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Serious Games, Simulation and IoT/IIoT for improving harbor performance

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Abstract

Shipping and ports are strategic areas for our country and their safety is essential to guarantee supplies, as well as competitiveness and sustainability in this sector. Furthermore, the even stronger connection with urban areas and the evolution of the connection structures with the port make it necessary to have a strategic plan capable of maintaining safe ports. Many stakeholders are involved in respecting port safety and security, a cross-cutting issue that requires coordination, collaboration and common understanding of complex interlinked situations and related risks.

Keywords: Port Safety, Artificial Intelligence, Modeling & Simulation, Serious Games

1. Introduction

Port security assessment is essential to ensure the solidity and sustainability of maritime traffic, of the connections with the cities and of the cities they serve. However, ports are very vulnerable and potentially subject to multi-layered threats due to their role and the complex service systems they need should be improved against potential threats and risks using innovative solutions (Alyami et al. 2019). For example, the 2002 US west coast blockade cost $ 20 billion in 10 days; the explosion of the port of Beirut in 2020 created 300,000 homeless in a few seconds, repeating in a more devastating way what happened in 2015 in Tianjin even if the blockade of the Suez Canal last year cost about 10 billion dollars. The impact of covid-19 on the health and safety measure of Chinese ports that same year was even more devastating and brought the entire world economy to a standstill with extensive damage and demonstrating how modern economies depend on continuing flow of goods through ports and how vulnerable they are to attacks and problems at their main logistical nodesFrom this point of view, it

emerges the necessity to address Safety and Security in a common way as an Extended Maritime Framework over multi layers and multi domains that combines Physical and Cyber World, Sea and Land, Air and Space with their mutual interdependencies respect accidents, malfunctions, errors and malicious activities. The security and safety of a port, which ensures its connectivity and stability of operation, depends on the ability of its operators, managers and authorities to identify and assess risks, promptly detect and effectively assess possible symptoms and choose the best mitigation actions to take. For this reason, The research goal is to use AI in order to fuse data from heterogeneous networks, sensor grids and digitalized processes and to connect with models and simulators able to identify risks and evaluate potential impacts to reduce vulnerabilities, prevent errors and accidents and mitigate their impact. From this point of view a crucial part of this papers is also to introduce in this Solution the mangers, operators as well as all subjects involved in Port Activities thanks to extensive use of Extended Reality (XR combining Virtual and Augmented Reality) that could allow to capture observations through IoT as well as to provide feedback and information to stakeholders for identify and react to potential risks.

2. State of the art

Port security requires high level of attention given the incidents that have occurred in recent decades. The vulnerability of ports is also related to cyber-attacks (König et al.,2019). Ports and port facility stakeholders around the world are reporting measurable increases in cyber threat activity, particularly since the outbreak of the COVID-19 pandemic and current Ukraine crisis as well as Hybrid Warfare scenarios. In facts, the marine sector experienced a fourfold increase in cyber-attacks between February and May 2020.

Serious Games and simulation are nowadays widely used for training and education in different sectors and at different levels (Bruzzone & Massei, 2017). Ports have always represented strategic keys in economic, military and political sectors. Training of operators in port and container terminals through simulation has been a successful modality for high-risk and costly activities (Bruzzone et al., 2011). However, staff training must be integrated with the large amount of data that can be collected and processed by Data Fusion and Data Analytics tools capable of integrating production, process, maintenance, dangerous procedures, malts, alert and personnel activity data. (Tsou, 2019). It must be analyzed and modeled in order to integrate it with the other data (Bruzzone et al. 2007), and it becomes even more crucial if problems develop and the action of the operators results in the good or bad outcome of the measures taken (Petrillo et al. . 2017). With the use of cloud computing, Internet of things, wireless sensors, social media, fast storage and retrieval, etc. We can now integrate a large amount of data on every aspect of a business. Industry and companies are adapting to this concept and thanks to the processing of this data it is possible to reduce the risks of accidents and delays (Choi & Lambert, 2017). Nowadays, however, due to the use of BigData, artificial intelligence ,IoT Systems, there is also a growing risk due to cyber attacks, so it is therefore essential to have a service able to support and face these risks as well. Preventing future IT risks through an algorithmic model that uses analysis and statistical machine learning is a current solution that can allow us to avoid unpleasant inconveniences (Subroto et al. 2019).

