Evaluation Software and IT Integration for IoT-based Healthcare Radio Frequency Identification Network Planning

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Abstract

For Internet of Things (IoT)-based on healthcare systems to autonomously monitor patients, radio frequency identification, or RFID, its essential. It is difficult to guarantee complete coverage throughout sizable healthcare facilities with a small number of RFID readers, though Software for RFID network planning must be optimized. The purpose of this paper is about optimizing related software and suggest a topological RFID network planning strategy that will minimize reader interference while deploying the fewest possible readers. The best location for RFID tags on patients as well as readers depends on the layout of the institution and how the patients move. To dependably scan tags across a variety of locations, RFID network design software precisely calculates the number and positions of readers using algorithms. Software features and network planning goals are developed to efficiently track patient status by automating the gathering of medical data. in this paper to find the optimal number of RFID readers required and their location in the system. After the algorithm was tested, it was found that the algorithm can determine the true effectiveness of the coverage and reduce the area of interference between the areas of coverage of RFID readers. PSO is a superior algorithm for solving difficult problems (NP). The PSO algorithm has shown a high efficiency in finding the optimal solution, with some of weakness in the performance of the algorithm, represented in finding functional boundaries that serve the research problem. By providing constant access to health information, this plan raises the standard of care.

Keywords: Software Integration; IoT-based Healthcare; Radio Frequency; Computer Networks

1. Introduction

The healthcare industry has been transformed by the Internet of Things (IoT) The IoT has created some new opportunities for amelioration patient care and administration by connecting devices and gathering data in real-time. Patient surveillance is one of the main uses of (IoT)in healthcare and it's essential to provide prompt and precise medical care [1, 2].

The field of patient monitoring has seen a rise in the usage of passive tags and in the Radio Frequency Identification (RFID) technologies in recent years by automatically recognizing and detecting patients, (RFID) technologies helps medical professionals follow their whereabouts and deliver the right care.

These systems are the perfect answer for accurate and effective patient management to handle patient-related data they use radio waves to track and Innovative solutions that may effectively meet the current challenges in healthcare, such as the changing demographics of the population and the demand for improved services, are required. One capacity way to address these issues is by the incorporation of (RFID) systems into the Internet of Things architecture. Healthcare providers can collect critical data, keep an eye on patients in real time, and guarantee smooth departmental collaboration by utilizing RFID technology [3]

Certain software criteria must be met to deploy a patient monitoring and detection system that is both successful and efficient [4]. These specifications include real-time monitoring capabilities, alerting and notification mechanisms, integration with current healthcare systems, data acquisition and processing modules, database management for storing Patient information, (RFID) middleware for communication with RFID readers, and strong. And, we take special steps to safeguard patient privacy making sure each person feels secure. [5]. The goal of this project is to create comprehensive RFID-based system that functions as the main hub for patient detection and monitoring during procedures. This system will improve healthcare performance by using RFID technology

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the microcontroller for additional processing and the Internet of Things to provide accurate and ti5mely information for better patient care and management. Looking at and potential applications in the medical field. We will also go over the software specifications needed to put such a system into practice. The RFID is used in this paper due to its effectiveness to monitor and track patients. The rest of the paper section 2 related work, section 3 RFID Software system, 3.1 Use case of Monitoring system, 4. Methodology, 5. Function Evaluation and section display Result and dissociation.

2. Related Work

The phrase "Internet of Things" refers to a broad category of Internet applications that support and grow services, as well as various forms of event monitoring and statistical analysis using computational and Web systems [6]. To create systems that connect digital entities with physical devices using information technology and communications systems, new features of applications and services can be added to existing systems. The primary applications in this field are those of identification, sensing, and programmed operation devices and equipment [7]. Electrostatic or electromagnetic coupling is used in RFID (Radio Frequency Identification) technology (RF). In the industrial sector, RFID is replacing bar codes. The benefit of RFID is that it eliminates the need for physical contact and line-of-sight scanning. The system communicates via an RFID tag, an RFID reader module, and a serial connection UART. When the tag is in range, this RFID module receives its 12-bit ID. Through the UART protocol, the distinct ID is transmitted to.[8]

Using radio signals sent by researchers and manufacturers have recently combined Internet of things technology with electronic health devices. each person's RFID device to send the specific patient's information that access his medical computer sheet record in the database of the health center and to follow up the development of patient's health. This technology enabled to monitor the patient's status changes automatically and without exposing employees in health units to the risk of injuries resulting from direct contact with patients [9][10].

