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Port emergency tourist flows management - experiments with drones and active RFID sensors

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Abstract

Providing information to tourists entering/exiting the port areas in an emergency and/or while managing delays or events that modify the scheduling of the port service is a primary need that is often little considered by port managers. This article experiments a low-cost emergency management system for tourist flows in ports, integrating it with a system for monitoring, information and rewarding. The proposed solution grants a continuous communication with port users for managing emergencies and unscheduled events responses. Moreover, it monitors the situation in ports and peri-port areas, providing timely, valuable and effective information to both private users and port authorities. The system is based on advanced ITS technologies that use rugged active RFID Tags in the 2.5 GHz band and Urban Air Mobility (UAM) equipment, in particular drones.

Keywords: Urban Air Mobility-UAM, Drones, Sustainable Tourism, Ship Passenger Mobility, Port Emergency

1. Introduction

In recent years, Unmanned Aerial Vehicles (UAV), also known as drones, have gained much relevance. The initial applications of UAV technologies included a somewhat limited number of tasks, such as aerial photography or mapping (Reiche et al., 2018; Urbanmobility.com, 2019), that were either costly or inconvenient to be performed using traditional aerial vehicles. However, with the advances of the relevant technologies concerning the payload of UAVs, the number of possible applications has rapidly expanded paving the way for future UAV based services (Scalabrin et al., 2020). This is even more interesting in the context of catastrophic and emergency events (due to climate change, to the recent pandemic and other causes).

It is rather evident that UAVs will be an increasingly relevant component of the mobility system, when it comes to transportation of both freight and humans (Gillis et al., 2021).

The use of drones also becomes important to manage emergency and unforeseen situations in port or peri-port areas, mainly for transportation, logistic and communication activities (Gillis et al., 2021). To this aim, and to make the most of the possibilities offered by new technologies as well, in this paper our attention is focused on the communication phase between drones and ship passengers, both inside and outside the port area. Currently, information is provided to passengers onboard, mainly by means of internal microphones, while off the ship this task is mainly entrusted to Variable Message Panels located in strategic nodes. These are

generally insufficient in emergency situations or in the case of traffic diversion (often differentiated by vehicle type, with the need to send passenger cars to areas other than those reserved for freight vehicles and, above all, heavy vehicles with dangerous goods). Moreover, we need to find a way to provide different information to different port users and to differentiate it based on of the location and the consistency of the "passenger clouds". The use of drones to communicate these information delivers a very flexible instrument to port and transport managers. It also enhances logistic operations and a number of other port activities. The main problem lies in the difficulty to communicate with every single user and a viable solution could be provided through the use of smartphones and a centralized application, able to collect messages from drones by means of appropriate communication sensors. The same instrument could be used in the peri-port areas to give detailed information about events and the conducts to keep for all entry/exit vehicles. Evidently, the main problem of creating an actual information systems based on smartphone applications (Gallicchio et al., 2020) is the necessity to have the corresponding apps installed on the smartphones of private citizens. To overcome this issue, a solution to encourage installation and use is strictly necessary (Petri et al., 2016).

Owing to these considerations, in the present paper an integrated system is presented that permits a continuous communication between drones and port users for emergencies and unscheduled events responses. The system is currently being tested in an on-going experimentation in the Portoferraio Municipality, where is located the Elba Island main port.

The paper is structured as follows: paragraph 2 presents the state of the art of the technical and managerial solutions that have already been proposed to introduce UAVs in ports and peri-port areas. Paragraph 3 introduces and discusses our novel approach for the technical and managerial solution for emergencies and unscheduled events responses. Finally, the outcomes of the research are highlighted in the Conclusions.

2. State of the art

In October 2019, the European Commission and the European Investment Bank (EIB) announced the launch of a "European Drone Investment - Advisory Platform" to support innovation and investment in drones. The initiative aims to improve access to EU support in this field, and to develop a better understanding of the market to increase investments in this emerging field. Several European projects specifically focus on application of UAM for emergency applications:

1. AiRMOUR project (Airmour.eu Project, 2020) focuses on the use of UAM for doctors and medical supplies, in order to develop a UAM toolbox for aviation and urban authorities. The project includes the cities of Luxemburg (simulations), Stavanger, Helsinki and Nord-Hessen (demonstrations);
2. The main objective of MOBNET project (Echeandía, 2018) is to locate isolated victims during natural disasters and situations of emergency such as earthquakes, hurricanes or large snowstorms. MOBNET will also help first responder services to find lost people in general;
3. AMBULAR (Yury, 2020) has a different focus, with the goal of developing an eVTOL (electric Vertical TakeOff and Landing) air ambulance;
4. SAFIR-Med (Safe and Flexible Integration of Advanced U-Space Services for Medical Air Mobility) (Safir-med.eu Project, 2020) aims at real demonstrations in collaboration with hospitals, focusing on demonstrating the operational safety level.

