisoni College of Engineering, Nagpur.

2Professor, Department of Computer Engineering, GHRCEM, Pune, Supervisor at G.H. Raisoni College of Engineering, Nagpur.

3Head, Department of Computer Science & Engineering, G.H. Raisoni College of Engineering, Nagpur.

amreenkhan786@gmail.com

Abstract. In the worldwide road accidents are very common and happened throughout the day. It is not restricted to time, density of population, geographical location, tropical geography, etc. Due to rapid increase in population and many other factors like driving and safety rules, driving pattern, etc., the worldwide rate of roadside accidents are also increasing. The African countries is having highest road accident inhabitants along with highest number of fatalities, whereas the Asian countries are the second rank in the world incurred rate of accidents with more fatalities during the road accidents. Hence, In order to handle these road accidents the major concern is to provide quick and fast emergency and health-care services like deployment of quick response team(QrT), first-aid, immediate hospitalization, and various assistance services that helps in reducing the fatalities during the road accidents. Now there is a need to develop effective and less parameterized approach which will helps in reducing the road accidents and provide quick response assistance to the needy. In order to develop the effective and comprehensive solution to the above mentioned problem, optimization is the key ingredient, which results in the evolvement of one of the most popular and effective algorithm called particle swarm optimization. In this paper we are going to evaluate, analyse and simulate particle swarm optimization (PSO) algorithm in order to design and develop novel solution to the above mentioned problem based on accident pattern and the behaviour of a person who met with the road accident.

1. Introduction

Road accidents are one of the incidents where the life of a person is always in trouble. It is not a generic activity, instead it is occurred due to many reasons like violation of traffic rules, road side conditions, driver mental conditions, etc. Many of the cases where the road accidents happened, there is always a need of emergency health care facility. Quick and immediate availability of this facility leads to the safety of persons involved in the accident. There are many requirements of healthcare facilities like first-aid, immediate hospitalization, etc. hence by providing all these facilities on-time we can reduce the rate of fatalities caused in the road accidents. Every government in the countries taking many active efforts in order to provide healthcare facilities to the persons involved in the road accident. Providing the healthcare facilities at the roadside in not new, since all the concern organizations are continuously working on it. Hence if we analyze all the requirements and data collected when the accident happened and after a while, we can make a better system which can serve to provide quick and effective healthcare facilities and assistance to the needy one. Optimizing the complete process of this healthcare assistance, in order to meet the need of availability of resources to the persons is very essential. Now, there is a need to identify...
the mechanism and technique that will help us to analyze available past experience, transform it into meaningful data and use this data to make an optimize solution to the above discussed problem.

Optimization is a process of selection of one of the best solution out of the available list of solutions available to solve a given problem. In most of the cases this may not be an exact solution but it is one of the most deserving and key candidate that will be most suitable as a solution to a problem. While selecting one of the best solution out of available, it is very important to arrange the solution in order of maxima and minima. Optimization techniques are generally classified as: Collaborative in nature like population technique; biological and evolutionary like evolutionary algorithm; Inspired by swarm knowledge like swarm intelligence algorithm; Inspired by nature phenomenon like nature inspired; knowledge from tight bound processes like Chemical algorithm; inspired by fundamental activities like physical algorithms.

Particle Swarm optimization is one of the most popular technique that uses group based features and knowledge together in order to generate inference as one of the solution to a problem face by a same group. Due to this feature of PSO we can use it as one of the technique that can be implemented along with the data and knowledge involve in the process of providing the healthcare services to the needy one. PSO can be integrated with the useful information, which is generated and available from the road accident, that can be used to distribute the effort and make a collective work on a above problem. Providing a healthcare assistance at roadside is distributive in nature, hence the solution of this problem must be distributive and collective in nature. So, we are proposing a modified particle swarm optimization algorithm based on person’s accident behavior that will help our swarm particle to better travel in the direction towards the target. In the next two sections we will present the brief idea about various dimensions of road accident along with PSO and general idea about particle swarm optimization. In the subsequent sections we will elaborate our proposed PSO based on person’s accident behavior algorithm followed by evaluation of the above algorithm with the help of sample subset. In last two sections, discussed our findings based on proposed algorithm along with concluding remarks.

2. Road Accidents and Particle Swarm Optimization (PSO)

In the Indian subcontinent road accidents is one of the major cause of concern. In the year 2018, there were 1.5 lakh fatalities in India due to road accidents. Every year around 3-5 % of GDP involves in handling the road accidents. Now, a day’s the population of the countries goes on increasing in proportion the sale of vehicles is also increasing. The rate of vehicles on the road goes on increasing day-by-day that makes heavy traffic flow on the roadside, further that heavy traffic flow increases probability of road accidents.