The uses and applications of (RFID) systems are divided into active and passive tags forms which is available to identify patient risks and often suffer from specifying RFID readers positions which considered the main factor for efficiently implementing the RFID system and taking the correct measures to obtain the best system outputs. Examples of these obstacles are the barriers that cause a dispersion in radio signal and transmit weak signal [11]. The growing application of this technique encourage many researchers to develop and provide significant research to optimize this device. [12].

[13] in 2019 saw the development and proposal of an Internet of Things (IoT) system. It is employed as an RFID network planning (RNP) technique that, by monitoring the network and allocating frequencies, wireless location system parameters, and transmitter sites, offers adequate coverage for the necessary services. [14][15]

Other rescuers explain the value of RFID-based animal tracking for tracking health, behavior, and movement patterns in a variety of fields, including agriculture, wildlife conservation, and cattle husbandry [16] [17].

RFID is widely employed in logistics and products tracking, but a survey of the literature indicates that its use in tracking animals has increased dramatically in the last several years. To understand how RFID is deployed, the paper reviews existing animal tracking systems. It does this by examining the types of animals tracked, the issues they address, the frequencies at which they operate, and the integration of additional technologies such as GPS and cameras with RFID. According to the assessment, the most popular solutions tracked animals, such as cattle, utilizing passive UHF RFID tags and addressed livestock management. The article offers the state-of-the-art in RFID applications for animal tracking in a methodical manner.

3. RFID Software SYSTEM

An RFID software system is a complete software program created especially to support and enhance Radio Frequency Identification (RFID) technology in a particular setting, like healthcare. It includes all of the software elements in charge of overseeing and maintaining RFID readers, tags, and the information gathered from them Features of the RFID software system include data collection, processing, and analysis in addition to platform or system integration. It facilitates real-time data gathering, effective tracking and monitoring of RFID-tagged individuals or assets, and the provision of insightful information for decision-making processes.

An RFID software system would normally have features specific to inventory management, asset tracking, patient monitoring, and other pertinent healthcare procedures. It is intended to maximize the use of RFID technology and give medical staff rapid access to accurate information for better patient care and operational effectiveness.

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A. Use case of Mentoring system

Hospitals can maximize operational efficiency, boost asset management, and improve patient monitoring by putting an RFID software solution into place for this use case. The system makes it possible to track assets and patients precisely and in real time, which enhances resource allocation, staff productivity, and patient care. The use case UML illustrated as Figure (1)

