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SMART TECHNOLOGY-BASED SAFE TOURISM IN THE POST-COVID-19 ERA

Abstract: *The tourism sector is heavily influenced by the ongoing coronavirus pandemic, due to strict government measures including travel restrictions and, on the other side, psychological factors, such as fear and anxiety that together have caused a sharp decline in this sector. However, it is identified that state-of-the-art smart technology has huge potential when it comes to post-COVID tourism revival. Therefore, in this paper, we examine how the synergy of the following concepts can be adopted for the purpose of increasing work safety in sectors based on live human interaction: Artificial Intelligence (AI), Augmented Reality (AR), blockchain, Internet of Things (IoT) and smartphone applications. As an outcome, three case studies relying on them are proposed and evaluated: 1) smart tourist scheduling 2) gamified sightseeing with fitness elements 3) safe public events. They aim to provide engaging, content-rich, but safe tourism at the same time under novel, pandemic-related circumstances.*

Keywords: protection of employees, mobile applications, Internet of Things (IoT), deep learning, blockchain.

INTRODUCTION

The ongoing coronavirus pandemic dramatically impacts the tourism sector [1, 2], as safety becomes a major concern. Due to a huge number of new cases and high death rate in many countries [3], government responses are quite restrictive [1-8], applying measures [3] such as total lockdown, public event prohibition or limiting the number of participants, forbidding travel outside the boarders and closing hospitality objects. On the other side, policies aiming to reduce infection among employees, such as working from home and reducing open hours were counter-productive in sectors that are mainly based on live human interaction, such as tourism and hospitality [7, 8]. Later, the requirement of a green certificate as proof of vaccination or a negative COVID-19 test made traveling and event attendance even more demanding. Additionally, negative psychological effects of the current situation, such as fear and anxiety have also contributed to the overall decline of tourism and related sectors [4, 5]. Therefore, an enormous number of events, travels, accommodation and flight reservations have been cancelled worldwide [1, 2]. It is not only that the number of tourists has decreased significantly, but the current situation has shown many negative side-effects as well, such as the number of jobs lost in the tourism and hospitality sector [1, 2]. Due to the dramatic impact of pandemic on almost any aspect related to everyday life - including work, transportation, interaction and other regular activities, the period after the outbreak of coronavirus is often referred to as the post-COVID era [7].

However, it has been identified that safety engineering, relying on smart digital technology is crucial for improving employee safety in both outdoor and indoor working environments [5-9]. This way, the revival of sectors based on human interaction within on-the-spot activities becomes a reality even under these new circumstances. This work focuses on leveraging Artificial Intelligence (AI), Augmented Reality (AR), blockchain, Internet of Things (IoT) and smartphones as key enablers of novel scenarios aiming safe tourism. Fig. 1 depicts the notable use cases involving these technological concepts in the context of the COVID-19 pandemic, inspired by [7].

Figure 1. *Smart technology for post-COVID tourism revival and notable use cases (illustration).*

AR aims to make the on-site tourist experience more engaging, providing additional content, based on current context. IoT relies on affordable, small-size and low-consumption devices which are interconnected and equipped with various sensors used for acquiring enormous amounts of heterogeneous data from the environment. The collected data is further analysed in order to detect the events that occur within the environment, while actuator IoT devices execute the action in this context, to respond to the changes. AI enables the extraction of useful knowledge and patterns from huge amounts of data in order to make predictions of relevant aspects of previously unseen observations, enabling smarter decision-making based on these predictions. On the other side, blockchain, originally coming from the world of finance, enables storing information about the executed transactions permanently, in an immutable manner.

In this paper, we adopt the synergy involving these state-of-the-art digital technologies with the aim to enable safe, but content-rich tourism in the post-COVID era at the same time. As an outcome, three case studies built upon by extending the work from [9] are developed and evaluated from various perspectives.

BACKGROUND AND RELATED WORK

Augmented reality using AR.js

The main idea of augmented reality (AR) technology consists of merging realistic images coming from the camera stream with additional, overlayed multimedia content, such as text, sounds, images and 3D models. Moreover, these objects can be interactive, so user input, such as touch/click can trigger their actions or change, such as animation sequence. We make use of AR in order to make the self-guided sightseeing experience richer and more engaging while avoiding interactions that involve a huge number of persons. There are different implementations of AR frameworks and technologies aimed at various devices – from gaming consoles to mobile phones. In this paper, the focus is on mobile augmented reality due to smartphone portability and affordability, so additional equipment is not needed, which is suitable for tourism-related scenarios.

