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Implementation of Random Search Algorithm with FSSRS (Fixed Step Size Random Search) for Applicating the Patrol System Based on Mobile Computing

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ABSTRACT

Environmental security is very influential for the sustainability of human life. In order for environmental security to remain in a safe condition, a system is needed that can control the environment, such as patrolling at every point to ensure that the environmental conditions are safe. However, it is felt that this is not enough if the patrol system is not assisted by tools or systems that are digitalized and integrated with community service officers, such as firefighters, ambulances, and police, and are easy for officers to use when conducting patrols. So, it is necessary to schedule patrols to several points with different routes for each activity so that it is not easily read by unwanted parties in terms of crime. In order for the system to obtain patrol scheduling in a timely and efficient manner, an appropriate and efficient algorithm is needed, the algorithm is random search with FSSRS (Fixed Step Size Random Search) which can suggest random and precise patrol scheduling. From the results of training using four iterations, namely 50, 100, 150, and 200, the best value was produced in the 200th iteration. Data was taken from the results of a case study survey with eight patrol points using coordinates at each point. So, it can be concluded that the FSSRS algorithm is effectively used to randomize patrol points and can be implemented in the application patrol system.

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1. INTRODUCTION

The security of an environment is very influential in the survival of humans [1], if an environment is less safe then it is very influential on all aspects of life [2]. This of course must be prevented so that things that are less safe can be minimized. Many things can be done to minimize criminal acts such as crime, theft, and robbery. Where is the economic condition at this very moment which is getting tighter and weaker [3], potential to cause crime. To prevent this, of course, more control is needed to protect the surrounding environment. In carrying out environmental control, there are several ways, including conducting patrols or installing CCTV at each point to ensure that the area at that point is in a safe condition.

To support security control or patrols, of course, it is still lacking without the help of digitalized tools [4]. In anticipation of crime, that's the reason researchers built a security tool based on mobile computing with Android technology, [5] which can capture conditions in real time so as

to assist users or patrol officers in maintaining or controlling the environment. The tool is equipped with an integrated system with community service officers or agencies, such as Health services (Ambulance), Police (police), Firefighters, and other services that can be integrated with the tool. In addition, this tool is equipped with a website-based reporting feature, where interested parties can monitor or evaluate the performance of patrol officers so that they can be properly controlled.

In the previous patrol method the system was not digitized which was used well in the community [6] or agency. There are deficiencies in the scheduling side [7] to patrol to a predetermined point. This method is still carried out serially in each activity, therefore there are indications of the emergence of criminal acts because it is easy to read patrol route activities, both in terms of time and points to be visited. From these indications, an algorithm is needed that can provide advice in scheduling patrols to each patrol point in a random way using the system. In previous studies there were several activities regarding the random method [8], like research that has been conducted by A. Rahman using the Harmony Search method in Lecture Scheduling [9]. Algoritma Harmony Search [10] analogy with music with all its devices with optimization problems. For example, each musical instrument is related to a decision variable, musical notes are related to variable values, harmony is related to solution vectors, so that when applied to a lecture scheduling system an optimal class schedule arrangement can be created. However, this algorithm has drawbacks, namely the few constraints that are created so that constraints are needed [11] others in optimizing the algorithm.

Furthermore, research conducted by Yeni Roha Mahariani regarding the Firefly Algorithm (FA) in scheduling Patient Operations [12]. FA can support the scheduling process in computing efficiently according to the solution results as a scheduling candidate. This study resulted in a patient schedule that has minimal time in various conditions and can increase the utility of the operating room in the hospital by 50.6%. However, this algorithm has the disadvantage that it is trapped into a local optimum, the FA parameter is set unchanged during iteration and does not remember the history of each situation in each iteration [13]. Then research on the random search algorithm conducted by Fitiyani, et al regarding the effect of initializing the random search population on the evolved algorithm in optimizing the Traveling Salesman Problem (TSP) [14]. Using data on the effect of changes in fitness and diversity scores at each point of the path, it was then initialized with a generation number of 100 in each experiment. The problem with TSP is how to get optimal results to get the shortest path to be traversed. To solve the TSP problem, one way is to use the evolved algorithm. Evolution Algorithm (AE) [15] is a method that uses natural selection as its main idea in solving a particular problem. This algorithm is applied through a computer simulation that starts from a population of individuals that will be randomly generated (random search) [16], then evaluated to reach the best solution. However, the random search algorithm in the AE method has a weakness, namely uncertainty to produce a global optimum solution, because most of these algorithms relate to probabilistic random numbers, therefore it is necessary to optimize the random search algorithm using FSSRS (Fixed Step Size Random Search). [17], because FSSRS can perform a random search carried out from the best position that has a fixed radius value and the process is carried out until the number of iterations has been met [18].