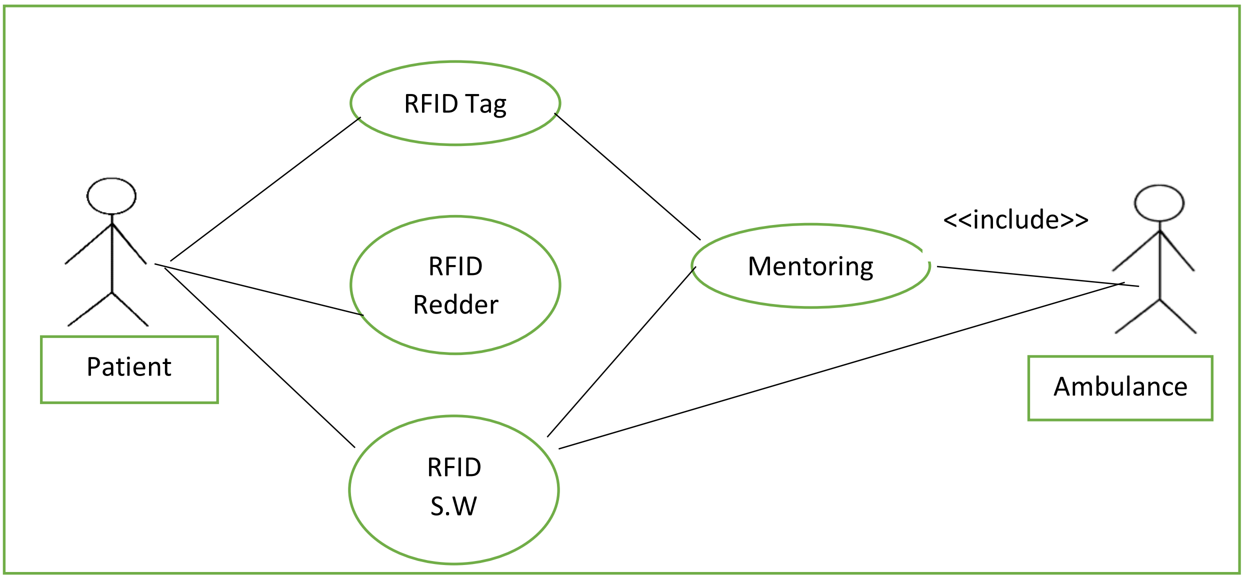

Figure 1: UML Use case Diagram

Use Case: Hospital Asset Tracking and Patient Monitoring

Objective: to use RFID technology and an RFID software system in a hospital to improve patient monitoring and expedite asset tracking.

I.Patient Monitoring

- RFID tags is an attached to patient ID cards.
- RFID readers are placed throughout the hospital
- If a patient moves within the range of an RFID reader; the reader's captures the tags identifier then transmits it to the RFID software system.
- RFID software system processes and update the data for patient's location at real-time.
- Hospital's emergency can access the system to track patient movements, monitor their, and receive alerts if a patient enters the embedded areas or leaves designated zones.

II. Asset Tracking:

- RFID tags are affixed to medical tools, such as pumps device, wheelchairs, diabetes device.
- As tagged assets pass by RFID readers, their identifiers are captured and transmitted to the RFID software system.
- Healthcare workers may view the whereabouts and availability of equipment thanks to the software system, which updates the asset's location in real-time.

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- Employees can easily find and collect equipment when needed, less time is lost looking for it, and equipment is always ready for patient care. This promotes effective asset management.

4. Methodology

5.

Creating a precise and effective way to ascertain the relationship between the reader's number and places is a crucial problem in topological network design. The primary obstacles are how to cover and interpret each patient's location that has been dispersed. based on tags radio signal to collect the heath information with a minimum number of readers and lower interface. This research sequence of processes involves:

A. Analyzing Image Statistics and Enhancing RFID Tracking

Pixels are altered by statistics method depending on the values of nearby pixels. In order to compute statistics and determine the local intensity range, this work specifies the neighborhood of a pixel. When processing images and extracting features and requirements, picture filtering is crucial. It was difficult to locate and identify sites from photos, and linking filtering to RFID systems is a novel endeavor. In order to ascertain patient mobility and limits—which are crucial for RFID tracking—this study uses filtering. For RFID tracking applications, filtering determines the optimal way to specify patient movement based on picture analysis.

Pixel altered =StatisticsMethod(Pixel,NeighboringPixels)--------(1)

analyzing and Enhancing Image Statistics for RFID tracking with the rangefilt function will range makes the edges of the building visible. In order to apply the filtering function on the case of this work .the steps will be implemented. The first process in the present method is by using rangefilt function as show in Algorithm 1

The Algorithm assumes that the input image is a grayscale image and that the window size is odd integer no. for correct centering in the window. The binary image will be created after edge detection which eliminates all connected components that have lower pixels), as shown in Algorithm 2

Algorithm (1): Algorithm (1 **) Analyzing Image** for Edge Enhancement
Inputs:- image:-2D array representing the input image Outputs:- filteredImage:-2D array representing the filtered image with enhanced edges 1-Initialize an empty 2D array filteredImage with the same dimensions as the input image. 2- Iterate over each pixel (x, y) in the input image, excluding the border pixels. 3- Create a 3-by-3 neighborhood centered at pixel (x, y) in the input image. 4- Apply the rangefilt function on the 3-by-3 neighborhood: -Calculate the range value by subtracting the minimum value from the maximum value of pixel intensities within the neighborhood. -Assign the range value to the corresponding pixel (x, y) in the filteredImage array. 5-Repeat steps 3-4 for all pixels in the input image, excluding the border pixels. 6- Return Analyzing Image as the result of the rangefilt filtering process.