In this paper, the case study application is developed AR.js [10], which represents a resource-efficient, lightweight, widely compatible web-based, mobile-friendly framework for JavaScript, offering a set of features necessary for mobile AR. Two major AR paradigms are covered by this framework: 1) location-based [11] – objects appear/disappear depending on current GPS location 2) marker-based [12] - objects will show up after the detection of pre-defined barcode-alike markers. Furthermore, AR.js also provides capabilities for drawing 3D primitives (cubes, spheres and others); transformations of 3D objects; and loading of externally stored 3D models and their animation. AR.js encapsulates the capabilities of several other frameworks into a simple, higher-level Application Programming Interface (API), implemented as a set of special HTML elements and JavaScript classes. Its syntax is quite intuitive, but still very expressive, enabling the development of sophisticated AR applications in just several lines of code.

In [13], a marker-based mobile AR approach to sightseeing in the city of Niš was presented. When the visitor points the camera to the years written on the Monument to the Liberators of Niš, additional objects pop up – both relevant textual info and multimedia (audio and images), depicting the events related to the liberation of Niš. On the other side, a similar approach to AR-supported museum visits can be found in [14], using QR codes, instead of year numbers as markers.

Deep learning in PyTorch

Deep learning refers to an approach in artificial intelligence that makes use of artificial neural networks that contain multiple computation layers (known as *hidden* layers) between their input and output [15]. The role of these layers is to help extract features from raw data at the input, in order to make as good as possible prediction of the target variable in some specific context. When it comes to supervised learning techniques, the so-called deep neural networks can be efficiently trained on a set of correctly labelled observations (train set) in order to make accurate predictions on previously unseen data (test set). Each layer contains a set of computational units, the so-called artificial neurons, which are adjusted iteratively during training in order to make as closest as possible predictions. Loss function is used to estimate the distance between the predicted value and the expected outcome during training. The learning rate parameter tells how much to adjust the model weights using the optimizer with respect to the previously calculated error value.

In this paper, we leverage the PyTorch [16] framework for deep learning in Python, introduced by Facebook in 2016. It covers three main aspects that enable the implementation of deep learning-based predictive models [16, 17]: 1) high-level specification of neural network architecture 2) tensor-based arithmetic operations and their manipulation 3) representation of datasets. Due to its object-oriented approach, clear syntax and solid performance, it is becoming more and more popular, especially in scientific works.

In [18], PyTorch was used for the prediction of two aspects related to ultramarathon running - regression for run distance and classification for injury prediction. Moreover, it was also used for yoga pose detection based on images leveraging a convolutional neural network (CNN) for image classification in the same paper [18]. On the other side, in [19], hotel booking cancellation and tourist number prediction using RapidMiner were presented.

Blockchain and smart contracts

Blockchain enables decentralized transaction execution and storage of corresponding records, holding relevant information about them (such as source account, destination account, amount transferred and timestamp) [20]. As an outcome of the transaction, virtual digital tokens are exchanged among different parties with the purpose of buying a service or acquirement of ownership over either physical or intangible assets. Distributed ledger is used in this context for transaction data storage purposes and represents an append-only sequence of data blocks. The storage is provided publicly, in an anonymous, immutable, and trackable manner without intermediary, relying on a large network of peer nodes [20, 21]. However, when a transaction is executed, nodes within the network have to confirm it relying on the protocol for consensus, making it extremely difficult to tamper it [20, 21]. Despite the fact that initial applications of blockchain were mostly in the area of finance and trading, this technology has been widely adopted nowadays in order to enable novel usage scenarios, especially since the rise of the Ethereum blockchain platform, together with smart contracts in JavaScript-alike Solidity language. In the world of blockchain, the smart contract represents executable software code that defines the protocol required for the realization of transactions relying on the targeted platform [20, 21]. They describe the business logic behind them, changes that should be made as an outcome of the transaction and which data should be kept within the blockchain. Even before the current pandemic, blockchain and smart contracts have been considered as enablers of many healthcare-related scenarios, especially in the case of record keeping and their access across different organizations [22]. In this paper, we use the Ethereum blockchain and Solidity smart contract synergy to check green certificate validity at public event entrances and keep the proof of presence in order to trace contacts in case when potentially infected persons were present and notify the other participants.