3. Conceptual Model

This Project aim is to create an Innovative and Intuitive Solution integrating AI, Simulation and XR in order to obtain a clear understanding of the port vulnerabilities and risk, through the use of the data from the field. The system is able guide decision makers to assess risks and threats and to reduce accidents and damage guaranteeing high efficiency. The use of innovative simulation allows to evaluate interaction among potential risks and to assess the effect of different decisions or mitigation options and thus to support decision-makers in process re-engineering as well as in crisis management. The Models proposed in the paper will create a virtual world able to increase the experience of decision makers, to make them more aware of the risks, threats, opportunities. The possibility to simulate different scenarios through the use of innovative techniques of Modeling & Simulation will contribute to the improvement of efficiency, safety as well as risk analysis and optimization of processes. Indeed, in order to do this, it is essential to use new generation AI, Models and XR able to combine the different information from the different actors, but also data from sensor networks and from IoT and IIoT in the field, allowing them to grasp these criticalities and react promptly by providing timely indications to those involved and guiding them: this obviously requires a capacity of data fusion, processing and understanding of the situation using the best Artificial Intelligence (AI) techniques, and advanced interoperable Simulation capabilities to provide elements to the AIs on possible future risks. XR (Extended Reality) it is also critical to make the context intuitively usable by different users and to guide them to prevent and/or to manage of the crisis.

4. Implementation

The goal of this Research is the development of an intelligent system integrated with M&S (Modeling and Simulation) capable of identifying the most effective lines of actions in the Port to mitigate risks. In particular, the system will be capable for proper risk assessment and that is suitable for the analysis and evaluation of current and simulated situations. To

reach this goal through the use of Modeling & Simulation and AI generates different proposals to be tested over the scenario and to identify and evaluate the value of the different target functions related to the decisions. The research will consist in Port risk Analysis and in the investigation of the state of the art in the international technical-scientific literature, and trough the experience of technical experts. The Artificial Intelligence algorithms and in particular Machine Learning and Genetic Algorithm, will be to identify best strategies and actions, as well as to develop a decision support systems. This system will be based on the situation awareness obtained from current conditions and future planning strongly reinforced by the AI. and integrated by historical data and expert estimates. In this way it will be possible to quantify the risks based on the combination of multiple factors (e.g.storage of two substances that present the low risk when separated, but much higher one if mixed together; presence of cyber alerts, inconsistency of storage locations, etc). Indeed the risk assessment is strongly based on the use of simulation to predict developments of the situation based on the surrounding conditions. Indeed, simulation allows also to introduce the impact related to the human factors, such as fatigue caused by work, stress as well as adverse weather conditions. In addition, the AI will be used by employing Intelligent Agents (IA) able to reproduce the actions and reaction of the different players within the scenario, such as operators, authorities, external actors, internal threats, coordinators and supervisors. These IA will simulate the different players that, by dynamically perceiving the evolving status of the situation and reacting to it, determine the evolution of the system.Finally, the augmented reality application aims to provide decision Makers with quick and intuitive access to critical information needed to organize activities and plan investments to reduce risks and vulnerabilities.

5. Conclusions

The paper proposes an innovative solution based on the combined use of Artificial Intelligence (AI) and Simulation in order to create a platform able to identify most promising actions to reduce vulnerabilities as well as to prevent crisis and mitigate their impact. AI allows to identify most effective decisions related to improve safety and security in port over multi domain threats including accidents, cyber attacks and general crisis. Through the simulation of different scenarios is possible to evaluate the performance of each line of action in order to support the optimization and to present to decision makers the results.

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