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A novelty design of a smart road for crowd prediction and prevention SRCPP

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ABSTRACT

The portable smart road is a mobile road that can be installed on roads that had crowd accidents in the past or roads with a high probability of crowd. The product is designed to predict the intended crowd based on sensors fixed at certain points along the road path. Once the sensor is activated, the Field Programmer Gate Array (FPGA) sends a signal to trigger motors to block the road from reverse movement and open emergency paths to evacuate pilgrims. At the same time, the FPGA sends a signal to a smart application (webpage and/or phone application to the organizers to take further actions). The apps which been installed previously in the organizer smartphones. The apps provide alarm, crowded area number, quick call, chat, and gate status.

1. Introduction

The kingdom of Saudi Arabia is in the surge of expansion in several economic, political, and social areas. Crowd control is a public security practice where large crowds are managed to prevent the outbreak of crowd crushes. The product of this project can be implemented in the Hajj and other new developments including the Alqadiah project, sports events, and any other gathering with expected crowds.

For Hajj, the product can help to prevent pilgrimage from congestion due to reverse crowd. The product of this project will help smooth direct pilgrimage in direct ways to prevent reverse walking which will prevent any fatal congestion. The same principle can be applied to any crowed by directing the crowed in one specific direction. This will help to manage and prevent fatal crowd clashes due to reverse walking direction. For these reasons and for saving the lives of pilgrims and the citizens. The care that the government of Saudi Arabia is considering for the safety of its citizens and visitors we believe this project is with a very high priority in the field of crowd management due to its impact on saving people's lives and can be exported to other countries in the production stage.

Due to the road crowd during Hajj, which might have resulted in the deaths of pilgrims. In addition, crush and stampede in crowded places such as in Mecca during Hajj is a serious issue that caused deaths. From this point, we think that the road crowed is one of the series of problems that needs a solution. So, we come up with an idea that we called "A Smart Road for Crowed Predication and Prevention (SRCPP)."

Using the traditional way where groups of people are standing to manage crowded places is not always sufficient even that the number of the groups is high. Therefore, artificial intelligence can have rolled out to manage crowded places and take proper action to prevent any accidents. In addition, artificial intelligence is able to provide an analysis of the target place and situation status every certain time. The main aim of the research is to design a portable smart road that able to predict crowded and prevent accidents that can be used during the pilgrims' time (Hajj). The portable smart road is a mobile road that can be installed on roads that had crowd accidents in the past or roads with a high probability of crowd. The product is designed to predict the intended crowd based on sensors fixed at certain points along the road path. Since the project consists of many stages whether electrical work, mechanical work, and security. In addition, since the novelty of the design, a patent can be obtained. At the end of the project, we should have a new product of portable smart road for predication and prevent with different size and length as requested. In addition, one of the main properties of the product is, a

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normal truck can carry the product to any place when it can be built in the location.

As we mentioned above, the traditional way that used for crowded management in Hajj where the high group of people is standing to help pilgrims to pass smoothly. However, this way is not always sufficient. On the other hand, and based on the literature review that has made, still there is a lack of knowledge regarding the crowded management especially for high crowded places in certain times such as in Hajj. In Hajj, the pilgrims assembly at a certain time and leave at a certain time which makes the situation even worse. Yamin et al. (2008) described Crowd Management with RFID and Wireless Technologies. This technology is required an RFID chip as well as a database for each person in order to manage the crowd and provide more features such as tracking the person when he lost the location.

However, the author did not mention the road crowed management. Yamin et al. (2008) stated how hard is to identify and track individuals in large congregations such as in Hajj. A framework was presented that offers the services such as health information, places of assembly, and police location. However, the framework is required a huge database and gathering information. In addition, the authors did not mention how the framework will help during the crowded. Ma et al. (2017) developed a method where the image is used to estimate the crowd count. This method is based on convolutional neural networks that have been shown in many computer tasks. Mitchell et al. (2013) described their method of using RFID technology to track the movement of pilgrims. In addition, a location-aware mobile solution is integrated. The application will be available on smartphones. This service is also providing location-based services for Hajj. However, the authors have not stated a solution for the road crowded management.

Mantoro and Mahmud (2012) proposed a framework to track pilgrims in Hajj pilgrims in a crowded pervasive environment using a system called Hajj Locator. The Hajj Locator prototype is based on an SOS mechanism to monitor pilgrims while performing Hajj. Saeed et al. (2016) described an identifiable crowd-monitoring framework called iCrowd. The purpose of this framework is to collect, identify, infer, analyze, store, and recovered the real-time location information of each of the pre-registered pilgrims. In addition, it provides a digital view of the crowd in near real-time. A comprehensive survey of crowd modeling and simulation studies that referring to Hajj showed in Owaidah et al. (2019). The connection between shared social character and giving support to others was tougher in the plaza than in the Mosque and recommends the role of place and space in modulating processes of cooperation in crowds. These discoveries have suggestions for disaster hazard reduction and for applications such as computer simulations of crowds in pilgrimage locations. This article is a portion of the theme issue 'Interdisciplinary approaches for uncovering the impacts of architecture on collective behavior' (Alnabulsi et al., 2018). The bits of knowledge about the reasons that caused a vital crowd is necessary for the organization of more secure mass events. In specific, they permit one to get it where and when a crowd accident tends to happen. They have moreover driven to organizational changes, which have guaranteed a secure Hajj in 1427H (Helbing et al., 2007).