SAFE TOURIST SCHEDULING LEVERAGING DEEP LEARNING MULTI-OBJECTIVE OPTIMIZATION

Avoiding large queues and crowded places, especially indoors, is highly beneficial for safe tourism, as it contributes to COVID-19 spread reduction. Therefore, one of the common government responses to novel circumstances is putting limits on the maximum number of persons inside closed spaces and in case of public gatherings, even outdoors. However, this safety measure has a negative impact on tourism and sightseeing, especially when it comes to museum and gallery tours. In that context, the aim of this case study is to enable smart tourist scheduling, aiming to reduce the risk of coronavirus infection during the tour. The idea is to generate recommendations for safe sightseeing and show them to tourists via mobile app, taking into account several factors relevant to the COVID-19 pandemic. For that purpose, we adopt the approach for proactive planning leveraging deep learning-based prediction and linear optimization, as approved in case of pandemic resource planning scenarios [23].

Deep learning in PyTorch is leveraged for prediction of two aspects considered during tourist scheduling: 1) number of tourists that will visit some location and 2) tour cancellation prediction. The first one is treated as a regression problem, while the second is considered a binary classification.

The aim of the first predictive model is to estimate the number of tourists that would visit some location within the destination, taking historical data about visitor count and external factors like number of COVID-19 cases and average daily temperature as input. In Table 1, the layout of the dataset header can be seen (the output and dependent variable are gray). When it comes to tourist count data used as input for the training of predictive models, a camera-equipped Raspberry Pi executing computer vision script for human body detection is used for that purpose [24].

Table 1. *Visitor number predictor dataset*

COVID -19 cases	Temp.	Month	Day	Hour	Location	Visitor [num]

For regression, we used a deep neural network with the following architecture: input layer – 6 nodes (corresponding to the number of input variables); 3 hidden layers – 45 nodes each, rectified linear unit (ReLU) activation function; output – one linear node. For training such a neural network, we rely on the Adam optimizer and mean squared error loss function, while the value of the learning rate was 0.01. We decided to rely on the Adam optimizer due to fast computation time while it requires fewer parameters for tuning than others [18].

On the other side, the second predictive model has a goal to predict whether a tourist is likely to cancel the visit or not, considering the COVID-19 case number, price of ticket or reservation, season and number of persons within the reservation. In this context, for binary classification, we use a similar neural network, with several modifications: sigmoid activation function in the output layer, stochastic gradient descent optimizer, binary cross entropy loss function and learning rate 0.003. The header of the dataset used for the second predictive model is shown in Table 2.

Table 2. *Tour cancellation predictions*

COVID -19 cases	Season	Number of persons	Price	Location	Cancel [yes/no]

For particular tourist-oriented location *l*, the total estimated count of visitors $tourists_l$ is calculated as the difference between the outcome of the first predictive model for that location $predicted_l$ and the count of all reservations that will be cancelled multiplied by a number of persons involved:

$$predicted_l - \sum_{i \in N} cancelled_l[i] \cdot num\_persons_l[i] = tourists_l \quad (1)$$

Finally, once the tourist number estimate is known, multi-objective tourist allocation can be performed, relying on the Pymoo [25] framework for Python. For this problem, we observe the decision variable of transfers between tourist locations, denoted as *x[i,j]*, where *L* is the set of considered locations, *i* represents the index of the source location, while *j* is the index of target location (where tourists should go). For source destinations, the approximation is made with respect to the tourist's closest GPS location. This variable takes value 1 in case the tourist at current location *i* is advised to visit location *j*. When it comes to allocation, there is a constraint that the current number of tourists at each target location *tourists[j]* including the new visitors should be lower than the maximum number of persons allowed for that place *max_allowed[j]*:

$$tourists[j] + \sum_{i \in L} tourists[i] \cdot x[i,j] \le max\_allowed[j], j \in L \quad (2)$$

However, there are two objective functions – infection risk reduction and overall tourist commuting time minimization. The first one aims to keep the COVID-19 infection risk for location *j* as low as possible. Infection risk is defined as the ratio between the number of visitors *toursists[j]* and the size of the location, expressed in square meters (*size[j]*), given as:

$$minimize \sum_{i,j \in L} \frac{x[i,j] \cdot tourists[i] + tourists[j]}{size[j]} \quad (3)$$

On the other side, another objective function has a goal to minimize the estimated transportation time required to travel (denoted as *duration*) from one location to another, as longer trips in public and group transportation increase the risk of infection as well:

$$minimize \sum_{i,j \in L} duration[i,j] \cdot x[i,j] \quad (4)$$

Furthermore, the values obtained as the outcome of optimization process (decision variable *x[i,j]*) are interpreted as recommendations, so for the user currently on location *i*, the recommendation for the next visit is location *j*. The workflow of this case study is depicted in Fig. 2.

