## Potential Manned Navigation Methods on the Martian Surface

### Methodology

In depth research was necessary in order to thoroughly examine each possible method of navigation and weigh their advantages and disadvantages. In order to provide a clear comparison of each method a comparison in order of method complexity.

### Methods Considered

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
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<tbody>
<tr>
<td>Sextants</td>
<td>Can be used to calculate position and bearing based on celestial targets at night or known landmarks and a map.</td>
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<tr>
<td>Inertial Guidance Systems</td>
<td>Track the relative location of objects by continuously tracking an object's position, velocity, and acceleration.</td>
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<tr>
<td>Very High Omni-directional Radio (VOR)</td>
<td>Systems can provide both bearing and distance in relation from the receiver to the emitter using continuously pulsing signals.</td>
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<tr>
<td>The Global Positioning System (GPS)</td>
<td>Finds a fixed position of a receiver using four difference satellites each providing a different ping which all together give an exact point of position.</td>
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### Abstract

Mars is the next major step in manned space exploration. With many private companies and government agencies looking to use Mars as a goal it will be necessary to be able to navigate the surface of this dangerous planet. With the many differences between Earth and Mars several navigation methods can potentially be used, and some will not operate at all. Looking into navigation methods such as: maps, compasses and finding bearings using landmarks, to celestial navigation, inertial systems, radio systems, and global positioning systems, can provide the opportune system to be used for an initial manned Martian mission.

### Findings

To compare the listed methods of navigation in a reasonable way cost will not be looked at as it can fluctuate based on model, company, and time creation.

- **Sextants**, without automatized equipment, can provide fixes roughly every half hour based on the experience of the user with an accuracy as close as one kilometer, all this provided markers can be visually seen.
- **Inertial Guidance Systems**, provides continuous updates an initial fixed position using sensors, however, over time without calibrations error adds up leading to possible accuracy issues.
- **VOR**, provides a constant bearing and distance from the receiver to the emitter with accuracy within a degree and several feet respectively, so long as a radio signal can be read with high accuracy and uptime.
- **GPS**, gives updated fixed positions several times a second with an accuracy up to ten feet, but requires four signals from satellites resulting in the need for a satellite constellation of 24 satellites.

### References


### Conclusion

A GPS system would be the most reliable and accurate, however due to the need for a satellite constellation it is unnecessarily overcomplicated for an initial landing. The most suitable navigation method for an initial landing would be VOR or a variety of radio navigation with several layers of back up to ensure safety.