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A thermal infrared imaging observation system for the measurement of overland flow velocities

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Abstract: Flow velocity is an important physical quantity to characterize the hydraulic characteristics of water flow. The accurate measurement of overland flow velocities has great significance for understanding and modelling the sediment transport and soil erosion. In this study, a thermal infrared imaging observation system (TIIOS) based on thermal infrared imaging technique and computer vision recognition technology was established to measure overland flow velocities. The system consisted of three subsystems including thermal tracer control, image acquisition and transmission, and image calculation. By means of automatic control of thermal tracer, instantaneous image acquisition, image correction, noise removal and centroid determination, the change of shallow flow velocity was dynamically monitored. The observation accuracy reached 98.53% with a standard deviation of 0.004 $m \cdot s^{-1}$, a temporal resolution of 1/9 s, and a spatial resolution of 2 mm. The new system achieved higher precision and accuracy compared to the traditional dye tracing and salt tracing techniques, which can be used to observe the dynamic transport process of thermal tracer more accurately in different time and space scales. Our measurements demonstrate that flow velocity decreases as the roughness of the surface increases. Under the same slope and discharge conditions, flow velocity is the greatest on a smooth glass bed, intermediate on a sandpaper bed, and the least on a synthetic grass bed. The method provided a reliable way to measure the shallow flow velocity, which is crucial in the establishment of slope soil erosion model.

REFERENCES

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