

050: The Most Efficient Spectrum for 3D Scanning of Human Skin: Retrofitting a Standard RGB Projector with Three Wavelength-Shifted Red LEDs

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Introduction

Reflection-based mobile 3D scanners are widely used in modern medicine. Light patterns are projected onto the skin, reflected and then captured by 2D cameras. Reflection depends on the light colour and skin type, being strongest in the red to near-infrared range. Conventional RGB projectors emit green and blue light, which reflects poorly, especially on darker skin. This requires longer exposure times, causing motion artefacts and incomplete scans. Brighter projectors are not ideal because they significantly increase costs and power consumption.

Methods

A conventional RGB LED light engine (iViewLimited, IPD1231G) was examined by measuring each LED's power consumption and the reflected pattern was captured with a camera (Thorlabs, CS505MU). The efficiency, as the measure of performance, was defined as the ratio of the captured pattern intensity to the electrical power consumption. This was evaluated on eight volunteers and three silicone phantoms, representing the full range of skin types. Finally, a proposal for optimising the light engine was devised and validated through simulation.

Results

Red-LED pattern projection outperformed green and blue, particularly for darker skin types. It consistently showed the highest efficiency. It exceeded white light by an average of 68.6% for the eight volunteers and by 33.3% for the silicone skin phantoms. A new concept with three wavelength-shifted red LEDs simulates emission across the red to near-infrared range. This enhancement boosts the captured pattern intensity and increases efficiency for darker skin tones by up to 49.3%.

Conclusion

The three wavelength-shifted red LED concept capitalises on the natural reflectance of human skin, surpassing standard RGB white-light setups in both pattern intensity and efficiency. Retrofitting a conventional RGB light engine, rather than building one from scratch, offers a cost-effective yet powerful approach to more efficient pattern projection on human skin. Crucially, it also ensures reliable medical 3D scanning of darker skin types.