By referring various online survey reports we have conclude that:
1. Two wheelers are more involved in the road accidents rather than the four wheeler.
2. Most of the road accidents are happened at the T-junctions on the road.
3. Mostly the accidents occurred when the driver ignores the traffic and safety rules, ignores the specified speed limit in the various parts of the road.
4. The highways have share of 25% of road accidents rather than the city or inner roads.
5. Roughly 17 deaths happening every hour in India due to road accidents.
6. Road accidents happens more in urban areas than rural areas.
7. Around 65% of the road accidents involvement of youth in India.
8. The rate of involvement in the road accident and fatalities of men is more than the woman across the world.

According to the government officials there are two major factors of road accident:
1. Cause of accident.
2. Handling road accidents.

According to the research community [8] [18] [22] the major cause of concern is:
1. Type of road accident.
2. Cause of accident
3. Type of vehicle involved in road accident
4. Fatality rate
5. Location of road accident, etc.

Chunlu, Wang in his paper [8] proposed (MOPSO) technique to recognize the contributing factors that effects accident severity. Bird s. and co. [9] describes specification based particle swarm optimization algorithm for the improvement in the local convergence. Yare Y and co. [16], presented MD-PSO which is designed for generator maintenance scheduling problem. Engelbrecht A. P [19], illustrated the Heterogeneous H-PSO optimization to solve a multidimensional optimization problem. Phung, M.D and co. [24], shows how optimized path planning can be implemented using Enhanced discrete particle swarm optimization algorithm. Xia, X and co. [25], designed and developed a hybrid optimizer to solve an optimization problem based on firefly and PSO algorithm.

In biology, swarm is a phenomenon of knowledge extraction by observation. Many researchers used this concept for developing the solutions for the optimization problem. Through these studies and discussions we have concluded that, if we integrate the PSO along with the information involved in the road accident, it can provide the better solution in order to handle the road accident and will reduce the fatality rate.

Our major objective is to design and develop a novel solution to improve the availability of healthcare assistance services while handling the road accident as well as to contribute towards improvement in the featured solutions available for handling the road side accidents. The solution of the mentioned problem needs to have two basic features: optimization and evolutionary in nature. Due to need of incorporation of these two features we have proposed particle swarm optimization (PSO) which is evolutionary and also has swarm intelligence.

3. Particle Swarm Optimization

The particle swarm optimization is a population based algorithm which basically work on the group rather than on the single sample (Fig. 1). PSO is generally applied to the group of random particles and then search optima by updating the generation of every iteration. In each iteration PSO will calculate two best values as:

a. Pbest (Personal best): It is the first solution that meets the criteria to solve a problem. Some time’s it is also called as fitness function / fitness value.

b. Gbest (Group best): It is the value that is evaluated by the PSO as a best value, one can have in a group of particles in the network at a given moment of time that meets the criteria of being as a one of the solution to the problem.

After the calculation of the above two base parameters the next is to calculate the next position of the particle by updating the velocity and the present position.

\[
\text{List (v)} = \text{list (v)} + c1 \cdot r \cdot (\text{list (Pbest)} - \text{list (present)}) + c2 \cdot (\text{list (Gbest)} - \text{list (present)})
\]

\[
\text{List (present)} = \text{list (present)} + \text{list (v)}
\]

Where,

\[
\text{List (v)} \leftarrow \text{particle velocity}
\]
\[
\text{Present} \leftarrow \text{current particle}
\]
\[
P\text{best} & \text{Gbest} \leftarrow \text{Personal best and Group best}
\]
\[
c1 & c2 \leftarrow \text{learning factor (c1} = c2 && c1 \leftarrow c2 \leftarrow 2)
\]
\[
r \leftarrow \text{random number between 0 to 1}
\]
4. Proposed Technique and Methodology PSO inspired by Person Accident Behaviour

4.1. Problem statement:
There are list of persons involved in the road accidents, based on the injury they need/referred to healthcare. We have limited number of healthcare resources which can be allocated to a needy person who met with a road accident. Now we need to write an effective and optimized algorithm that make the participation of needy person and the healthcare assistance and facilities to a maxima and helps to improve availability of healthcare services to the person needed.

4.2. Description: The algorithm to solve a problem need some information like how many number of persons met with an accident; criticality of person; availability of resources and etc. using this available information we need to design and develop an optimized solution in order to serve all the needy persons, save the life as much as possible by providing quick and easy access to life care facilities available nearby.

