Tourist Attraction Recommendation System Employing IoT and Artificial Intelligence

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Tourism is considered a business that both the public and private sectors aim to profit from. Many countries receive millions of tourists each year and generate millions of dollars in revenue from this business. The increasing importance of tourism has led to the integration of this industry with recent technologies in order to effectively manage remote tourist sites. One such technology is the Internet of Things (IoT), which is currently utilized in almost all sectors of daily life. This technology can be used to connect a network of cameras at various public, remote tourist locations to provide live streaming views of these sites, aiding visitors in making informed decisions about their travel plans.

The number of tourist sites or locations may reach hundreds or thousands in some countries, which constitutes a significant amount of data. This large volume of information may be overwhelming for tourists. Artificial Intelligence (AI) algorithms can alleviate this problem by making it easier to select a location based on various inputs, such as the tourists' demographics and the current weather at the site. This study proposes a number of reasoning rules that utilize these inputs to provide recommendations for tourists seeking suggestions. The information gathered by the system will be stored in a knowledge base and used to update the reasoning rules through techniques like backward chaining or other learning methods.

This research proposes a system to provide holidaymakers with direct views of tourist locations and make location suggestions based on knowledge base conclusions that assist in destination selection and journey optimization. A prototype of the system has been developed using a combination of programming languages, including PHP, JavaScript, CSS, and HTML, and is designed to be platform-agnostic.

***Keywords*: Tourism; Internet of Things (IoT); Artificial Intelligence (AI)**

1. Introduction

Tourism is a form of leisure activity that involves traveling to a new location [1]. In 2018, tourism provided 15.7 million job opportunities and generated $1,089 billion in yearly American expenditure, making it a significant industry [2]. To support this volume of job opportunities and revenue, technology is necessary. There are many recent technologies that can be applied to improve the tourism industry, such as mobile technology, chatbots, virtual tours, and the Internet of Things (IoT) [3]. When choosing a destination, most people prioritize safety, followed by natural and historical sites, among other factors [4]. Live streaming of current tourist sites may provide greater satisfaction to tourists.

The IoT is a paradigm that represents the next evolutionary step in internet-based computing and is already having a positive impact in various areas, such as smart cities, sustainable living, healthcare, manufacturing, and more [5]. Tourism, as a business, is not immune to the revolution of using IoT and digital technology. This paper proposes a system that collects different tourist locations into a single database and suggests a number of locations from a large pool of options based on certain parameters, in order to save tourists time and money.

The system will ask tourists questions and save their answers in a knowledge base, then use these answers to reason and suggest a camera for tourists. This intelligent behavior is a defining characteristic of artificial intelligence (AI), which is achieved through computational means [6]. Knowledge representation is a part of AI that involves how an agent uses its knowledge in deciding what to do. This research aims to develop everything from the beginning, including creating an online webpage, completing a form on the webpage, and creating the backend for the website to collect data entered by tourists. The machine will be taught to make decisions, including selecting camera feeds for the client and using a weather sensor for all locations with tourism centers for travelers. This research will be very helpful in completing and executing the webpage as required by the client.

In addition, tourists will have an easier time selecting which tour sites to visit, as the system records details such as weather predictions, humidity, and temperature for each location. Tourists will be able to make informed decisions about which locations to visit before traveling. Additionally, tourists will become more familiar with the countries or locations they are traveling to through virtual visits.

2. Literature Review

Using artificial intelligence (AI) has a significant impact on tourist technology. In [7], several AI topics are mentioned in relation to the tourism industry, such as big data, natural language processing, smart travel agents, and robotics in hospitality. In comparison, [8] uses AI to find a reasonable routing at the lowest cost. An AI-based wireless sensor travel route planning study was proposed in [8]. In [9], a bibliometric method was applied to study the progress of AI in the tourism field. 102 papers were collected from the Scopus database, and key factors such as the most productive authors, collaborations, and institutions were identified.