From the elaboration of the algorithm above, it can be concluded that the correct method for determining patrol scheduling at each point is the Random Search algorithm with FSSRS (Fixed Step Size Random Search) by using patrol coordinate data in each randomization carried out. Then from the random results it will be integrated with a mobile computing-based patrol system [19] as a reference in carrying out their duties. In addition, the system will be developed by sending notifications via chat media such as WhatsApp as a reminder before officers carry out their duties on patrol. This research will be carried out or tested to be implemented at Peachblossoms School which is located in Harapan Indah, Bekasi City. Peachblossoms School is an international standard school that has educational levels, including Junior High School, Primary School, and Preschool & Kindergarten. In the school there are several points attached qr-code [20] which will always be patrolled and scanned during patrols to ensure safe conditions. For the continuation of this patrol system research, it will expand to residential areas such as villages, even housing or industrial scale.

2. RESEARCH METHOD

This study uses a qualitative approach. Qualitative research is inductive, and the researcher generally explores meaning and insight into specific situations [21]. The qualitative approach consists of a philosophical perspective, assumptions, postulates, and this approach makes the research results open for further analysis, criticism, replication, and adaptation. In this case, the qualitative methodology is used by the researcher as a research tool to design the study, collect and analyze the data. This approach is used to answer questions and describe the phenomenon of the development of the Patrol System which will be implemented at the Peachblossoms School agency as a case study for this research. Apart from the qualitative approach, this research will use an experimental approach because in addition to analyzing research data, this research will create a system that can be used by the community. In this study there are methods including the relayed work, data collection methods, FSSR algorithm calculations, and general process rules for implementing the patrol system with the mobile computing concept.

2.1. Releted Work

Leventides John, et al conducted research on random matrices and controllability of dynamical systems which introduced the concept of €-uncontrollability for random linear systems, namely linear systems where the usual matrix has been replaced with a random matrix. They also estimate €-uncontrollability in the case where the matrix is derived from an orthogonal Gaussian ensemble. from the research they conducted using tools from systems theory, probability theory, and convex geometry [22]. Zhou You, also conducted research related to the patrol system with A UAV patrol system using panoramic stitching and object detection. They also proposed a UAV patrol system based on panoramic image stitching and object detection. This system uses the SPHP algorithm [23] which is combined with a region growing algorithm [24] based on image differences to produce panoramic images and to eliminate motion ghosts [25].

Saputra L K Probo, et al With his research entitled Development of a Security Monitoring Activity Monitoring System with a QR-Code Dynamic Validation Process on the Patrolee Application by utilizing a Dynamic QR-Code viewer device, android application, web application, and integrated cloud-based database for each result data monitoring reports and can be accessed in real time. Security reports are immediately viewable, both in text and photo form. Each security officer on duty is marked with a unique QR-code for each schedule and monitoring location. So this system ensures that each security guard is tasked with carrying out supervision according to a predetermined location and schedule [26]. In the research of Papaioannou Savvas, et al analyzed the problem of joint searching and tracking for several cellular targets by a group of cellular agents [27]. Targets appear and disappear randomly within the surveillance area and their positions are random and unknown. Agents have a limited sensing range and receive less precise measurements of targets. A decision and control problem arises where the mode of operation (i.e. search or search) as well as the mobility control measures for each agent and at each time, must be determined so that the collective goal of search and trace is achieved. Researchers build an approach based on the theory of Random Finite Sets (RFS) [28] and researchers use Bayesian multi-object stochastic filtering [29] simultaneously to estimate the number of time-varying targets and their status from the noise measurement sequence. The researcher formulates the above problem as a non-linear binary program (NLBP) and shows that it can be approximated by a genetic algorithm.

2.2. Research Method

This section explains how the research flow in conducting data acquisition, managing data, and validating training data as in figure 1 below.