The second steps is to specify the building centroid. This step is essential due to the importance of initiate the boundary condition to the evolutionary [18] by equation.

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$$dX/dt = F(X, t) \qquad \text{-----}(2)$$

Where x; represents the state variables of the system, t represents time, and F (X, t) represents the function that describes the dynamics or evolution of the system. This work offers flexibility by allowing the user to select the

Algorithm (2): Elimination of Connected Components with Lower Pixel Count in Binary Image with fill hole

Inputs:- binaryImage // 2D array representing the binary image

Outputs: processedImage // 2D array representing the binary image with eliminated connected components and filled holes

1- Initialize empty 2D array processedImage with the same dimensions as the binaryImage.
2- Create a copy of the binaryImage and assign it to the processedImage.
3- define a list or queue called components to store the connected components found.
4- Repeat over each pixel (x, y) in the processedImage.
- Check if the pixel (x, y) is a foreground pixel (value of 1).
- If it is, perform the following steps:
- Create an empty set called currentComponent to store the coordinates of the current connected component.
- add pixel (x, y) to the currentComponent set.
- add the currentComponent set to the components list.while the currentComponent set is not empty, do the next
    a- Eliminate a pixel (i, j) from the currentComponent set
    b- Highlight the pixel (i, j) as background (set its value be 0) in the processedImage.
    c- Checked the 8 neighboring pixels around (i, j)
- If any neighboring pixel is foreground (value of 1) and not already in the currentComponent set, add it to the currentComponent set.
5- Repeat over each connected section in the mechanisms list.
- Compute the size (number of pixels) of the connected component.
- If the size of the connected component is below a predefined threshold, do,
- Repeat over each pixel (i, j) in the connected component.
- Make highlighting the pixel (i, j) as background (set its value to 0) in the processedImage.
6- Do hole filling on the processedImage:
- Make a hole-filling algorithm to fill any holes present in the binary image, while that all foreground regions is connected.
- The exact hole-filling algorithm was used may dependent on the requirements and characteristics of the image.
7- Return the processedImage with lower pixel count and filled holes.

patient's movement. Because the current technology can be employed in a variety of space situations, this characteristic is crucial. It can be applied in the full university place or just part of it. Also, it can be used in other space positions such as another university, clinics, or hospitals. For that the software program will mimic the user needs to choose the distance and specify the boundary conditions as description of the classes and the relationships as steps. The UML classes for the software program illustrated in figure (2), and describe how user to move manually and adding boundary limitations to an evolutionary equation (2). The chosen image with the boundary conditions of the patient's mobility, obtained from a Google Map, will be the end product. The image data will be forwarded to the following stage in order to determine the locations of the RFID readers and the distribution of the patients.

will detect the radio signal came from the tags and transfer it to the middleware which represent the central computer. The used technique to create the tags position is POS Algorithm

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1- UserInterface:-

a- responsible for interacting with the user.

b- displays the chosen image and prompts the user to be select the distance and specify boundary conditions.

c- Obtains the user input (distance and boundary conditions).

2- ImageProcessor:-

- input chosen image as
- Receives the user-specified for (distance and boundary) conditions since the UserInterface.
- manually based on user interaction add the specified boundary constraints to the image.
- Applies the evolutionary equation to the image using the stated distance.
- Creates the processed image with added boundary constraints and the evolutionary equation applied.

3- GoogleMapAPI:-

- Attaches to the Google Maps API to get the image data of the patient's mobility.
- Retrieves the chosen image from the Google Maps API.

4- RFIDReaderLocator:-

- receives the processed image // from the ImageProcessor.
- determine the locations of RFID readers by analyzes the processed image.
- outputs locations of RFID readers.

5- Patient Distribution:-

- Receives the processed image from the ImageProcessor.
- Analyzes the processed image to determine the distribution of patients.
- Outputs the distribution of patients.

6- Main:-

- Performances the entry point of the software program.
- Instantiates the (User Interface, Image Processor, GoogleMapAPI, RFIDReaderLocator, and Patient Distribution classes)
- Calls the needed methods to execute the program.