Research hotspots were also determined. In [10], a tourism management information system based on PSO-optimized neural networks was designed and implemented. The approach adds customized components to the user's search rating outcomes so that the routes and scenic locations shown to users in the result interface are more in line with their spending preferences. Various tests were conducted to validate the performance of the model and algorithm proposed in this paper. In [11], a smart tourism destination is described as an innovative tourist destination built on an infrastructure of state-of-the-art technology that ensures the sustainable growth of tourist locations and is accessible to everyone. It enables holidaymakers to interact with and integrate into their environments, improves the quality of the experience at the locations, and enhances the quality of life for inhabitants. Smart tourism involves multiple components and layers of "smartness," including Smart Destinations, which are special cases of smart cities that integrate ICT into physical infrastructure.

On the other hand, several papers have been published on the use of the Internet of Things (IoT) in the tourism industry. In [12], the researchers discuss how the IoT is expected to impact the industry and visitors vividly. The paper aims to identify the effects of the IoT on the leisure industry and proposes a model to simplify the industry by analyzing tourists' movements in order to fully understand their experience and address issues related to accurate data collection in the tourism industry. In [13], a paper explores the IoT in the context of Smart Cities, environments that are fully benefiting from recent technological advances. Both the IoT and big data are technology-driven developments, leading to scenarios such as Smart Cities, which have the potential to improve civilians' lives. In [14], an increasing number of tourist destinations and hotels are using new technology and solutions. The paper states that the IoT represents a great opportunity for tourism and hospitality to increase customer satisfaction while simultaneously reducing operational costs. The aim of this research was to define what the IoT is and explore how it can benefit people in tourism and hospitality. In [15], this paper conducts an in-depth study and analysis of the tourism management strategy of the intelligent tourism IoT service platform. The intelligent tourism system was designed from the overall system architecture to the design of each functional module of the system, and the database design was accomplished with the support of the database Entity-Relationship diagram. The paper also uses a weighted regression mathematical method to analyze passenger flow at different stages of the scenic spot. In [16], both deep learning in AI and the IoT are used. It proposes a tourist attraction IoT-enabled deep learning-based recommendation system to enhance the tourist experience in a smart city.

3. Methodology

The display result of the locations will depend on the traveler's selection. Therefore, the analysis of the options is the primary determinant of the outcome for each case. However, the part of the case statement entirely depends on the artificial intelligence decision-making process. The system will also collect information through a form and store it in a database.

Tourist attractions consist of four main categories: natural, artificial, sports, and events. The last two categories cannot be viewed live, as this paper proposes using a camera streaming through an IoT for tourists before their visits. Natural attractions include national parks, beaches, caves, waterfalls, and mountains. Artificial attractions include entertainment, wildlife, museums, and historical or heritage attractions [17]. This paper uses this classification to provide tourist locations, including hiking, beach and waterfall, picnics and wildlife, national parks, museums, and historical or heritage sites. A live camera cannot be used to broadcast some of these attractions to the public due to privacy policies, such as most entertainment and resort places. Each of these locations will be provided with a number of cameras to provide a live view of these locations. In addition, a number of sensors will be provided to collect the temperature of the locations. Weather will also be considered when selecting cameras for viewers. Other parameters are considered, such as whether the group is a family with children looking for a nice outing in a public place or just friends looking to have a good time..

The proposed system offers two modes. In the first mode, tourists can choose an attraction type directly. The system will then save the selected option in a database along with the age, gender, and family status of the tourists. This will help to produce statistics to find the relationship between these factors to be used in the future. The second mode suggests locations based on age, gender, and family status. These factors are all used in inference rules to provide a forward chain to find the destination. For example, for families with children, hiking will not be shown as an option with a camera streaming option. For groups of friends without children, age and temperature will be the main factors considered. This paper sets these criteria, so there is

no historical data that the system can depend on or learn from. After using the system for a while, feedback can update its knowledge base through supervised learning as the system saves the information in a database.

4. The System Implementation

The tourists use the interface to make selections and communicate with the system, so it is important that the appearance and use of the system be as simple as possible. The navigation and expected functionality of the system should be easy to understand and self-explanatory in order to avoid confusion and ensure satisfaction. With this in mind, a mobile application has been developed as a prototype of the proposed system. The reasons for this are: it is easy to use, all devices support it, it loads quickly, and there are many other benefits. The following interface is displayed when the application is opened for the first time. Artificial intelligence algorithms will play a major role here and will display a number of locations at the top of the screen based on previous information collected by the system.