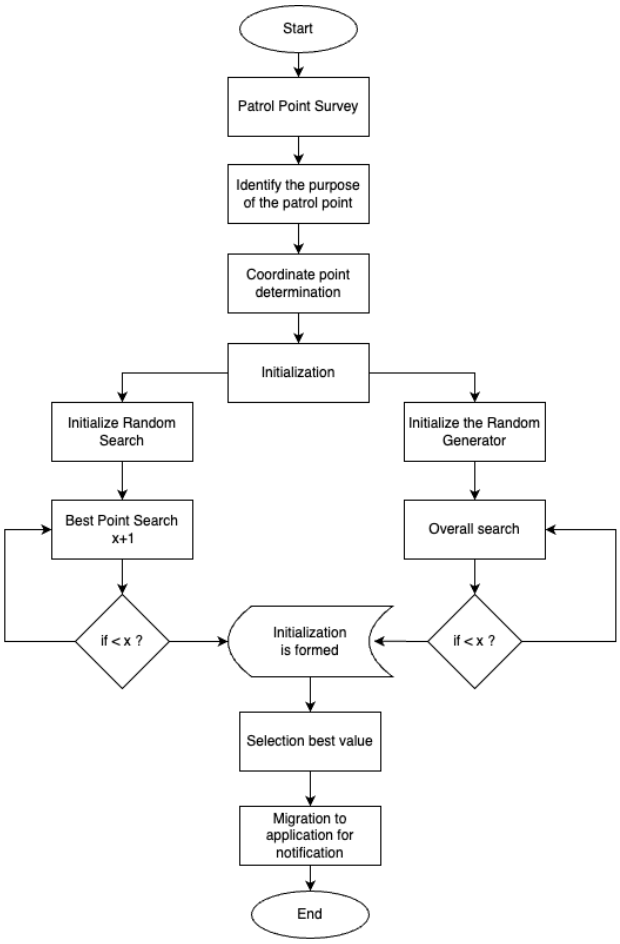


Figure 1. Research Method

The explanation from Figure 1 above is that in determining points, we conduct a survey first to review the location of patrol points, then identify patrol points and determine coordinate points at each point. After the coordinates are obtained, then measurements of the distance between patrol points are carried out. The collected data is traned on the FSSRS algorithm. The results obtained will be searched for the best value from each training iteration, then will be migrated into the system so that it can be implemented into the system for real-time scheduling notification needs.

2.3. Data Collecting

The following is the data collection process to get the results of patrol points, patrol officer data, patrol cycle data for each shift. The data is generated from field surveys and interviews with patrol officers in certain areas. The following are the results of data collection as in Table 1.

Table 1. Point Data

Area	Total Point	Distance (m)	Shifting Schedule	Cycle Time
Outside	2	50	2	3
First Floor	3	30	1	3
Second Floor	2	30	1	1
Third Floor	1	40	1	1

In table 1 there are several areas including outside, first floor, second floor, and third floor. Each area has several points and distances between points, has a shift schedule, and patrol cycle time for patrol officers.

2.4. FSSR (Fixed Step Size Random Search) Formula

The following is the formula for calculating FSSRS using the objective function $f(x) = x^2$ which will be maximized. On this algorithm to find x which produce $f(x)$ optimally by using the FSSRS method, there are six steps in FSSRS, namely making Initialization, Random Step Generation, Update Solution, Evaluate Objective Function, Comparison and Update, and Termination Criteria.

1. Initialization in determining the starting point.
   x_0 (1)

2. For each iteration, we will generate a random step of the Gaussian distribution with mean 0 and variance 1.
   $r_i \sim \mathcal{D}$ (2)
   where $\mathcal{D}$ is the predefined distribution (e.g., Gaussian, uniform, etc.).

3. Calculate the new solution x_{new} by adding the random step to the current solution.
   $x_{i+1} = x_i + step\_size * r_i$ (3)

4. Next is to calculate the value of the objective function in the new solution
   $f_{i+1} = objective\_function\ x_{i+1}$ (4)

5. Compare the value of the objective function in the new solution with the value of the objective function in the current solution.
   $IF\ f_{i+1} > best\_value, then\ best\_value = f_{i+1}\ and\ best\_solution = x_{i+1}$ (5)

6. 6. Repeat steps 2-5 for the amount (N) certain iterations or until a stopping criterion is met.

The following is an explanation of the FSSRS formula x_i represents the current solution at iteration i, r_i is the random step generated at iteration i from the distribution $\mathcal{D}$, $step\_size$ is the fixed step size used to determine the size of the step taken in each iteration, f_{i+1} is the objective function value at the new solution x_{i+1}, $best\_solution$ and $best\_value$ store the best solution and best objective value found throughout the iterations.

2.5. Flow Process Applicating the Patrol System

The following is the flow process of the system patrol application, which includes patrol officers receiving periodic patrol point notifications that have been randomized using the FSSR algorithm, then officers conducting patrols by scanning the qrcode located at each point and taking photos of the environment around for such processes in Figure 1 below.