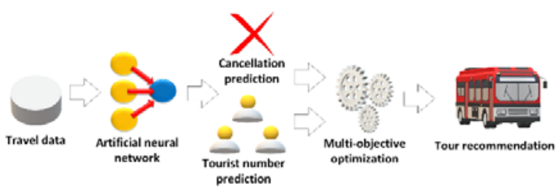

Figure 2. *Smart tourist scheduling leveraging deep-learning and multi-objective optimization workflow*

AR-ENABLED APPROACH TO GAMIFIED SIGHTSEEING

In traditional tourism, a group of travelers usually follows a tourist guide giving the necessary information and additional details about the visited destination and its sights, such as buildings and monuments. However, in the post-COVID era, gathering of large groups is considered quite problematic due to infection risk, so an adequate alternative to the traditional approach is needed, in order to ensure equivalent self-guided experience [7]. In this case study, the goal is to adopt mobile AR technology not only to change the role of the human guide by the mobile app but also to provide an additional motivational factor in the form of gamification for tourists, promoting local craftmanship and physical activity, making the overall experience more engaging and entertaining.

This case study leverages both location- and marker-based approaches to augmented reality relying on smartphones, their cameras and GPS sensors. While traversing the tourist destination, at specific locations of interest, especially near buildings of importance and monuments, several types of interactive 3D objects pop up over the camera stream. The first type is *info objects*, which represent location-triggered animated 3D models aiming to depict some important historical or cultural event, relevant to the tourist destination. Furthermore, the user is redirected to a page providing textual info about the location by clicking or touching one of these objects. Another type of location-based object is question boxes, which give the opportunity to the tourists for collecting points, which can be later used for discount coupons. When clicked, they redirect to the input form where the user can answer the destination-related question, usually about history and culture, based on information provided by info objects. These questions are either to fill in the gap in sentences with correct word or multiple-choice. Each correct answer brings points, which are accumulated for a given e-mail address. Later, users are able to claim prizes for a given amount of points, selecting one of the traditional local craftsmanship products, such as wine, chocolate and cheese. The prizes are received in the form of digital coupons via tourist-provided e-mail.

Fig. 3, 4, and 5 give representative screenshots of AR-enabled mobile app for a gamified tourism experience. Fig. 3a shows a 3D model of Sebastokrator Momčilo with knight guards popping up at the entrance of his fortress (Momčilov Grad) in Pirot, Serbia. Clicking on the 3D model, the user is redirected to the info page, stating that the Seabstokrator built Pirot Fortress in the 14th century and the name of his legendary horse was Jabučilo [26], as can be seen in Fig 3b.

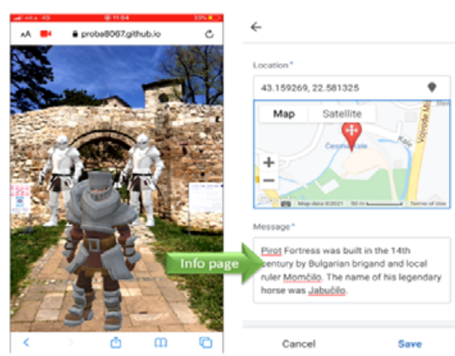

Figure 3. *Location-based AR for tourism: a) 3D historical reconstruction b) info page*

Moreover, Fig. 4a shows a 3D question box that appears in Kazandžijsko Sokače, Niš, Serbia, while arriving close to the Monument of Stevan Sremac and Kalča. This box redirects to the question form (Fig. 4b), where the user has to respond from which book/movie this character comes from (referring to "Ivkova Slava"). Finally, Fig. 4c shows the prize selection screen.