The most recent UAM case studies (Gillis et al., 2021) that present the use of drones in port areas are the following ones:

1. the Port of Antwerp (Belgium), after a first risk analysis and situation sketch, uses drones for surveillance flight (terminal container and oil spill inspection);
2. the Port of Amsterdam stimulates and facilitates emerging technologies, such as the development and deployment of drones. It uses sailing drones for various tasks, such as scanning the bottom (hydrography), measuring water quality or inspecting hard-to-reach locations, such as under jetties and quays. The Port of Amsterdam is also experimenting sailing and diving drones and has partially explored the impact this technology may have on its own nautical operations in a pilot in 2019. Just as for sailing drones, the port authority also foresees many opportunities and applications for flying drones;
3. the Port of Rotterdam is studying different drone use cases: monitoring incidents and water pollution measurements, firefighting, surveillance and inspections, the supervision of port operations, security, monitoring damage, inspecting installations at terminals. Moreover, drones can also be used for the construction and maintenance of port infrastructure such as roads and bridges, and to monitor emissions;
4. the Balearic Islands Port Authority (APB) has initiated a pilot programme to control and manage the public port domain by using drones in the port of Alcúdia to supervise port operations and environmental control. Currently, they perform a weekly flight operated by a specialized company that provides a video and 750 orthophotos.

There are a lot of private companies specializing in providing drone-based services for port areas. In most cases, these are solutions to connect port operations on the ground and at sea, with insights from the sky (the commercial income for UAM is estimated to increase of 200%, as evidenced by the Global Urban Air Mobility

Project, 2019). For example the international company Airobotics is proposing solutions in the areas of Port Monitoring and Traffic Control (aerial situational awareness beyond the shoreline, for purposes of vessel navigation and security), Environmental Health and Safety (rapid emergency response, supporting intelligent decisions in time and safety-critical situations and environmental and ecological monitoring of on-site processes and surrounding areas) and Operational Oversight (routine and on-demand equipment inspection, inventory volume tracking of outdoor bulk material storage areas, general monitoring of processes and statuses throughout seaport). One of the most interesting commercial use of drones in port areas has been proposed by Willensem, a company in Singapore. The company has been able to obtain test authorisation for an "Agency by Air", with which they intend to supply ships with small spare parts, documents, supplies or even consumables for 3D printers. This system will replace shipments by boat in order to reduce economic costs, lower pollution, and ensure faster and risk-free trans-shipment-delivery. In Chile, APM Terminal works with drones (Figure 1) for general supervision operations and risk detection.

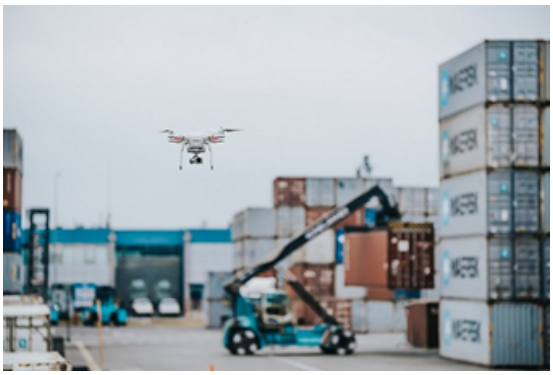

Figure 1. Typical application of drones in a portual area

Their devices have a loudspeaker built into the RPAs, allowing the operator to give directions to truck drivers or other people on the ground.

It is evident, from the above mentioned solutions, that there is still a void to fill. Indeed, there is no known solution (at least as regards the authors) referring to the continuous communication between the authorities and the port users for managing emergencies and unscheduled events. Today, most ports and peri-port areas already present a number of emergency management mechanisms and procedures, but timely and event-driven communication directly involving all port users is in general unavailable. As already stated, at present most information is provided to onboard passengers mainly by means of internal microphones or by direct communication, while off the ship this task is mainly entrusted to Variable Message Panels located in strategic nodes or by dedicated personnel. These solutions are generally insufficient in emergency situations or in the case of traffic diversion, that should be differentiated by vehicle type, with the need to send passenger cars to areas other than those reserved for freight vehicles and, above all, heavy vehicles with dangerous goods. Moreover, we need to find a way to provide different information to different port users and to differentiate it based on of the location and the consistency of the "passenger clouds". In particular, it is necessary to avoid crowding, traffic congestion and bottlenecks, that could endanger the safety of people located in the interested areas and worsen the emergency situations.