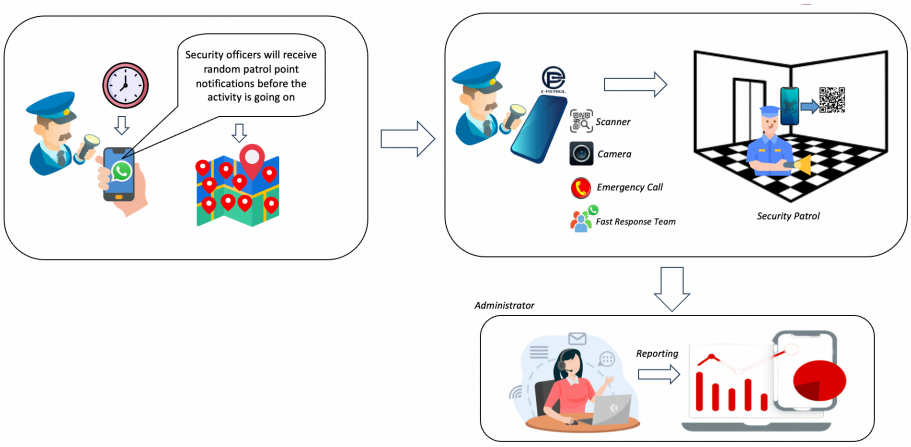


Figure 2. Flow Process Application Patrol System

3. RESULTS AND DISCUSSION

In this discussion, the results of experiments related to the use of the FSSRS algorithm will be presented in finding the best patrol points to be tracked continuously on each shift schedule. It will also explain the performance of the patrol system application in implementation at the case study site.

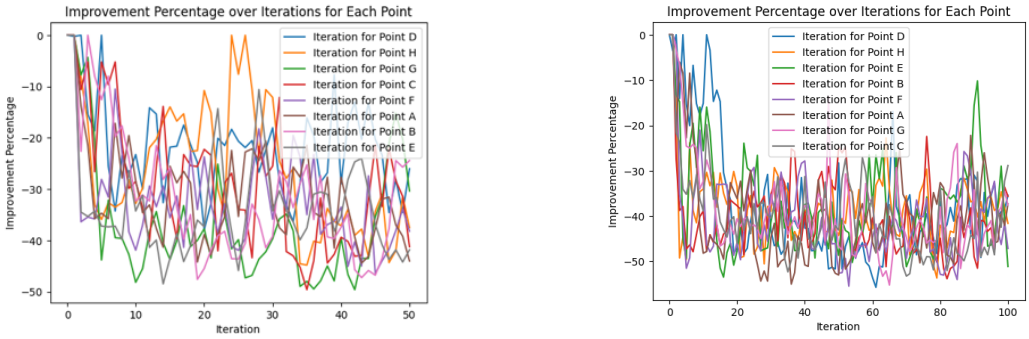
3.1. FSSRS Training for Random Point

The following is a discussion of the results of patrol point training using the FSSRS algorithm. In this study eight patrol points were used with different coordinates as shown in table 2 below.

Table 2. Latitude and Longitude Point

Point	Area	Latitude	Longitude
A	Outside	-6,16248171526551	107,002892618663
B	Outside	-6,16251541335171	107,002902750358
C	First Floor	-6,16249407967473	107,002881292687
D	First Floor	-6,16247274599688	107,002795462003
E	First Floor	-6,16253674702785	107,002881292687
F	Second Floor	-6,16248784041846	107,002905243644
G	Second Floor	-6,16246650674037	107,002883785973
H	Third Floor	-6,1625091740957	107,00284087063

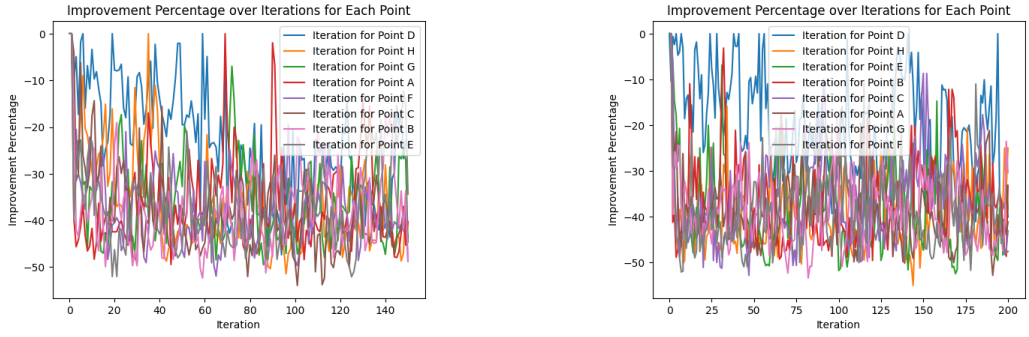
Next is the FSSRS (Fixed Step Size Random Search) algorithm at patrol points to find the best value from each randomization. In this case, the researcher tried to conduct data training using eight points in which it was iterated per batch. 50 iterations for the first batch, 100 iterations for the second batch, 150 for the third batch and 200 iterations for the fourth batch. The results of the training data are as shown in figure 2.



