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FAST TIME OF FLIGHT CAMERA LENS FOR MOBILE PHONE APPLICATIONS

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FAST TIME OF FLIGHT CAMERA LENS FOR MOBILE PHONE APPLICATIONS

ABSTRACT

A lens design for a TOF camera system is disclosed for use in mobile phone applications. The design is physical hardware comprising a four-element camera lens with an image sensor and infrared (IR) filter. The camera lens system, even with a small 9mm diameter, has significantly high performance in terms of contrast, resolution, field of view and working distance.

BACKGROUND

Traditional time-of-flight (TOF) systems use several approaches to build up a depth map of a scene, as required in 3D imaging. TOF cameras illuminate the whole scene with laser pulses and use a bank of sensors to register the returned light. Sensors that distinguish small groups of light particles such as photons are expensive, thus causing a typical TOF camera to cost thousands of dollars. TOF imaging systems are envisaged on portable devices such as mobile phones for gesture identification. Current lens designs are either bulky or have significantly less performance in terms of contrast, resolution, field of view and working distance. Thus, a better lens design for a TOF camera system is required.

DESCRIPTION

This disclosure presents a lens design for a TOF camera system for use in mobile phone applications. The design comprises a four-element camera lens with an image sensor and IR filter. The lens elements are typically made of plastic while the IR filter is made of special optical glass. Specifications of the components are listed in Table 1. Figure 1 illustrates the lens design.

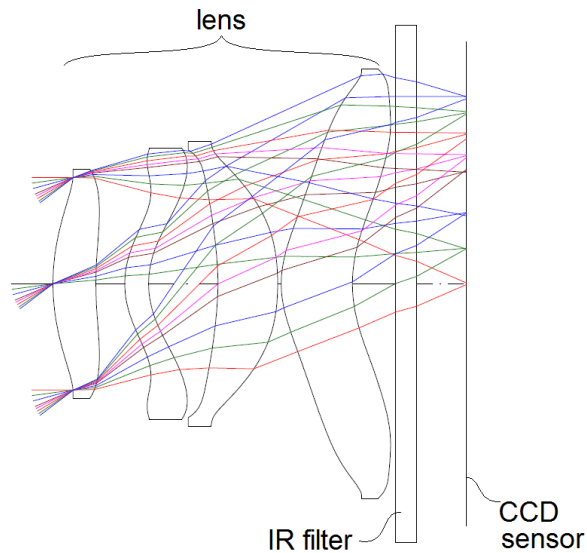


FIG. 1: Design of TOF lens

Table. 1: Specifications of Lens Components

Parameter	Specification
System configuration	Image sensor, IR filter and camera lens.
Wavelength (nm)	840 – 860 (weighted 1,1)
Full Field of view (FFOV) deg	60*45
Sensor active area size (mm)	4.2*3.15(Reference)
Pixel size (µm)	17.5*17.5(Reference)
Resolution (pixels)	240*180
Depth of Field (m)	0.6 - 10
Max Chief Ray angle (deg)	18
F/#	1.6
Worst case MTF (lp/mm) of depth of field 0.6-4 m	0.25
Max lens barrel diameter (mm)	9 (M9 packing)
Total Track Length (mm)	5,1
Lens material	Plastic
IR filter	
Material	Glass
Thickness (mm)	0.3
Transmission (%)	>90

The disclosed infrared lens design has a wide field of view (FOV) of 60 x 45 degrees for a TOF camera sensor with demanding performance such as high contrast and illumination at high resolution across the FOV over a long working distance of 0.6 m to 10 m, within a tiny package of size 9 mm diameter x 5.9 mm length. The lens and camera are designed to be insensitive to ambient illumination other than in the infrared band of 840-860nm.

The camera lens system is not bulky and has significantly high performance in terms of contrast, resolution, field of view and working distance in a lens with a diameter of just 9 mm. The cost and weight of the camera can be reduced using the disclosed design.