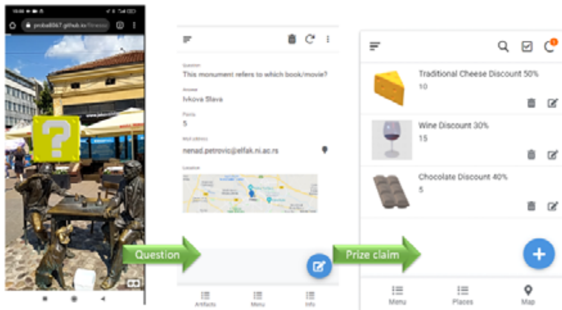

Figure 4. *Elements of gamification in AR sightseeing app: a) question box object b) question responding c) prize selection*

Furthermore, this app includes two more gamification elements, related to the promotion of physical activity, which is also one of the aspects relevant to health in the post-pandemic era, especially after long-term quarantine periods. While exploring the tourist destination, the user is also rewarded for the calories burnt between the last two 3D objects discovered. In this context, we also leverage deep learning-based regression for energy spending prediction, based on dataset from [27]. In Table III, the layout of the dataset is depicted.

Table 3. *Dataset for predicting the burnt calories*

Activity type	Weight [kg]	Duration [min]	Calories burnt [kcal]

The assumed type of activity is walking, while the duration required for passing between two interactive 3D objects is considered as input, together with user-provided weight. The predicted value of calories burnt is divided by 100 and added to the sum of accumulated points.

Additionally, the third gamification element is also related to physical activity and relies on marker-based AR. The goal of this element is to enable safe exercise instructions without the involvement of large groups. Additionally, it is assumed that near locations of importance, QR code markers printed on paper are placed. When the camera is pointed at them, each marker shows a 3D animated model of a yoga instructor showing a distinct exercise pose. After that, the user is able to provide a picture of himself/herself repeating the exercise. In case that pose is correct, a certain amount of points will be collected. For pose correctness classification, a convolutional neural network (CNN) was used, as described in [18]. The neural network is able to recognize 5 different yoga poses and is trained on a publicly available dataset from [28]. Its input is images of size 256x256 and it contains 5 convolutional layers followed by max-pooling layers performing downsampling, to reduce the size of the feature map and increase processing speed. On the other side, the classification part consists of 4 fully connected layers with ReLU activation and 5 softmax nodes in the output, as it performs multiclass distinction into 5 categories.

Fig. 5 shows the screenshots of the marker-based part.

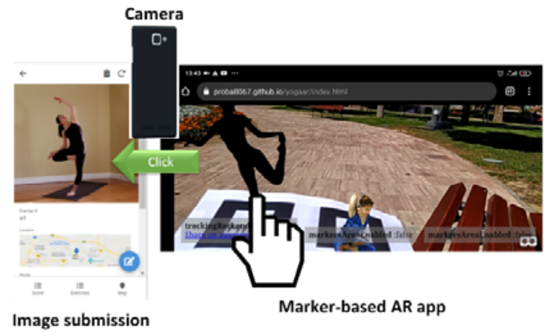

Figure 5. *Marker-based AR to support physical activity*

Fig. 6 depicts an overview of the AR application workflow used in this case study. Its architecture is based on the works from [18, 29]. Several different technologies were adopted as described: 1) AR.js – for location – and marker-based mobile AR; 2) AppSheet – a codeless platform for multiplatform mobile applications, used for the creation of info pages and input forms (questions and image submission) relying on Google Sheets for data storage; 3) AppsScript - a framework for integration of Google's services built upon JavaScript, leveraged for trigger-based backend business logic (checking the question answers, uploading pose images, score calculation, prize claim, coupon generation and delivery via e-mail) 4) Flask [30] – providing the interface to the PyTorch predictive models (calories burn prediction and yoga pose classification) via HTTP requests which are sent from AppsScript.

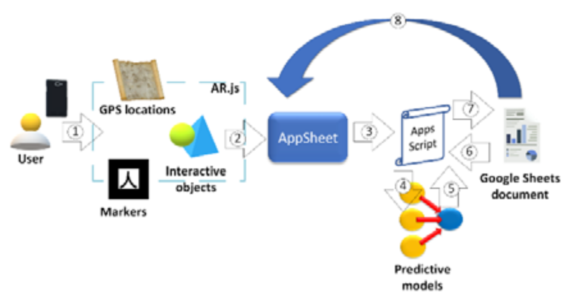

Figure 6. *Gamified AR-enabled sightseeing workflow: 1) Touch/click on 3D model 2) Redirection to info pages, questions and input forms 3) Apps Script trigger activation 4) HTTP requests via Flask API containing predictive model input 5) Prediction outcome 6) Retrieval of stored data 7) Storing new data 8) Update view*