Therefore, the present paper proposes a solution that uses drones, RFID sensors and smartphone applications (twined with appropriate incentive actions) that is able to continuously monitor the situation in ports and peri-port areas, providing timely, valuable and effective information to both private users and port authorities.

3. The proposed experimental solution

Starting from the previous UAM state of art analysis, this paper proposes a novel approach for an integrated information system and presents the on-going experimentation in the Portoferraio Municipality, where the Elba Island main port is located.

The main aim of the research is to create a continuous communication channel between drones and port users for emergencies and unscheduled events responses. The continuous link among drones and tourists is created by means of active RFID tags located on the drones (see Figure 2).

Figure 2. The Active RFID tag (source: IDNova srl)

Actually, these tags are equipped with a battery having a duration of about six years and a weight 0.2 kg. Each drone is capable of sending messages to all the smartphones located in the surroundings (at present, tags can be detected from up to 80 meters). Messages are collected, formatted and shown as notifications by means of a proper smartphone application.

Evidently, the main problem of creating an actual information systems based on smartphone applications is the necessity to have the corresponding apps installed on the smartphones of private citizens. To overcome this issue, a solution to encourage installation and use is strictly necessary. Therefore, we decided to integrate it

within a tourist information and rewarding platform, regarding the Points of Interests (POI) and the road danger points of the Elba Island. A number of active tags, identical to those mounted on drones, are located in the Elba Island main tourist points (as, for instance, Napoleone's house, Elba Mineralogical Museum, Archaeological Museums, Elba main beaches) and near road danger point in order to deliver information about significant tourist nodes or alerts for eventual traffic or emergency issues. When a tourist is near a POI, the app receives the message from the RFID tag and enables the dynamic information, that can be a website regarding the touristic point or a Virtual Reality reconstruction or other information. The system uses the same back-end (an evolution of the Rotas Vision system) to insert and manage all the notifications (Figure 3).

The platform also provides a system to monitor tourist flows (Figure 4), the gatherings of tourists and to manage the same flows, encouraging the less frequented tourist hubs and trying to reduce crowding and traffic situations. This is done thanks to the connection with the GOODGO reward system (Petri et al., 2016, Gallicchio et al., 2020), which allows to reward those tourists who visit the suggested tourist points and to constantly weigh the credits provided by each location, based on the recorded attendance. Tourists get credits for reading and using the multimedia contents connected to the various tourist sensors and with these (as shown in the internal dashboard reported in Figure 5) they may book vouchers with which, for example, they can move to those local shops adhering to the reward system and buy discounted products. The system also becomes a way of relaunching the local economy and retaining tourism.

From the tourist point of view, the application is the entry point to an integrated, interactive information and rewarding platform, easy to access by means of the smartphone Bluetooth sensor. In this way the communication link is established and it may be useful for drone information in all emergency cases.

4. Results and Discussion

The on-going experimentation in Portoferraio and Elba Island is currently showing the first practical results. In particular, it provides a clear idea of the application value. Although at the moment it is only available as an experimentation pilot program, with a limited number of connections and drones, the software platform and the communications among the drones and the smartphones have confirmed the technical feasibility of the proposed solution.

From the managerial point of view, the incentive system remains the only way to make sure that tourists and private citizens generally agree to actually install and use the application. However, since the system guarantees the privacy of the person, being sufficient to close the Bluetooth connection to stop any communication with the system, this should be a solvable issue.

According to some interviews and questionnaires, people have confirmed their interest in the solution. Notifications sent during the testing stage and related to fictitious events or to real traffic situations or to other problems in the territory were delivered promptly and reliably to the smartphones concerned, confirming the goodness of the proposed solution. Some aspects that still remain to be deepened relate to the average and minimal distances among the drones and the smartphones and to any sources of interference that could disturb the signal, especially if the recipient is moving inside a car. All those aspect will be investigated in the next future.