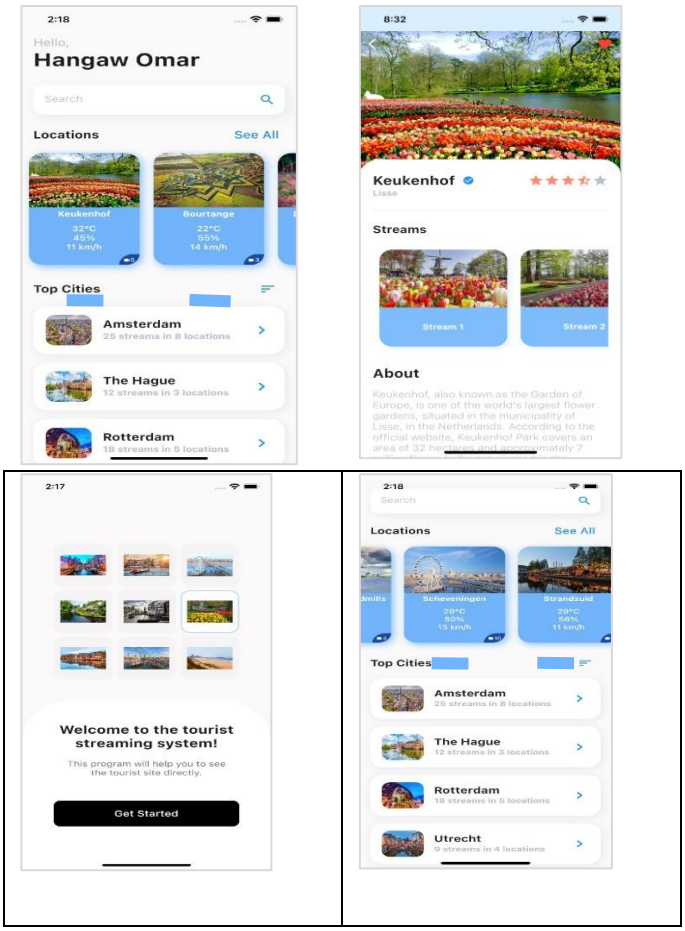

Figure 1. Random top tourism spots.

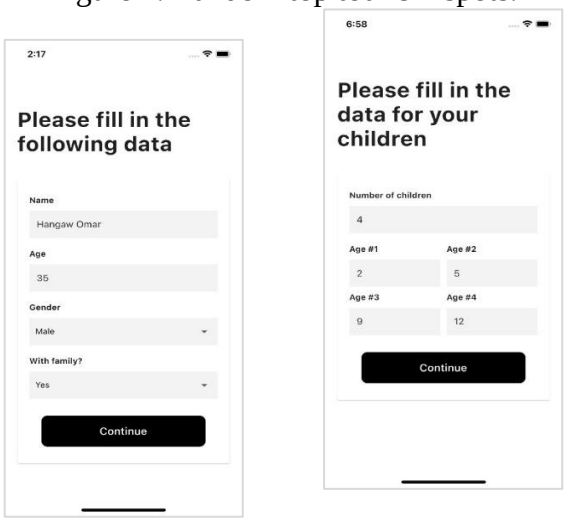

Figure 2. Fill out forms.

Figure 3. Tourism spots based provided information.

4.1. PEAS (Performance measure, Environment, Actuator, Sensor)

In the artificial intelligence phase, it is essential to define the agent in use and its goal in order to maximize the benefit of the system. To do this, the PEAS definition of agents will be used. The following is the PEAS description for the system.

- **Performance**: the system should be able to select the most appropriate camera feeds to the tourists immediately after the forms have been filed out. The collect of weather predictions and display them to the client as per the location of choice from sensors.
- **Environment**: a number of different locations should communicate with the webpage to provide a streaming for clients from the different cameras to collect the data beside connecting to global weather system to collect data on the weather forecast especially temperature and humidity. All the systems: camera, webpage, and Artificial Intelligence system should be connected and given access to each other.
- **Actuators**: The primary actuator is the webpage displaying the camera feeds to the client in a combination with AI decision.
- **Sensors**: Different sensors are used to collect information, such as temperature, humidity.

4.2. Artificial Intelligence

An intelligent agent in the system needs knowledge about the system users and a knowledge base for taking decisions and reasoning using inference rules to act efficiently.