SAFE PUBLIC EVENTS USING IOT AND BLOCKCHAIN

When it comes to post-COVID tourism, culture and entertainment-related events, such as gallery and museum expositions, concerts, theatre and cinema, indoor safety is of utmost importance. In this context, governments of many countries around the world are imposing specific requirements for entering closed-space public events, such as a green certificate. Pre-requisites for such documents are often a negative coronavirus test, vaccination proof, or the presence of healed COVID-19 within the health record's disease history. However, checking the validity of green certificates manually by approved personnel is not only time-consuming but could also cause large waiting queues at the entrance, which increases the risk of coronavirus infection as well. Moreover, if later turns out that some of the event participants were infected, in order to reduce further spread of coronavirus, it is highly beneficial to inform the attendants about that.

Therefore, in this case study, we introduce an IoT-based system for automated check of compliance with indoor safety conditions, in order to speed up the procedure and avoid crowd. For this purpose, we rely on an affordable, small-size, low-consuming Arduino Uno microcontroller equipped with an RC522 RFID reader. Moreover, the Ethereum blockchain in synergy with Solidity smart contracts is adopted for vaccination record checks and contact tracing.

The workflow of the proposed system is illustrated in Fig. 7. First, the person who enters the event, provides an RFID tag, either in the form of a distinct card or integrated with a smartphone. Furthermore, based on tag ID, it is checked if disease history containing COVID, vaccination, or test record with valid duration (depending on the specific country) exists on the Ethereum blockchain. In case that check is passed, the entrance opens, otherwise, it remains closed, preventing the person from entering. Additionally, the the number of persons present in this location is counted and leveraged for the creation of the dataset from Table I. Storage and retrieval of green certificate data is implemented in the form of Solidity smart contracts, based on [8, 9]. For vaccination records, the relevant data is kept, such as dates of first, second and booster doses, type of vaccine and validity duration. Similarly, for coronavirus tests, type (such as quick antigen, PCR) and duration are also relevant. Moreover, for each person who passed the check, the presence record for the purpose of contact tracing is stored on the blockchain, which contains the location ID, tag ID, phone number and timestamp. In case of a positive coronavirus test for at least one of the attendants during the next 7 days, all the people who attended the event together will be informed via SMS that risky interaction might have occurred on that day. The storage and retrieval of contact tracing records are done in a similar way, as in the case of green certificate-related data.

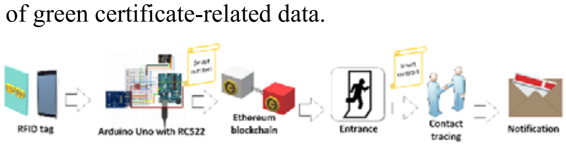

Figure 7. *Event safety check workflow*

RESULTS AND EVALUATION

This section describes the experiments used for the evaluation of the previously presented case studies, considering various relevant aspects. The experiment execution environment mainly relies on free cloud resources. When it comes to the execution of Python components (predictions and scheduling), we rely on cloud resources offered by Google Collab [31]. It is both a development and runtime environment, allowing to leveraging of high-performance GPUs which accelerate the training phase of deep learning models significantly. On the other side, for the AR app, the GitHub Pages [32] service was used for deployment. Additionally, business logic and mobile app input forms are executed on Google Cloud infrastructure offered within the free plan of AppSheet and Apps Script. For blockchain-related experimentation, we make use of Ganache [33], an Ethereum blockchain simulation environment running on the local computer (laptop equipped with quad-core i7 CPU and 16GB of DDR4 RAM).

Table 4 summarizes the results of experiments from the perspective of two metrics: execution time for various processing steps and prediction quality. The first column represents the name of the case study to which the experiment refers to. However, the second column shows the aspect that was evaluated within the experiment. The third column shows the metric used for the evaluation of the selected aspect. Finally, the last column presents the value achieved for the selected metric, as the average result obtained in 100 experiments.

In what follows, the achieved results shown in Table 4 will be discussed for each of the case studies. For the first one, the calories burn prediction model shows high performance (low mean relative error), which is suitable even for more sophisticated fitness-related use cases. However, the processing time in the reward claim scenario is longer than 1 second considering the usage of the remote mail server responsible for sending prize coupons, which is still acceptable as it does not depend on real-time user interaction. Furthermore, the smart tourist scheduling case study achieves faster processing times more appropriate for real-time (which is a must here) together with satisfactory prediction quality - low relative error for regression-based tourist number prediction and high accuracy for classification-based reservation cancellation prediction. Finally, the last scenario shows slower response times, mainly dependent on the limitations of the underlying blockchain infrastructure itself when it comes to data retrieval as a compromise for other desirable features at the same time, such as traceability.