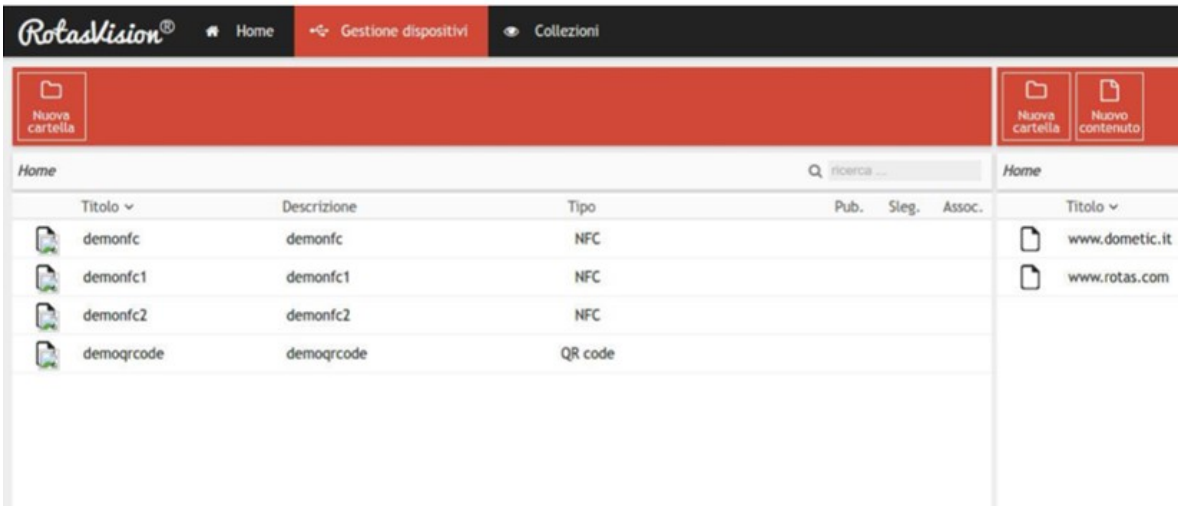

Figure 3. RFID message management portal (source: IDNova srl)

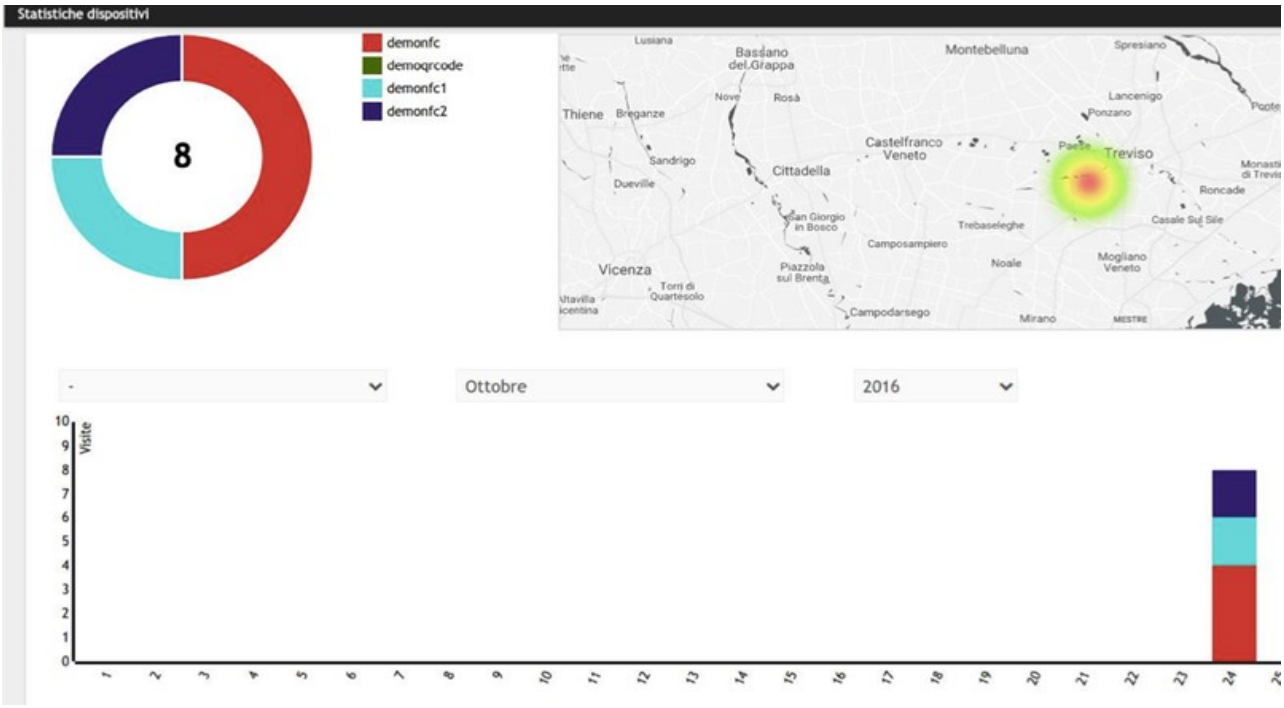

Figure 4. Attendance monitoring by single sensor dashboard (source: IDNova srl)