Inputs parameters:
9. NP ← Count of people meet in the accident
10. Upi ← Urgency of saving factor
11. Nv ← No of nearby available vehicles
12. Pvi ← Participation of each Vehicle
13. Ovi ← Occupancy Rate
14. Svi ← Each Vehicle seat count.
7. £ ← urgency of saving people (NP)

Algorithm: PAB-PSO (Person Accident Behavior based PSO):
1. $Supi ← sort(descend(£))$
2. $Evi ← Cal. (rate of (Ø Vehicle)) \{Evi \mid 1-Ovi\}$
3. $ESvi ← Evi \ast Svi$
4. $DESvi ← sort(descend(ESvi))$
5. For vehicle(V) in \{Pvi<1 \& Pvi \in list(DESvi)\} if Pvi = = 1 : accommodate needy from list(SUpi) & assign to assistance service
5. Evaluation of PAB-PSO (Person Accident based PSO algorithm)

In order to better understand the above describe and proposed PAB-PSO algorithm, we have considered the sample scenario: The 10 tasks are available to be scheduled on 10 already working processors with some tasks in a process as follows:

### Task Scheduling Problem

| Sr.No | Parameters          | Values                        |
|-------|---------------------|-------------------------------|
| 1     | Task                | T01 to T10                    |
| 2     | Rate of emergency  | 0.5, 0.3, 0.6, 0.8, 0.7, 0.9, 0.6, 0.3, 0.5, 0.4 |
| 3     | Available processors| P01 to P10                    |
| 4     | Involvement rate / processor | 0.2, 0.5, 1.0, 0.5, 0.5, 1.0, 0.6, 0, 0 |
| 5     | Probability of Processor Occupied | 0.4, 0.5, 0.6, 0.5, 0.4, 0.6, 0.8, 0.2, 0.9, 0.2 |
| 6     | Task capacity / processor | 2, 3, 3, 2, 4, 3, 4, 1, 2, 3 |
| 7     | Participation of each processor | 0 / 0.5 / 1.0 [NO/PARTIAL/FULL] |

Table 1. The number of officially reported plague cases in the world.

5.2 Algorithm contrivance coup

1. The list of tasks set to be scheduled as SUpi with the available processors need to be sorted in descending order of task priority as T6, T4, T8, T5, T3, T1, T9, T10, T2, T7
2. % processor empty: \( \text{Evi} = 0.6, 0.5, 0.4, 0.5, 0.6, 0.4, 0.2, 0.8, 0.1, 0.8 \)
3. Tasks schedule capacity: \( \text{ESvi} = 1.2, 1.5, 1.2, 1.0, 2.4, 1.2, 0.8, 0.8, 0.2, 2.4 \)
4. Sorted \( \text{ESvi} = \text{DESvi} \)

4a. Evaluating \( \text{DESvi} \times \text{Pvi} = \text{PSvi} \)

and sort in descending order to find DPSvi.
4b. Find the convergence factor (Cf) = (No. of people Assisted / Total number of people).

\[ \text{Cf} = \frac{\text{No. of people Assisted}}{\text{Total number of people}} \]

5. Pvi = 1 for P2, P1, P3, P6, P4:

\[ P2 \leftarrow 1.5 :: P1 \leftarrow 1.2 :: P6 \leftarrow 1.2 :: P3 \leftarrow 1.2 :: P4 \leftarrow 1.0 \]
\[ T6 \rightarrow P2 :: T4 \rightarrow P1 :: T8 \rightarrow P3 :: T5 \rightarrow P6 :: T3 \rightarrow P4 \]

If (urgency (Pi) > urgency (Pj) && if Pi volunteers for Pj) \{ (urgency (Pi ⊗ Pj)) \} and Restart the complete system again and serve Pj before Pi. (i.e, if particle Pi belongs to young and particle Pj belongs to child or elder then the system must serve Pj before Pi based on the criticality of the injury and reset the system)

6. DESvi * Pvi

\[ P10 \leftarrow 2.4 :: P5 \leftarrow 2.4 :: P2 \leftarrow 1.5 :: P1 \leftarrow 1.2 :: P3 \leftarrow 1.2 :: P4 \leftarrow 1.0 \]
\[ P6 \leftarrow 1.2 :: P4 \leftarrow 1.0 :: P7 \leftarrow 0.8 :: P8 \leftarrow 0.8 :: P9 \leftarrow 0.2 \]
\[ T1 \rightarrow P10 :: T9 \rightarrow P10 :: T10 \rightarrow P5 :: T2 \rightarrow P5 :: T7 \rightarrow P8 \]

This implies that task 1, 9 is scheduled on P10 processor and Task 10,2 on P5 and Task T7 on P8 processor.

