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Adaptive Hybrid Genetic Algorithm for Autonomous Vehicle Road Network Construction: a Study on GPS Navigation Failure

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Original Article

Adaptive hybrid genetic algorithm for autonomous vehicle road network construction: A study on GPS navigation failure

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Abstract

Study enhances road network construction based on geospatial noisy data reduction. Global positioning system (GPS) applications conforms special standards, formats that establishes an inaccurate model for decision making. A small percentage of major accidents are caused by failures of navigation systems. To construct an established road network an adaptive multi-objective data mining technique is introduced followed by F-score statistical analysis for measuring accuracy of result. Data extracted from GPS are processed using genetic algorithm employing with flexible spatial, temporal, and logical constraint rules, produces an adaptive hybrid genetic algorithm (AHGA). This establishes a framework to construct an optimized road network representing a digital map from real time data. In order to control metaheuristics, data is broken into smaller pieces of improved local search algorithm (Continuous state spaces) in addition towards feature extraction-score concentrates on precision and recall capacities for recognized standards of data extraction, classification, and identification of statistical perception.

Keywords: adaptive hybrid genetic algorithm, PS navigation failure, F-score, Local searching algorithm, autonomous vehicle road network construction

1. Introduction

GPS navigation relies upon receiving signals from satellites. Problems can occur when obstacles, such as walls, buildings, skyscrapers and trees obstruct a signal(Mirjalili, Dong, Sadiq, & Faris, 2020). Extreme atmospheric conditions, such as geomagnetic storms, can also cause problems (Mirjalili, Dong, Sadiq, & Faris, 2020. In addition, the mapping technology which is used in conjunction with the GPS may not be up to date and cause navigational errors(Jennings, Lysgaard, Hummelshøj, Vegge, & Bligaard, 2019). An increasing number of public vehicles such as taxis, buses, and other public service vehicles are being equipped with global positioning system (GPS) devices(Fedorchenko et al., 2019). Constructions of road network from extraction of raw data gathered from GPS are not optimized without the supervised learning strategy(Tuncer & Yildirim, 2012). A goal set optimization algorithm, are required to be improved with considerable stopping criteria(Tuncer & Yildirim, 2012). GPS failure without prior optimization has greatly impacted the transportation since automated road construction requires aggregation for individual data points (coordinates) into line segments(Xin, Zhong, Yang, Cui, & Sheng, 2019). The consequence of a minor failure in the satellites that provide the data for self-driven car navigation system(Xin et al., 2019). The satellites provide timing information that coordinate path edges often leads to failure due to insufficient time synchronization(Madhavan & Durrant-Whyte, 2004). As approach two separate systems are affected by the cause of the same failure.

Genetic algorithm

Genetic algorithm comprise with the following steps

Step 1. Characterize the problem domain as population of fixed length n

filter the size of the population N, a crossover probability pc

and a mutation probability pm(NEGNEVITSKY, 2005).

Step 2. Outline a function f to estimate the performance of an individual population in problem domain(NEGNEVITSKY, 2005).

Step 3: Randomly construct an initial population of population of size N: x1, x1, ... ,xN(NEGNEVITSKY, 2005).

Step 4: Calculate fitness of individual chromosome: f(x1), f(x2),f(x)N(NEGNEVITSKY, 2005).

Step 5: From current population select a pair of chromosomes for reproducing. Parent chromosomes are selected with possible compression associated to their fitness(NEGNEVITSKY, 2005).

Step 6. Construct a pair of new chromosomes by implementing the genetic crossover and mutation from existing parents(NEGNEVITSKY, 2005).

Step 7. Locate constructed new chromosomes with the new population(NEGNEVITSKY, 2005).

Step 8: Replication from Step 5 until the new population size equals the old population size(NEGNEVITSKY, 2005).

Step 9: Interchange the initial (parent) chromosome population with the new population(NEGNEVITSKY, 2005).

Step 10: Go to Step 4, and repeat the process up until termination criterion is satisfied(NEGNEVITSKY, 2005).

Repeated fitness function evaluation for complex problems are often the most prohibitive and limiting segment of artificial evolutionary algorithms. Finding the optimal solution to complex high-dimensional, multimodal problems often requires very expensive fitness function evaluations(NEGNEVITSKY, 2005). Structural optimization

problems, a single function evaluation may require several hours to several days of complete simulation(NEGNEVITSKY, 2005).Incorporation of approximate models may be one of the most promising approaches to convincingly use GA to solve complex real life problems(NEGNEVITSKY, 2005).