During the annual Hajj pilgrimage, a huge number of pilgrims endure passing as a result of misfortune and normal causes. Others, new with the area, getting to be misplaced with the crowd. As a result, crowd control and communication between pilgrims and those responsible for the provision of services remains an important issue for both the local authority and the pilgrims themselves (Latif et al., 2016). Khozium et al. (2012) proposed a decision system to spread out a prior observing exertion that allows for near observing and control of crowd places. The authors described in the paper progresses on crowd management with a particular interest in high congestion of people such as Hajj and Umrah. This survey points to allow considerations to these curiously future inquire about zones based on examination of current visual reconnaissance investigate (Salih and Simsim, 2014).

The portable smart road is able to predict the intended crowd based on sensors that are fixed at certain points. Once the sensor is activated, that controller (FPGA) sends a signal to trigger the motor to open emergency paths to evacuate pilgrims. At the same time, the controller (FPGA) sends a signal into the smartphone of the organizers to take further actions. The apps have been installed previously in the organizer phones, which contain alarm, crowed area number, and quick call.

2. The principle of a smart road for crowed predication and prevention (SRCPP)

The proposed Smart Road for Crowed Predication and Prevention (SRCPP) is designed to predict the intended crowd based on sensors fixed at certain points along the road path. Fig. 1 shows the schematic diagram that consists of three main parts: The smart road, the controller, and the organizer's mobile application.

The smart road contains different hardware devices such as sensors, motors, and emergency doors. The mechanism of the smart road is based on sensors that are fixed in certain places. When the walk direction of the pilgrims reverses, the sensor sends a signal into the controller to take action. Immediately, the controller sends a signal to trigger the motors to block the area determined and to open the emergency paths for evacuation. At the same time, the controller sends a signal into the organizers' apps for further actions.

The mobile application has been created to monitor and control crowded roads. We design and simulate the smart road using a webpage to show

the function of the sequences. After that, the organizer apps develop and test using android studio.

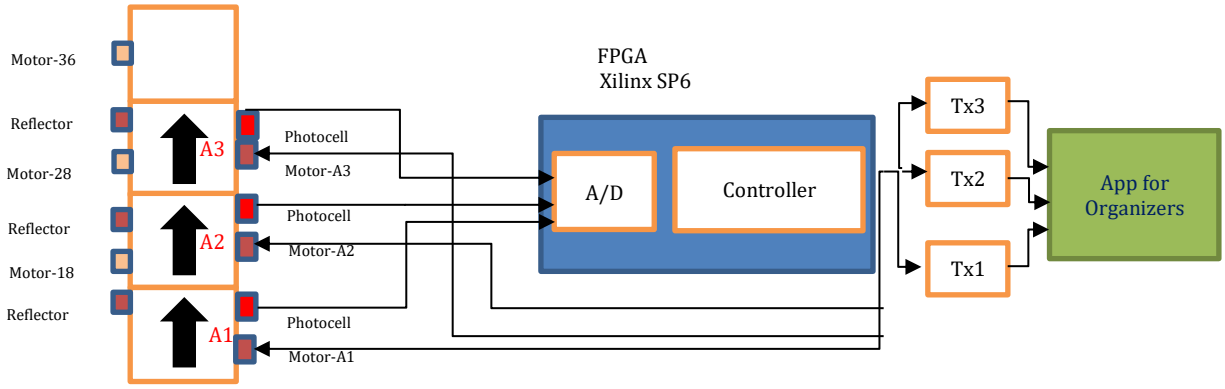

Fig. 1: The schematic diagram of SRCPP

3. The hardware implementation steps of SRCPP

The project uses a Spartan-6 FPGA board as a controller. Fig. 2 shows the steps of the hardware implementation of this project.

- Simulink model: Simulate and test the model until we get the desired result.
- Xilinx system generator: Convert the Simulink model into real-time simulation and test it until we get similar results.
- Integrated synthesis Environment (ISE): This tool is used to implement the model by generating bitstreams. The bitstream is downloaded into the FPGA board.
- Spartan-6 FPGA board: We test the hardware model and compare it with the real-time simulation.

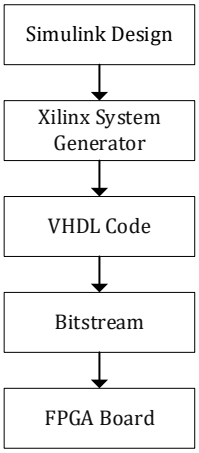

Fig. 2: The hardware implementation of SRCPP

4. Conclusion

The aim of this project is to develop a real-time simulation and monitoring mechanism for Massive Crowd Movement with early warning capabilities. In addition, to build up a prototype of the portable smart road that can be easily carried using a small truck. The portable smart road is a mobile road that has been designed and simulated based on a webpage. Mobile applications for the organizers have been created using Java. The mobile application has been created to monitor and control crowded roads. We design and simulate the smart road using a webpage to show the function of the sequences. In addition, the organizer apps develop and test using android studio. The challenge we ran into is that the prototype of this project needs more time, tools, equipment, and material to achieve it as desired.

Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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