Influence of high dynamic range images on the accuracy of the photogrammetric 3D digitization: A case study

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A B S T R A C T

Small and start-up companies that need product quality control can usually only afford low-cost systems. The main goal of this investigation was to estimate the influence of high dynamic range images as input for the low-cost photogrammetric structure from motion 3D digitization. Various industrial products made of metal or polymer suffer from poor visual texture. To overcome the lack of visual texture and ensure appropriate 3D reconstruction, stochastic image in the form of the light pattern was projected on the product surface. During stochastic pattern projection, a set of low dynamic range and sets of high dynamic range images were captured and processed. In this investigation digital single lens reflex camera that supports five different tone-mapping operators to create high dynamic range images were used. Also, high precision measurements on a coordinate measuring machine are performed in order to verify real product geometry. The obtained results showed that reconstructed polygonal 3D models generated from high dynamic range images in this case study don't have a dominant influence on the accuracy when compared to the polygonal 3D model generated from low dynamic range images. In order to estimate 3D models dimensional accuracy, they were compared using computer-aided inspection analysis. The best achieved standard deviation distance was +0.025 mm for 3D model generated based on high dynamic range images compared to the nominal CAD model.

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Vpliv slik z visokim dinamičnim obsegom na natančnost fotogrametrične 3D digitalizacije: Študija primera

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POVZETEK

Majhna in zagonska podjetja, ki rabijo nadzor kakovosti izdelkov, si običajno lahko privoščijo le poceni sisteme. Glavni cilj te raziskave je bil oceniti vpliv uporabe slik z visokim dinamičnim obsegom za poceni fotogrametrično digitalizacijo strukture iz 3D gibanja. Različni industrijski izdelki iz kovine ali polimera imajo slabo vizualno teksturo. Da bi premagali težave s teksturo in zagotovili ustrezno 3D rekonstrukcijo, je bila na površino izdelka projicirana stohastična slika v obliki svetlobnega vzorca. Med stohastično projekcijo vzorcev smo zajeli in obdelali niz slik nizkega dinamičnega obsega in niz slik visokega dinamičnega obsega. V tej raziskavi smo uporabili digitalno refleksno kamero z enim objektivom, ki podpira pet različnih operatorjev za kartiranje tonov za ustvarjanje slik z visokim dinamičnim obsegom. Da se preveri realna geometrija izdelka, so bile izvedene visoko natančne meritve na koordinatnem merilnem stroju. Pridobljeni rezultati so pokazali, da rekonstruirani poligonalni 3D modeli, ustvarjeni iz slik z visokim dinamičnim obsegom, v tej študiji primera nimajo prevladujočega vpliva na točnost v primerjavi s poligonalnim 3D modelom, ustvarjenim iz slik z nizkim dinamičnim obsegom. Za oceno dimenzijske natančnosti 3D modelov je bila izvedena primerjava z računalniško podprto analizo. V primerjavi z nominalnim CAD modelom je bila najboljša razdalja s standardno deviacijo +0.025 mm dosežena za 3D model, ustvarjen na podlagi slik z visokim dinamičnim obsegom.