Genetic algorithms do not scale well with complexity. That is, where the number of elements which are exposed to mutation is large there is often an exponential increase in search space size(NEGNEVITSKY, 2005). In order to make such problems tractable to evolutionary search, they must be broken down into the simplest representation possible(NEGNEVITSKY, 2005). GA algorithms encode design for, constructing geospatial shapes instead of detailed construction plans(NEGNEVITSKY, 2005). Complexity creates obstacles that have evolved from GPS failure. To resolve the obstacles in GA mutation, emphasis the fitness assumption that includes combination components to construction GA with improved in optimization procedure(NEGNEVITSKY, 2005). However, the result of success/failure sample recurring with possible results, percentage of successes to failures delivers a sustainable measurement of population.

Hybrid genetic algorithm

Hybrid genetic algorithm (HGA) is to incorporate local optimization as an add-on extra to the canonical GA loop of recombination and selection(Perkins et al., 2000). The hybrid approach, local optimization is applied to each newly generated offspring to move it to local optimization before injecting into the population(Perkins et al., 2000).GA is to perform global exploration among a population while heuristic methods are used to perform local exploration among a population while Genetic algorithm for geo spatial data optimization consists of various strategic phenomenal

approaches(Perkins et al., 2000). Optimal location search is frequently required for web based geospatial data. Genetic algorithms are a particular class of evolutionary algorithms that consists of inheritance mechanism and sequencing this provides sufficient searching in specified domain consists of mutation, selection, and crossover (also known as recombination).Genetic algorithms provides effective searching mechanism to find a considerable solution in a complex obstacles(Perkins et al., 2000). Granted they aren't instantaneous, or even close, but they do an excellent job of searching through a large and complex search space(Perkins et al., 2000). For effectively solve the spatial decision problems common features are to be extracted with the extension of various situation analysis(Huang, Cai, & Xu, 2007). As a validation for feasibility and high efficiency, a web version of geographic digital map tested by using the solution as frame for construction and evaluation process(Huang et al., 2007). Hybridization of GA is adopted to overcome the drawback of Genetic Algorithm. The betterment of local searching and preemptive junction in order to make the algorithm more efficient and powerful(Huang et al., 2007). A hybrid optimization strategy combines of GA and local search ability that initiates a strategic optimization approach towards construction of road network. In this approach, local search algorithm minimized possibility of GA from enclosed in local optima.

Adaptive learning

The adaptive learning method mostly provides a better performance, this provides recognized for its ability to deliver a more modified version of learning mechanism for including a pattern constructing a framework . Adaptive learning is designed to reconstruct and create an environment that requires the necessity of specific learners technique(AMARI, 2003). Through various techniques, adaptive learning technologies improve a benchmark for assessment of each entity's knowledge. Adaptive learning algorithms creates predictions that requires learning essentials and provides learning suggestions for assignments according to the needs in complex situation during GPS failure(AMARI, 2003).

2. Materials and Methods

Algorithm reaches a value of 200 at generation 50, then this value doesn't change for 15 generations (30% of 50), so the algorithm stops. The resultant values extracted from GA undergoes a complete transformation, the second method requires good knowledge of the problem under some tests by first stop criteria and only recommended for problems with expensive computationally fitness functions by means of feature extraction., the first stop criteria has been used. A hybrid procedure is created which brings out the best characteristics in both GA and the technique. The changes are made to the GA by combining it with either a local search method or by making some changes in the operators like selection, crossover and mutation by using specified rules. Work is being done to modify the GA to fulfill the objective of finding the best possible solution.in meta-heuristic applications of the study introduces technique that can be

used for construction of 'hybrid framework' that intends to provide an adaptive with considered parameters for conjunction of hybrid GA algorithm.

Time optimization

Adaptive behavior of the proposed algorithm changes its behavior at the time it is run for strategic optimization. To enhance its performance behavioral it is monitored for a sequential pattern using statistical analysis, from these experiments, a number of observations were made.

Stopping Criteria

Duration pattern matching and duration interval is undertaken for evolutionary algorithms consists two kind of stopping criteria: At initial stage maximum number of iterations (generations) that when the generation reaches this predefined value, it stops and provides the solution in the last generation. After the completation of initial stage, GA algorithm proceeds to find the best solution when the evolution process unable change for gaining a improved predefined result for generations. Predefined result can be 60% or 70% of the generation number until best solution is suggested as a result. F-score accuracy testing is introduced for enhancement of better solution.F-score provides a precision and recall the results for overcoming the complex situations during GPS failure

