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A MACHINE LEARNING APPROACH FOR ASTRONAUT MONITORING AND TRACKING DURING SURFACE EXTRAVEHICULAR ACTIVITY

Abstract

EVAs are essential to accomplishing the scientific goals of planetary surface exploration. During EVA, astronaut location is critical information for both the astronauts in the field and habitat, and the support staff in Mission Control. In normal protocol, location information is relayed verbally amongst EVA astronauts and support teams through radio communication, as well as via active monitoring of helmet camera video feed. This reliance on manual communication can be inaccurate and cause confusion. During EVA, the astronauts can be under considerable physical and mental stress, putting their ability to effectively update their fellow astronauts with their status and location at risk. This could cause dangerous delays and errors in the relaying of mission-critical information. Therefore, an automated way of tracking astronaut location has clear potential for increasing the safety and efficiency of EVAs. This project proposes a software system which utilises the latest developments in artificial intelligence and machine learning to autonomously detect and track astronauts via camera footage. This software has been tested using a range of computer vision models on footage captured during EVAs from the EuroMoonMars CHILL-ICE simulation campaign in Iceland last year, and has shown high degrees of accuracy in autonomously detecting and tracking astronauts in image and video data. Evaluated using the metric Intersection over Union, which indicates the level of overlap between the predicted and actual astronaut location with an overlap of at least 50% representing a successful classification, the most accurate model correctly detects the astronaut in 97% of the images. Along with accuracy, model size and detection time were also assessed, as the system must be capable of real-time detection with low storage requirements. For this reason, highly efficient and lightweight detection models were used, ranging from 14MB to 90MB in size, with all models achieving above 90% detection accuracy and approximately 21 to 66 Frames Per Second detection speed. The high accuracy, lightweight model size and real-time processing speeds observed make the developed system promising for future use in the field. Currently at the proof-of-concept stage, the software is now being tested on a portable, lightweight camera with a linked alarm system, with future plans to implement on-board the helmet of an EVA astronaut suit. This system could greatly enhance the safety and efficiency of EVAs and accelerate the scientific return of exploration missions.