Figure 2 : UML classes for the function of applied boundary condition

3. Functions Evaluation

The patient's distribution represents an essential step to specify the RFID reader's position. It represents the one of the input representations to the evolutionary algorithm. The tags distribution represents the patient's distribution in the selected movement area used by patients which specified in the previous section. Each patient has a tag which will send a personal signal to the RFID reader to register the patient's temperature in real time.

A. Scenery of PSO Algorithm and HMM and MEMM

The PSO approach operates on the same principles as evolutionary computing (EC) since the PSO algorithm is based on the movements of fish and birds. It is closely linked to a genetic algorithm that gathers the optimal particle potential for a bird that tracks a potential food source. In order to share the optimal location for eating that is, the

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optimal answer to the set of equations all the variables are interacting with one another. PSO makes use of the idea of particle position and velocity mathematically. Prior to PSO makes use of the idea of particle position and velocity. Prior to initiating the search for the optimal solution, several values must be considered. For example, the best known locations discovered by a particle serve as informants or neighbors for any particle inside the swarm also, HMM and MEMM represent the cost function that needs to be minimized in formal terms.. The objective function that we wish to minimize is likewise defined. Using the HMM and MEMM equations as a guide

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presented as a step-by-step bellow

1- Set up the problem:
   - Define the search space boundaries.// patient area (example school)
   - Ascertain how many particles
2- Indicate the maximum quantity of tries. Initialize the particles:
   - Create a starting particle population.
   - Give every particle in the search space a random position and velocity.(boundary area)
3- Determine each particle's
4- Set the global best:
   - Determine which particle is the global best value.
   - Update the system best position.
5- Output the result:
   - Show the best position found.
   - Show the best fitness value obtained

HMM and MEMM algorithm was used to identify each model's global optimal value, with the supplied model formulation serving as the target. RFID device requirements were met by utilizing necessary reader. numbers, which were followed by the generation of estimated reader placements to improve location efficiency. When the system first operates, these are the conditions.

Now when used reader positions are provided by the PSO algorithm and are displayed in Table (1). Reader numbers and positions, the number of patients identified by each readers shown in table bellow

4. Discussion and Results

When the PSO algorithm is used in a real-world case study, quantitative findings are obtained that yield insightful qualitative comments. The Proposed display how dispersion and spread of RFID readers depending on patient distribution are purely hypothetical. Presents the patient positions in the selected patients area in figure(4)

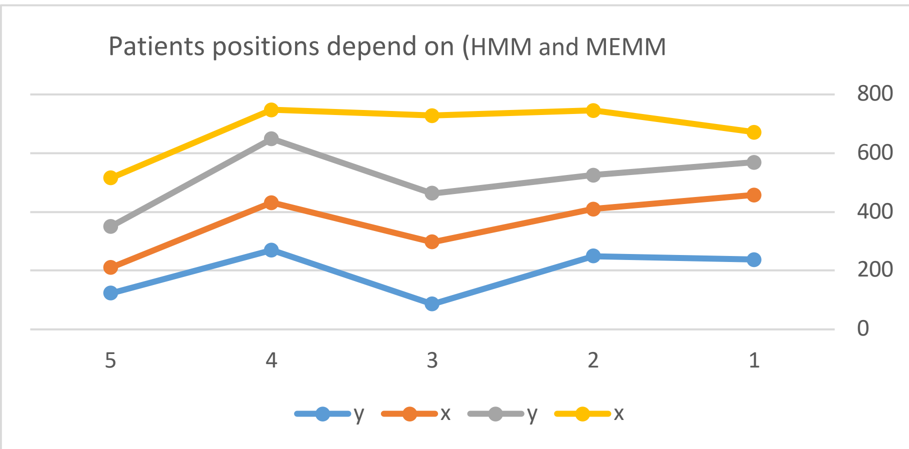

Figure (4): Patients positions

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Table (1): The number of Covered patients area				
FRID reader		Reader AREA	**HMM and MEMM** reader	Number of Covered patients area
POINT 1	POINT 2	28.232	30.252	2
110.777	162.376	22.132	25.444	2
180.0787	213.432	16.1827.	23.760	1
220.8564	170.456	35.345	40.555	3
120.001	110.345	38.232	41.345	3

The reader positions are provided by the PSO algorithm and are displayed in Table (1). Reader numbers and positions, the number of patients identified by each reader, the algorithm's fitness, and each reader's propagation range are used to illustrate the results.