$$\text{Precision} = \frac{True\ Positive}{True\ Positive + False\ Positive}$$

$$\text{Recall} = \frac{True\ Positive}{True\ Positive + False\ Negative}$$

3. Results and Discussion

There is still a huge area for technology improvement that needs to be taken seriously by manufacturers to ensure safety on the roads. Most effectively ability to find solution to critical issues during GPS failure that might cause road accidents. Creative solution to the problem consists of logical synthesis of the findings, and to formulate a deeper framework, under phenomenal investigation subsequent results are determined. The study provides an adaptive framework to construct road network at specified time of GPS navigation failures. As mostly GPS does not operate in real-time, and mostly unable to account for construction, road closures, and weather conditions affecting driving. During the failure of GPS navigation road network real time data extracted from sensors (LIDAR, or RADAR) could be improvised for capturing real-time data. AHGA constructs a new approach towards GPS navigation failure that can be introduced in detection and construction of real time objects such as road network and associated road obstacles. This can be framed as new research findings that emerged as a result of road hazard analysis of autonomous vehicles. The simulation is conducted using MATLAB followed by adding sensors and cameras to find the effective test results. The study analysis found evidence for problem arises due to GPS failure and find a solution towards construction of road network. The relationships between patterns and principles highlights key finding with association of specified location in standardized pattern. Construction of algorithm involving local searching has optimal solution delivers a new approach for overcoming hazards towards road network construction by introducing a framework. Result simplifies accuracy and optimization considering large data to be trained requires a large amount of time since it outbound from the specified range.

4. Conclusions

As addressed in the analysis of research on road construction using adaptive hybrid genetic algorithm, improves performance and behavior of genetic algorithm that could be improvised and added in autonomous vehicle for avoiding road accidents caused by GPS navigation failure. When GPS navigation fails alternate solution of real time data with abide framework could help in saving life hazards.

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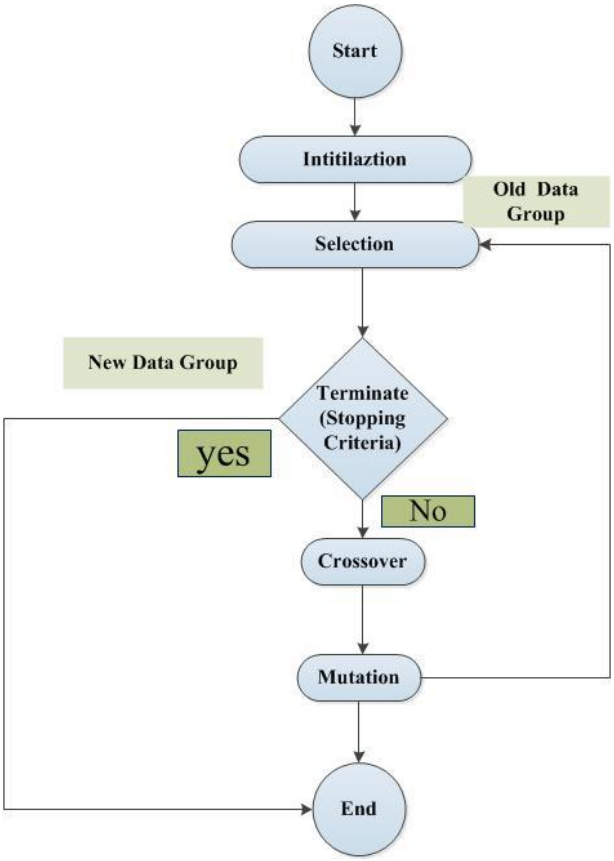

Figure 1 Genetic algorithm.

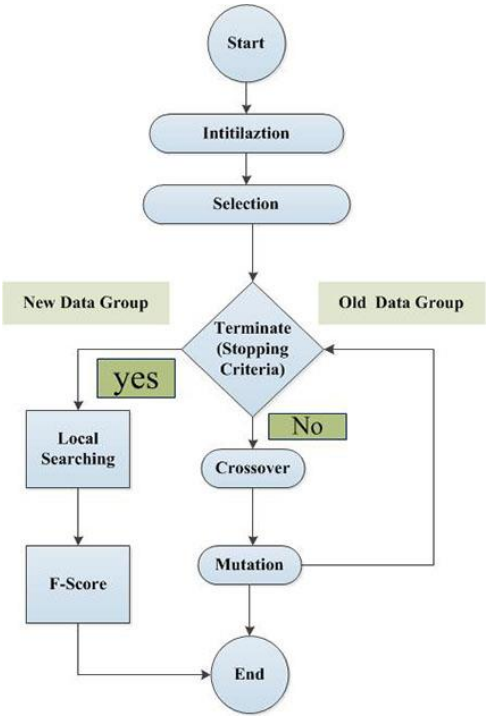

Figure 2 Adaptive hybrid genetic algorithms using local searching with F-score.