Table 4. *Case study evaluation*

Case study	Aspect	Metric	Value
Gamfied sightseeing	Question check	Execution time [s]	0.571
	Reward claim		2.27
	Calories burnt prediction	Execution time [s]	0.615
		Mean Relative Error [%]	7
Smart scheduling	Tourist number prediction	Execution time [s]	0.127
		Mean Relative Error [%]	14
	Cancellation prediction	Execution time [s]	0.241
		Accuracy [%]	89
	Multi-objective optimization	Execution time [s]	0.012
IoT/Block chain	Contact tracing - notification	Execution time [s]	70.41
	Green certificate check	Retrieval time [s]	8.42

CONCLUSION AND FUTURE WORKS

According to the results achieved for the presented case studies, it can be confirmed that state-of-the-art smart technology effectively provides support to tourism and related sectors in the post-pandemic era, contributing to their revival. Additionally, the adoption of open-source and free-of-charge software and affordable, widely compatible hardware platforms is promising, especially when it comes to countries under development. Moreover, the fast prototyping using the combination of the proposed technologies is also beneficial to early adopters as well, such as regions relying entirely on tourism. However, the main limitation of the current work is the lack of a framework for imposing data privacy policies on the involved users when it comes to contact tracing and green certificate scenarios.

In the future, it is planned to focus on safe air quality control and regulation mechanisms relying on IoT and artificial intelligence, in order to further reduce the risk of COVID-19 transmission, especially indoors, which would contribute to the revival of large-scale public events. Finally, we will also aim to enable the adoption of country-specific privacy preservation policies based on data anonymization before storing it on the blockchain.

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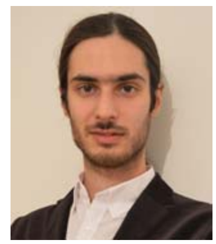
BIOGRAPHY of the first author



Nenad Petrović was born in Pirot, Serbia, in 1992. He is a teaching assistant at the Faculty of Electronic Engineering, University of Niš, Serbia. He received his bachelor's degree in the area of Electrical Engineering and Computer Science at the same faculty,while his master's degree inComputer Science and Engineering comes from Politecnico di Milano, Milan, Italy.Moreover, he has been occasionally working as an ICT analyst/consultant in TELCO, e-commerce, machine learning and DevOps areas. Nenad is the author of around 150 research publications (conference papers, journal articles, and book chapters) with both national and international recognition and is the holder of 4 IcETRAN Conference Best Young Paper Awards (1 in 2018, 2 in 2019, and 1 in 2022). His main research interests cover semantic technology, IoT, and deep learning.

BEZBEDAN TURIZAN U DOBA KORONAVIRUSA OSLANJAJUĆI SE NA PAMETNE TEHNOLOGIJE

Nenad Petrović, Vasja Roblek, Maša Radenković, Valentina Nejković, Nino Papachashvili

Rezime: *Turizam je jedna od najugroženiji grana za vreme trenutne pandemije koronavirusa, s obzirom na stroge mere bezbednosti u mnogim državama, koje ograničavaju putovanja, ali i psiholoških faktora (poput straha i anksioznosti) sa druge strane. Međutim, takozvane "pametne" digitalne tehnologije pokazuju veliki potencijal, što se tiče oporavka turizma u novonastalim okolnostima. Prema tome, ovaj rad razmatra kako je moguće primeniti sinergiju sledećih koncepata u tu svrhu: veštačka inteligencija, proširena stvarnost, blokčejn, internet stvari i pametni telefoni. Kao ishod, predstavljene su i evaluirane tri studije slučaja: 1) pametno raspoređivanje turista 2) primena gejmifikacije i mobilne proširene stvarnosti za interaktivan obilazak znamenitosti 3) bezbedna javna okupljanja. Cilj ovih studija slučaja je da obezbede ne samo bezbedan, već i sadržajan obilazak turističkih destinacija upotrebom pametnih tehnologija.*

Ključne reči: zaštita zaposlenih, mobilne aplikacije, internet stvari, duboko učenje, blokčejn.