

# Dynamical analysis of spread of online misinformation and a delayed optimization technique

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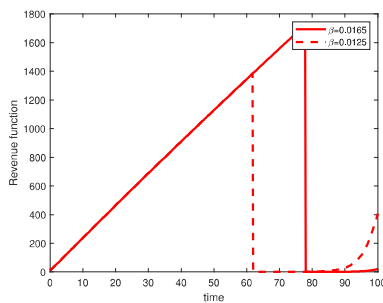
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**Abstract.** The Spread of online misinformation has momentous impact on people's daily life. Nowadays with advent of various social media platforms, the twisted news targeting the public opinion have started to disseminate significantly fast and in wide scale. Sometimes it really induces panic or influences mass perception [1, 2] that demands to study the dynamics of rumor spread [3, 4]. On the basis of attitudes of netizens toward misinformation, here we have proposed a delayed Susceptible-Exposed-Infected-Recovered (SEIR) model to study the dynamics of propagation of misinformation, considering four categories of netizens, namely, ignorant population (people, who are still uninformed of the misinformation), exposed population (who have encountered misinformation, believed it and pass it to lesser number of people), active spreaders (who create and deliberately spread misinformation on internet among large number of people having some vested personal or group interest), aware (people who are aware about the misinformation, do not spread and ask others not to spread). Here the delay is incorporated to signify that the online misinformation usually lacks credibility and it takes time to persuade netizens to believe it or circulate it to others. Next the critical value of the spread of misinformation (spreading threshold,  $\mathcal{R}_0$ ) is derived, that gives the condition of prevalence of misinformation. With the help of  $\mathcal{R}_0$ , we analyze the local stability dynamics for the corresponding non-delayed system. For the delayed system, the system bifurcates from its stable condition, when the time delay crosses a certain value. Also the streaming rate of misinformation destabilizes the system when it reaches its threshold value. To counter misinformation and inhibit its spreading process, an optimization technique with the help of mainstream media is formulated and solved by Pontryagin's maximum principle with constant delay. We use mainstream media as it easily reaches a large number of people and is efficient to control misinformation by promoting logical explanation behind it or broadcasting authentic news. Finally some numerical results are presented to validate our analytical findings.

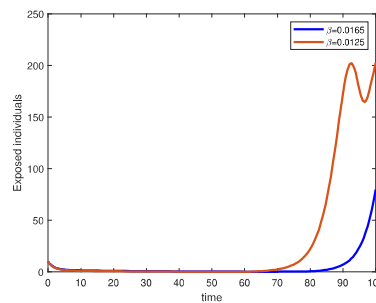
**keywords:** Online misinformation, Spreading threshold, delay, Hopf bifurcation, Optimal control

## Results and discussions

To enhance the theoretical analysis some plots are simulated using MATLAB2018. The impact of some significant parameters with diverse impacts on  $\mathcal{R}_0$  are discussed. We have also demonstrated how the bifurcation threshold value of spreading rate of misinformation changes with different delay values. And the following figures demonstrate impacts of control on our system. First figure presents the variation of cost function with slight change in  $\beta$ . One can see that, when the transmission rate increases a bit, the execution of control is



(a) Comparison of evolution of cost function with different values of  $\beta$  after application of control.



(b) Exposed population with higher value of  $\beta$  decreases to lower value after application of control.

also increased. But from the first figure, we see that the cost function corresponding to higher transmission rate is finally lesser than the cost function corresponding to lower transmission rate. Second figure shows the impacts of control on exposed population which depicts that the control is effective to control the rumor believers, the exposed individuals. Here control is effective only for exposed class, because control cannot stop deliberate (active) spreaders. We have proved that in case of an emergency caused by any sensitive misinformation, the control using mainstream media is efficient to inhibit the spreading rate and bring back the stability of the system with minimum cost.

## References

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