Summary:
The study focuses on the engineering constraints and challenges faced by China's Chang'E-7 lunar rover during its exploration of the Moon's south polar region in 2026. The lunar polar regions are vital due to continuous illumination and shadowed areas that may trap water and other volatiles. The research analyzes factors such as polar illumination conditions, slopes, and electric fields to inform landing and sampling-site selection. Using a 3D model created with the Spacecraft Plasma Interaction Software, the study explores the rover's behavior in different operating environments, considering solar altitude angles and surrounding terrains. The results suggest that strategic site selection, such as positioning the rover upwind of elevated terrains or craters, minimizes charging effects.

Contribution:
The study contributes valuable insights into the complex lunar polar environment, addressing the interplay of illumination, terrain, and electric fields on rover operations. It emphasizes the importance of real-time path planning for rover exploration, considering dynamic conditions. The proposed rover traversing strategy provides practical guidance for minimizing charging effects and optimizing exploration efficiency.

Methodology:
The research employs a comprehensive approach, combining engineering constraints analysis, 3D modeling with the Spacecraft Plasma Interaction Software, and simulation of rover behavior under varying solar conditions. This methodology enables a detailed understanding of the challenges posed by the lunar polar environment.

Limitations:
The study acknowledges limitations, including the need for higher-resolution surface terrain integration into the modeling. The complex terrain at the meter scale is considered, but further refinements in the model may enhance accuracy. Additionally, the material properties of the rover and their impact on charging effects warrant further investigation.

Future Scopes:
Future work should integrate higher-resolution terrain data into the Spacecraft Plasma Interaction Software model to refine the 3D rover interactions. This improved model can guide surface traversing and sampling plans for in situ geological investigation, optimizing solar energy utilization and minimizing risks for future rover explorations in lunar polar regions. Further research on the material properties of the rover and ground experiments in simulated polar environments can enhance the understanding of the charging effects and contribute to mission success.