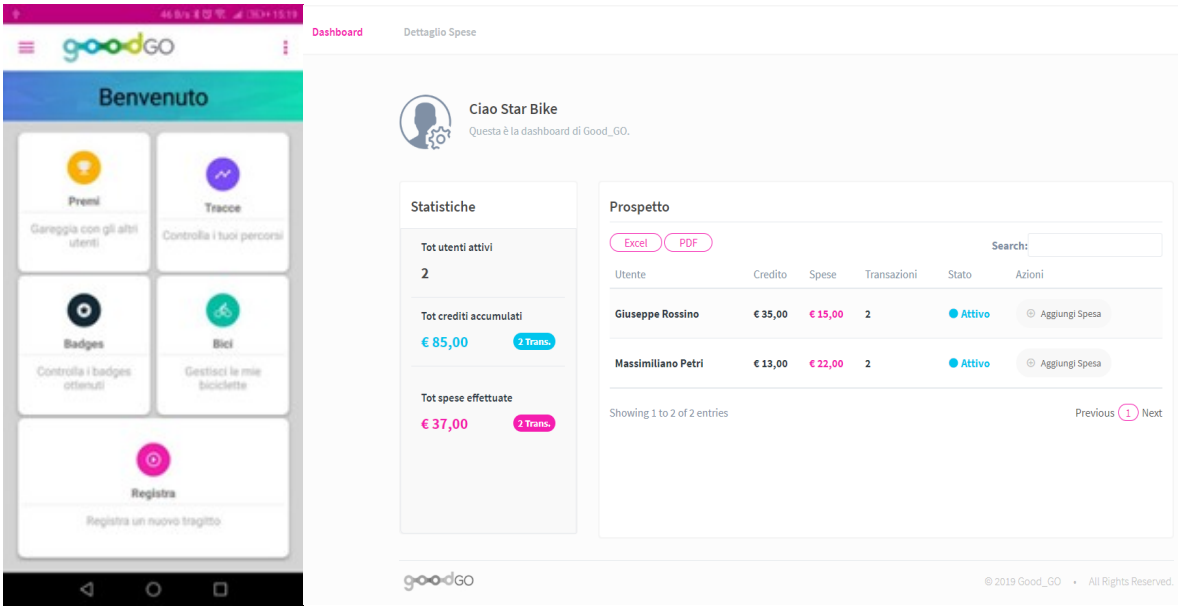

Figure 5. The rewarding dashboard (shops section) and the linked GOODGO App (source: EcoGeko srl)

5. Conclusions

The present study presented a novel integrated system to provide information to tourists entering/exiting port areas in an emergency and/or while managing delays or events that modify the scheduling of the port service. This is a primary need that is often little considered by the managers of the port areas and the road network accessing them. Incentives are provided by means of a rewarding system that can encourage the use of the solution. A low-cost emergency management system for tourist flows in ports has been developed and tested, integrating it with a system for monitoring, information and rewarding of tourist flows. This system is based on advanced ITS technologies that use rugged active RFID Tags in the 2.5 GHz band and Urban Air Mobility equipment, in particular drones.

Besides, there are a lot of possible features to study and verify:

- Privacy preservation (this is why we have not used GPS tracking with mobile phones to manage the monitoring of tourist flows);
- Acceptance of the system from all involved stakeholders like:
  - Portoferraio Municipality (that will disseminate the action);
  - Tourist stakeholders (tourist associations and others);
  - Local Shops and commercial associations participating to the rewarding system;
  - Ship's owner (that will communicate to passenger about the tourist platform).

The final verification of the system will be done in the nest months by verifying the nodes frequentation level and the percentage of tourists having installed the app and connected their Bluetooth sensor. Moreover, there will be a thorough testing of the communication between drones and mobile phones to understand the real communication range and to verify the feasibility of the whole solution.

Aknowledgments

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