6. Results

Figure 2. Shows the results of above described PAB-PSO algorithmic results, by simulating multiple times along with parameters: no. of peoples, no. of vehicles, vehicle capacity, and accuracy. Through the experimental analysis it has been observed that the highest accuracy seems to be 93% as we increase number of persons to serve.

![Graph](image1.png)

Figure 2. Runs of algorithm with change in values with effect on accuracy and delays.

Fig. 3a and 3b, Illustrates the performance analysis of the above described PAB-PSO algorithm. We have simulated the designed algorithm around 50 times and the observed the results of all benchmark functions CEC 2006 and presented all the attainable benchmark functions with their output characteristics found in the analysis of outcome from the experimental simulation. We have seen different characteristics of benchmark function as quadratic, non-linear and linear in nature.
Table 1. Shows finding of experimental results based on multiple run (50 times) performed independently on each test functions G01 – G13 from the standard test functions of CEC-2006 test suit on “Matlab” as a simulating tool; Machine with T8100, 2.10 GHz, 3M cache processor and 2GB memory. The algorithmic simulation results on test function based on optimized value, accuracy, delay, no. of run, lowest generation is presented this table(1). The values where the global optimum is reached is represented with * mark and '-' represents where no results meet the desired criteria to be as candidate value. Out of G01-G-13 benchmark function: G1, G2, G3, G4, G8, G10, G11, G12, G13 reached to the level of being as global optimum.

Table 2. Obtained results from PSO algorithm
7. Conclusion

In this paper, we have presented an improved version of Particle swarm optimization named PAB-PSO to optimize the process of serving the healthcare facilities during the road accidents at the roadside. In the process of serving the people who met with road accidents, it is most important to provide life care assistance service immediately. In order to make this process optimized and ability to serve more and needier peoples at road side we have considered previous knowledge of person’s accident behaviour as a learning model of swarm particles and make the process optimized to get maximum throughput. The proposed algorithm has been evaluated on G0-G13 benchmark function using MATLAB featured tools and the results have been presented. Out of the evaluated benchmark functions G01-G4; G8; G10-G13 is reached to a global maxima. However the functions G5-G7 and G9 show worst performance during evaluation. We have also presented the various characteristic features of these functions shown as quadratic, non-linear and linear during evolution. The sample evaluation of the proposed algorithm is also discussed in section(6) which will helps us to understand how the proposed algorithm will going to schedule a processes and optimizes the complete healthcare assistance at road side. At the end it is important to compare these results with the available benchmark techniques for analysis and validation.

References

[1] Parsopoulos, K.E.Vrahatis, M.N., 2001. “Modification of the particle swarm optimizer for locating all the global minima, Artificial Neural Networks and Genetic Algorithms”, Computer Science series, Springer, Wien, pp. 324–327.
[2] Parsopoulos, K.E., Plagianakos, V.P. 2001. Magoulas, G.D., Vrahatis, M.N., “Improving particle swarm optimizer by function “stretching” ”, Nonconvex Optimization and Applications, vol. 54, ch. 3, pp. 445–457, Kluwer Academic Publishers, The Netherlands.
[3] Y. Shi and R. C. Eberhart, 2001. Fuzzy adaptive particle swarm optimization,” in Proceedings of the Congress on Evolutionary Computation, pp.101–106.
[4] J. Kennedy and R. Mendes, 2002. “Population structure and particle swarm performance,” in Proceedings of the IEEE Congress on Evolutionary Computation, pp.1671–1676.
[5] W.-J. Zhang and X.-F. Xie, 2003. “DEPSO: Hybrid particle swarm with differential evolution operator,” in Proceedings of the IEEE International Conference on System Security and Assurance, pp. 3816–3821.
[6] A. Ratnaweera, S. K. Halgamuge, and H. C. Watson, 2004. “Self-organizing hierarchical particle swarm optimizer with time varying acceleration coefficients,” IEEE Transactions on Evolutionary Computation, vol.8, no.3, pp.240–255.
[7] J.J.Liang and P.N.Suganthan, 2005. “Dynamic multi-swarm particle swarm optimizer,” in proceeding sof the IEEE Swarm Intelligence Symposium (SIS’05), pp.127–132.
[8] Bird S., Li X., 2007. “Using regression to improve local convergence. In: Proceedings of the 2007 IEEE Congress on Evolutionary Computation, Singapore, pp. 1555–1562.
[9] Yare, Y., and Venayagamoorthy, G. K., 2007. “Optimal Scheduling of Generator Maintenance Using Modified Discrete Particle Swarm Optimization,” Proceedings of the Symposium on Bulk Power System Dynamics and Control - VII. Revitalizing Operational Reliability, iREP, Institute of Electrical and Elec- tronics Engineers (IEEE).
[10] Y.-P. Chen, W.-C. Peng, and M.-C. Jian, 2007 “Particle swarm optimization with recombination and dynamic linkage discovery,” IEEE Transactions on Systems, Man, and Cybernetics, Part B: Cybernetics, vol.37, no.6, pp.1460–1470.
[11] Nema, S., Goulermas, J., Sparrow, G., Cook, P.,2008 “A hybrid particle swarm branch-and-bound (HPB) optimizer for mixed discrete nonlinear programming”, IEEE Trans. on Systems, Man, and Cyber- netics, Part A, vol.38, no.6, pp.1411-1424.
[12] Yang, X.S., 2009. “Firefly Algorithms for Multimodal Optimization”, In: Stochastic Algorithms: Foundations and Applications. SAGA 2009. Lecture Notes in Computer Science, vol 5792. Springer, Ber- lin, Heidelberg.
[13] Z.-H. Zhan, J. Zhang, Y. Li, and H. S.-H. Chung, 2009. “Adaptive particle swarm optimization,” IEEE Transactions on Systems, Man, and Cybernetics, Part B: Cybernetics,
Rymut, B., Kwolek, B., 2010. “GPU-supported object tracking using adaptive appearance models and Particle Swarm Optimization”, Proceedings of the 2010 international conference on Computer vision and graphics: Part II, ICCVG’10, Springer-Verlag, Berlin, Heidelberg, 227–234.