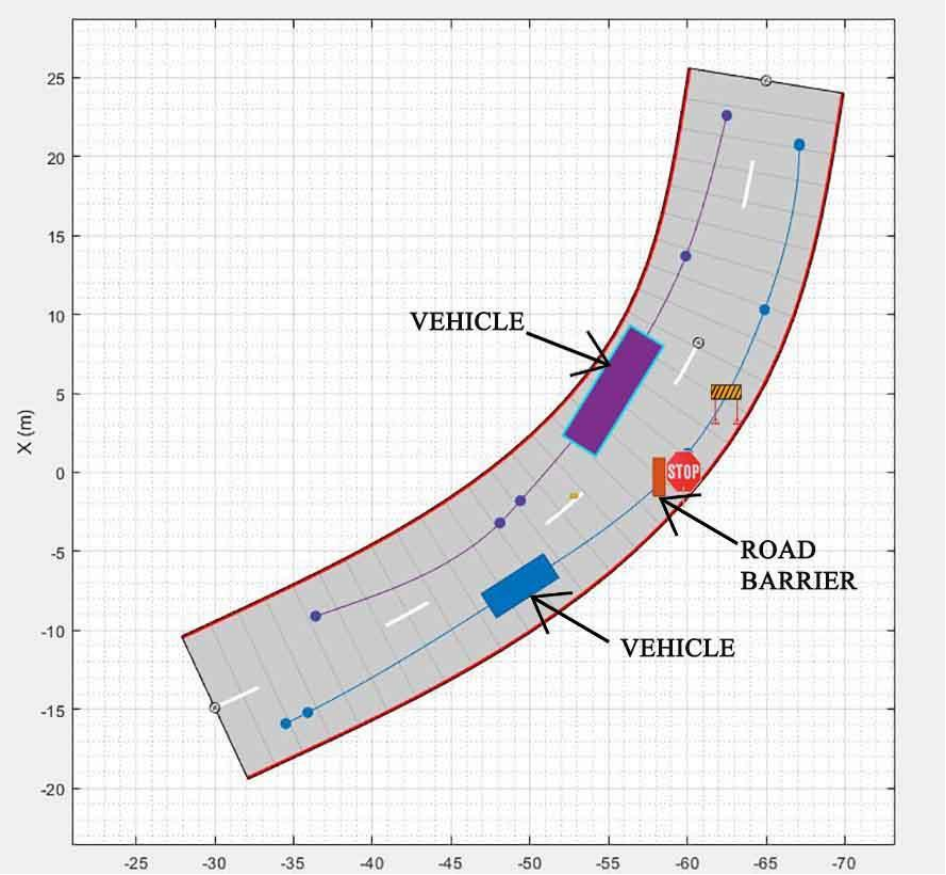

Figure 3 Road network constructions with obstacles detection using AGHA

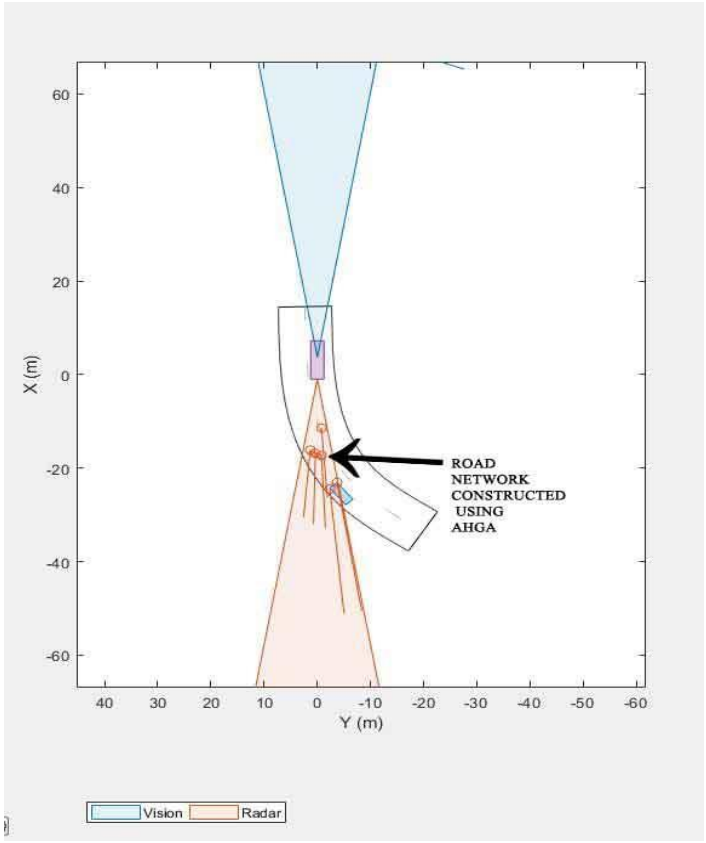

Figure 4 Performance monitoring of AHGA using sensors and camera