# COVID-19 RESEARCH NEWSLETTER

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Agent-Based Modeling of the Hajj rituals with a possible spread of the COVID-19

As the Hajj season approaches and with the ongoing COVID-19 pandemic, Muslims around the world are expecting some measures to protect the pilgrims during their Hajj rituals journey. These measures should take into consideration the nature of this infection disease. The majority of the infected people are asymptomatic (infectious but do not show symptoms) and the fatality is very high in elderly people and people with comorbidity.
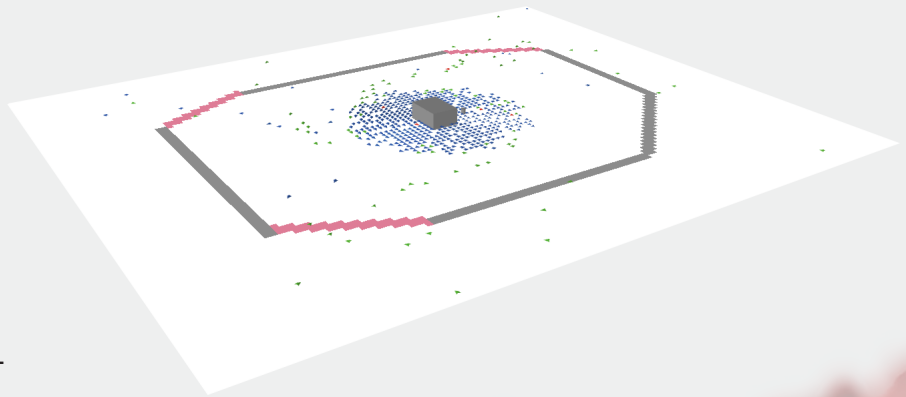
Among the measures that the Saudi authority could implement are to: reduce the number of people going to Hajj this year, require temperature testing at the entrance of mass gatherings (for example Tawaf and Ramy al-Jamarat) and impose mandatory surgical masks for all the pilgrims. However, it is not clear how efficient are such measures in protecting the pilgrims from COVID-19.

In this work, we investigated, *via* an Agent-Based Model (ABM), the efficacy of these measures during the Hajj rituals. The model takes into consideration the spatial nature of the Tawaf and Ramy al-Jamarat and the nature of mobility of the pilgrims during these rituals.

Our simulations showed that the efficacy of only measure enough to contain possible infection of COVID-19. To assure high protection of the pilgrims and lowering the virus prevalence, it is required to have 90% face mask efficiency. The combination of high face mask efficiency and temperature testing should lower the virus prevalence to less than 5%.

The model can also include different features such as a super spreading event which is one of the possible features of COVID-19.

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