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A method of regolith dielectric constant inversion with Lunar Penetrating Radar onboard the Lunar Rover of Chang'e-3

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The LPR (Lunar Penetrating Radar), which will be the first ground penetrating radar working on the planetary body surface, is one of the most important payload onboard the Lunar Rover of the Chang'e-3 mission. The primary goal of the LPR is to detect the lunar regolith thickness on its route which will be achieved by the 10[U+FF5E]1000MHz probe channel with one transmitter and two receivers. The detecting result is not only related to the delay of reflected echo between the regolith bottom and upper layer, but also the propagation speed which is decided by the dielectric constant of the regolith. This paper introduces a way to calculate the regolith dielectric constant making use of the different delay from the same target between the two receivers. Because of the time accuracy restriction caused by the sample rate this method is just working when the target located in certain depth range. The depth range is related to the distances between the transmit antenna and both the receiving antenna. In the case of LPR the regolith dielectric constant just can be calculated at the presence of target above 31cm depth in regolith. In order to evaluate the LPR performance, a series of ground tests were carried out in Glacier and simulant lunar soil from August to October 2011. In the simulant lunar soil ground test the thinnest soil layer is 15cm, so the soil dielectric constant is calculated using the way mentioned above. The results is in a good agreement with the TDR (Time Domain Reflectometry) measurements, showing the approach introduced here can be used on the inversion of regolith dielectric constant during LPR exploration. The method is also useful in the design of later planetary surface penetrating radar, optimizing the working depth range on inversion of dielectric constant of the upper surface layer.