(a) (b)

Figure 3. Randomly using FSSRS 50 and 100 Iteration
(a) 50 Iteration, (b) 100 Iteration

The iteration is continued again with 150 and 200 iterations, as shown in figure 3 below.



(a) (b)

Figure 4. Randomly using FSSRS 150 and 200 Iteration

(a) 150 Iteration, (b) 200 Iteration

Table 3 is the result of the best value and accuracy for each iteration that is executed.

Table 3. Best Value and Accuracy

Iterasi	Best Value	Accuracy
50	-0.0002506455637422545	-3989.697584
100	-0.00022439413830506206	-4456.444395
150	-0.0002356174419525236	-4244.167969
200	-0.00023227497252235782	-4305.242141

From table 3 above produces the best value and accuracy for the 200th iteration. The results of these iterations will be implemented into the patrol system to be used as scheduling notifications in each sequence.

3.2. Application Patrol System Architecture

The following is the Application Patrol System architecture built from several platforms such as the Linux operation system, database, WhatAapp notification endpoint server, Android as a mobile application for system patrol, and API as a bridge for integration from several platforms as shown in the image below.

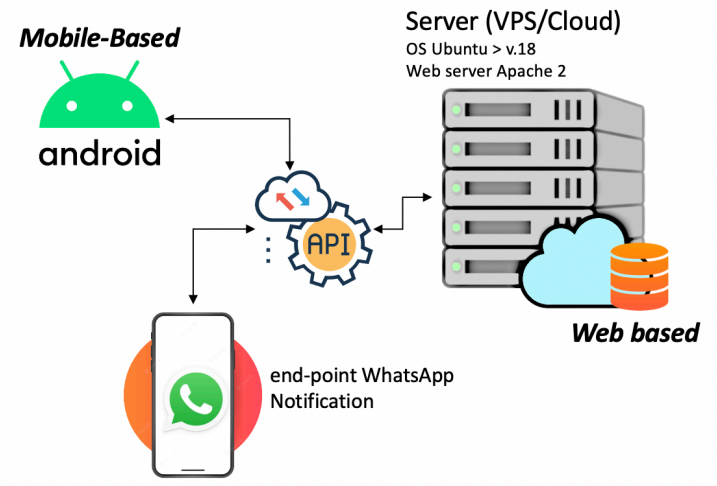


Figure 5. Architecture Application

3.3. Application Patrol System Performance

At this point, we will discuss the performance of the applications that have been implemented in the case study locations. Which includes the schedule of patrol officers sent automatically by the system, scanner features, as well as other additional features such as emergency calls and emergency responses described in Table 4.

Table 4. Performance of Application

Feature	Platform	Release/ Development	Performance (%)
Login	Website and Mobile	Release	100
Emergency Call	Mobile	Release	100
Emergency Respon	Mobile	Release	100
Patrol	Mobile	Release	100
Schedule Random	Whatsapp	Release	100
API	Website	Release	100
Manage User	Website	Release	100
Master Data	Website	Release	100
Reporting	Website	Release	100

In table 4 there are features that have passed the test results, both on a development scale and on a production scale with satisfactory performance so that they are both safe for periodic activities.

4. CONCLUSION

From the experimental results, the FSSRS algorithm can randomize eight patrol points with different coordinates. By conducting training using four iterations, namely 50, 100, 150, and 200, the best value is produced in the 200th iteration. So, it can be concluded that the FSSRS algorithm is effectively used to randomize patrol points and can be implemented in the application patrol system or in optimizing other parent algorithms. From the random search algorithm used, there are still other algorithms that can be studied, such as harmony search algorithms and the like used to do randomization. But from the results of the research conducted, the FSSRS algorithm can overcome the problem of randomly searching for points in patrol activities.

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