Figure 5 illustrates how the PSO different from HMM and MEMM algorithm displays the numerical results of reader positions. Reader numbers, the (x,y) locations, and the number are used to indicate the results, of patients identified for every reader, the algorithm's fitness, and each reader's propagation range.

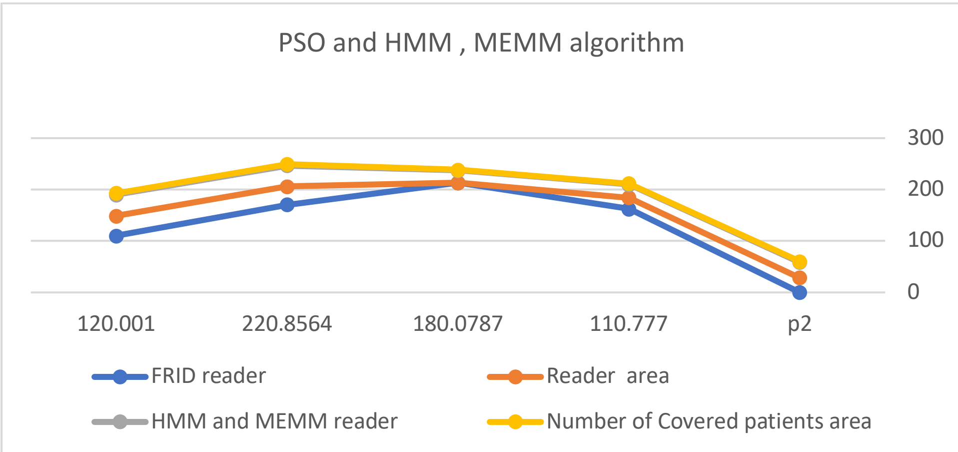

Figure (5) PSO and HMM and MEMM algorithm

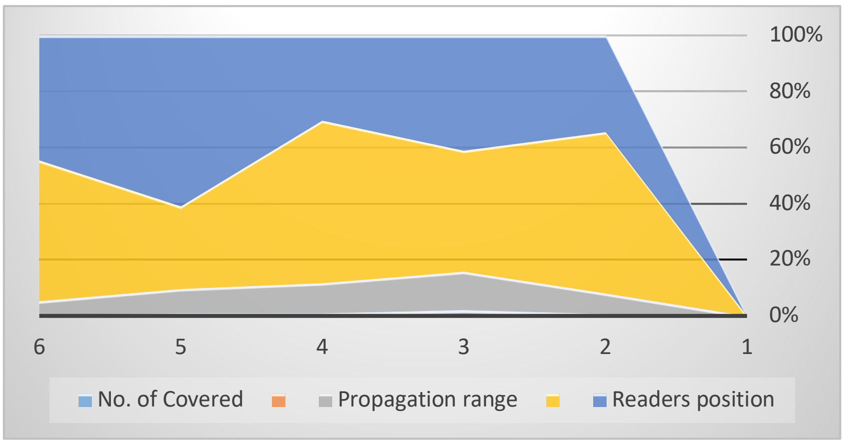

figure 6: display the reader range

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6. Conclusion

A full software package designed specifically to support and improve Radio Frequency Identification (RFID) technology in a certain environment, such as healthcare, is called an RFID software system. It consists of all the software components responsible for managing RFID readers, tags, and the data collected from them. This study tackled the difficulties in precisely tracking patient movements and positioning readers in an RFID-based patient monitoring system by utilizing particle optimization (PSO) and PSO different from HMM and MEMM algorithm. Although the PSO method exhibited efficacy in optimization, its ability to boundaries is limited reader while the algorithm PSO different from HMM and MEMM algorithm. The work It shows how FRID interacts and responds to reading in the two algorithms POS and HMM algorithm. As shown in the results, RFID responds to reading in the PSO algorithms different from HMM and MEMM algorithm from POS and within the same area.

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