Knowledge-based agents can maintain an internal state of knowledge, reason over that knowledge, update their knowledge after observations and take actions. These agents can represent the world with some formal representation and act intelligently [20].

A knowledge base system consists of the following features.

1. Knowledge base (KB), where all the facts are collected and considered as a main component of the knowledge base agent, which is a mixture of sentences, for instance the KB must be provided with following information.

- Most friends prefer hiking or other physical activities that aged under 50 years and a temperature below 35 C.
- Both family and friends in any age prefer the beach and waterfall in temperature between 18 and 35.
- Both family and friends are like to camp or go for picnic or enjoy in temperature above 18 C.
- Families are mostly like to go to national parks and friends under 40 years also like too, when the temperature is 28 C or less.
- Museums and old church are mostly visited by the family and friends below 28 years in exploring age and above 40 years which, and in temperature under 17 C or above 29 C as they are indoor place and more safe, the temperate between 17 and 29 is preferred for camping or for the beach.

2. Inference Engine (IE) is a new knowledge extracted from the old one. The inference system works mainly on two rules providing forward and backwards chaining, the information that provided for the KB along with inference rules that extracted from this information are determine which camera(s) to be streamed for the user.

3. Actions performed by an agent are updating the information by TELL and ASK operation [21], first the knowledge base must be told all facts then asked according to user's option, figure 2 show the simple algorithm for knowledge base that suggest some tourist attractions.

A system can use two methods in decision-making. Backward chaining and forward chaining. Backward chaining is a goal-pushed method in that you begin with speculation, after which you search for proof to confirm (or refute) the theory. It includes growing and assessing sub-goals. In backward chaining, start by turning the goal right into speculation. One can specify whether the hypothesis is proper or untrue. Afterward, begin with the plan, and if all the premises are accurate, helping the speculation, the guideline of thumb is acceptable. [22]

However, the data-pushed method is forward chaining. As understanding becomes available, start by concluding. Finding statistics that suit the IF part of the regulations enables; the Expert System to look at the issue. In ahead chaining, place the statistics to apply and draw sparkling conclusions. If those outcomes guide the goal, the decision is that the reason is first-class and is accurate; otherwise, if not, the decision is that the reason is untrue. In this situation, if the area aids the goal, the client has to get admission to the digital camera feeds, and every other area.

Function Tourist-Suggested-Agent (percept) return action
Input *percept* a list [*family with kids, friends, temperature, age*]
Static: *KB*, initially either family or friend
A1 to A4 for diffident age level
T1 to T4 for different temperature
Attractions, Dh for hiking, Db for beach,
Dp for picnic, Dn for national parks,
Dm for museum
action, C1,C2,C3,C4,C5 for camera array
Open camera Stream
if(friend and A1 to A3 and T1 to T3) **then** TELL(KB,Dh)
if(family or friend, all Age and T2 to T3) **then** TELL(KB,Db)
if(family or friends, all A and T2 to T5) **then** TELL(KB,Dp)
if(family and A1 to A3 and T2) **then** TELL(KB,Dn)
if(family or friends and (A1or A3 or A4), (T1or T3)) **then** TELL(KB,Dm)
if (Dh) is none empty **then** ASK(KB, C1=(Dh)
if (Db) is none empty **then** ASK(KB, C2=(Db)
if (Dp) is none empty **then** ASK(KB, C3=(Dp)
if (Dn) is none empty **then** ASK(KB, C4=(Dn)
if (Dm) is none empty **then** ASK(KB, C5=(Dm)
action = Open Camera Streaming[C1,C2,C3,C4,C5]
return action

Table 1. The algorithm of Tourist suggested knowledge base

The feed of cameras for the user is show due to the reasoning rules that preset by this paper as there were no such statistical data about the age and temperature of the tourist locations, there for some informal observation from local tourism experts used as primary suggestion criteria. As showed in the algorithm, the statement Dh is set for hiking, Db for beach, Dp will indicate picnic or camping places, Dn is national parks in the research and finally Dm is for museum and other historical places like old church.

The user parameters are also classified to family and friends, Fd is used for the family with kids less than 16 year, and the age of tourist can be classified as follow:

A1 from 18 to 28
A2 from 29 to 39
A3 from 40 to 50
A4 from 51 onward

As mentioned above, the tourist parameters along with temperature are determine the best destination for the user to see the location live. Here the temperature is set as follow.