Yang, X. S., 2010. “A new meta heuristic bat-inspired algorithm,” in Nicso 2010: Nature Inspired Cooperative Strategies, pp. 65–74, Springer, Berlin, Germany.

Engelbrecht, A.P., 2010. “Heterogeneous particle swarm optimization”, in: Swarm Intelligence, Springer, pp. 191–202.

Zhang, J., Pan, T.-S., Pan, J.-S., 2011. “A parallel hybrid evolutionary particle filter for nonlinear state estimation,” in Proc. Robot, Vis. Signal Process. First Int. Conf., Nov, pp. 308–312.

Awwad, O., Al-Fuqaha, A., Ben Brahim, G., Khan, B., Rayes, A. 2013. “Distributed topology control in large scale hybrid RF/FSO networks: SIMT GPU-based particle swarm optimization approach,” Inter- national Journal of Comm. Systems, vol. 26, no. 7, pp. 888–911.

Chunlu Wang Chenye Qiu Xingquan Zuo Chuanyi Liu, 2013. “An Accident Severity Classification Model Based on Multi-Objective Particle Swarm Optimization”, In: IEICE Transactions on Information and Systems Vol.E97-D No.11 pp.2863-2871.

Chen, R.-B., Hsu, Y.-W., Hung, Y., Wang, W., 2014. “Discrete particle swarm optimization for con- structing uniform design on irregular regions,” Computational Statistics & Data Analysis, vol. 72, pp. 282–297.

Pan,T.S., Dao, T.K., Nguyen, T.T., Chu, S.C.,2015. “Hybrid Particle Swarm Optimization with Bat Algorithm”. In: Genetic and Evolutionary Computing. Advances in Intelligent Systems and Computing, vol 329. Springer, Cham.

Kvasov, D.E., Mukhametzhanov, M.S., 2016. “One-dimensional global search: nature-inspired vs. lipschitz methods.” AIP Conf Proc 1738(1):400012.

Wang, X.; Q., 2016. “The Study of K-Means Based on Hybrid SA-PSO Algorithm”, In Proceedings of the 2016 9th International Sun, Symposium on Computational Intelligence and Design (ISCID), Hangzhou, China, 10–11 December, pp. 211–214.

Phung, M.D., Quach, C.H., Dinh, T.H., Ha, Q., 2017. “Enhanced discrete particle swarm optimization path planning for UAV vision-based surface inspection”, In Automation in Construction, Volume 81, 2017, Pages 25-33, ISSN 0926-5805.

Xia, X., Gu, L., He, G., Xie, C., Wei, B., Xing, Y., Wu, R., Tang, Y., 2017. “A hybrid optimizer based on firefly algorithm and particle swarm optimization algorithm”, In Journal of Computational Science, ISSN 1877-7503.

Javidrad, F.; Nazari, M., 2017. “A new hybrid particle swarm and simulated annealing stochastic optimization method.” Appl