T1 from minus to 17 Celsius
T2 from 18 to 28 Celsius
T3 from 29 to 35 Celsius
T4 from 36 Celsius onward

A set of inference rules can be applied to create a list of proposed locations as follow

$\neg Fd \wedge (A1 \vee A2 \vee A3) \wedge (T1 \vee T2) \rightarrow Dh$
$T2 \vee T3 \rightarrow Db$
$T2 \vee T3 \vee T4 \rightarrow Dp$
$Fd \wedge (A1 \vee A2) \wedge (T1 \vee T2) \rightarrow Dn$
$(A1 \vee A2 \vee A4) \wedge (T1 \vee T3) \rightarrow Dm$

In the above inference rules more than one output may curried out that means more than one suggested place, Table one explain all public suggested destinations

Table 2. Destination table criteria's

Destination	Details	Criteria
Dh	Hiking or any muscles effort	Not family , A1, A2, A3 in T1 and T2

Db	Beach or Swimming pool	Family and friends all ages in T2, T3
Dp	ıic, Camping or Enjoying of natu	Family and friends all ages in T2, T3, T4
Dn	tional park or Archaeological site	Family A1, A2 in T1, T2
Dm	Museum or cultural landmarks	Family and friends A1, A3, A4 in T1, T4

The results are saved in an array that permits a randomized function to show the streaming of the cameras in places proposed by the knowledge base agent, this will help the tourist to see the best location live, due to his age and the temperature of the site,
The rules mentioned in table 1, can be changed from community to other and from a country to another depending on the tourist attraction sites and cultural restriction in that community.
Not all tourists need such type of proposing tourist site or give any suggestion, some of them had a wide experienced or they want to open the cameras of specific place without any AI interfere and they take their decision by their own, in such case the data is saved in table 2 in the system, this will be a backward chain which help change the inference rules according to the current cultural background and community this will make it better fit to different communities, for instance if someone above 50 year old opened the camera of beach in 5 Celsius degree it will be saved as it shown in table 3.

Destination head of Clause	Temperature	Age	ıily with kids? Yes/N
Dh	T1	A4	No

When the tourist chooses one of these locations to visit the saved data in table 2 is provide a historical data to create a data set. After a period of time, using this system will provide a sufficient amount of data to create a data set depending of that community and use for future in changing the current inference rules.
A supervised learning can use the data set to train the system and provide a better reasoning from the knowledge base and perpetuate the system.
The example above gives a definite description of how the use of forwarding chaining is a dependable method in making such choices and the backward chaining to provide a dataset. The tourist's requirement for a tourism site will be the conditions in the system that will decide the camera feeds the client will receive.
Further, in making decisions, the weather can advise the client when to visit the selected area. For this to happen, the webpage requires an embedded cameras and temperature sensors of weather. The same forward chaining is used to make the decision. It is mainly depending on the analysis to make the decision.
Such procedures can be improved by integrating enterprise systems and connecting to cutting-edge technology by utilizing APIs. These include robotic systems, machine learning, big data sets from social media, and other Internet of Things (IoT) networks appliance [23][24]. Other weather factors can be added in future in decision making rules like wind speed and humidity where they only viewed in current system, and extra user parameters can be added like gender for example; to make the system better fit in all communities for instance in some middle east countries women don't prefer hiking.

5. Conclusion

In summary, creating a webpage that features a large number of tourist sites can be a great resource for tourists to explore remote sites before spending money on visiting them. This is a cost-effective way that can save tourists both money and time. Using cameras and sensors at remote sites will have a significant impact on the tourist system, providing live streaming using IoT technology, as well as gathering data for future analysis.
Artificial Intelligence (AI) plays a significant role in decision-making. Forward chaining and backward chaining are important for collecting data from users, which is the second mode in the mobile

application for choosing sites discussed in this paper. The knowledge base reasoning is used to provide an easy way to suggest tourist places based on age, temperature, and whether the group includes children. Several inference rules are used to suggest a place based on these parameters, and the backward chain can be used to update these rules.

HTML, CSS, JavaScript, MySQL, and PHP were used to develop the system and create a concrete database for saving data and creating a data set for future use.

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