Applications for 3D Sensor Technology in Security Business

Carina Peter and Stefan Schwope

TriDiCam GmbH. Falkstraße 73-77, Duisburg, Germany
carina.peter@tridicam.de, stefan.schwope@tridicam.de

Abstract. This paper gives an idea of how the TriDiCam CMOS 3D Sensor Technology works and in which ways it can be used on various security systems. After a short overview about the TriDiCam 3D Technology, different applications for 3D sensor technology in security business are given.

Keywords: 3D Sensor Technology, Time-of-Flight, Security Business, Face Detection, Security Areas, Car Alarm System

1 Introduction

In many areas of life it is possible to pass restricted information unintended to another party. To defend oneself or the own company against spying, not only the use of the right security software is important. The identification of authorized persons by face detection with depth characteristics is one possible addition to data encryption. Furthermore there are situations in which the use of certain information, like security, access or PIN codes, must be safeguarded. Also admission control with about 1cm exact dimensioned observation areas could be very interesting for a broad band of applications, e.g. access control for a Car Alarm System. Generally the observation of safety areas can be improved and become much easier by using depth information of 3D sensors. Meanwhile many different 3D technologies were placed on the market.

2 The TriDiCam Technology

The TriDiCam GmbH is a Spin-Off of the Fraunhofer Institute for microelectronic circuits and systems in Duisburg (IMS). The scale of business of the TriDiCam GmbH includes the development, production and marketing of 3D Time-of-Flight sensors. The TriDiCam Technology itself is described in the next section.

2.1 Measurement Principle

At time t_0 a laser light pulse E_0 of length T_{pulse} is send to the 3D scene. The first measurement of the reflected light ends when the laser pulse stops ($T_{shutter1}$) and represents the distance to the objects. The second measurement, starting at the same time t_0, stops later ($T_{shutter2}$) and detects the complete reflected pulse as a reference measurement.

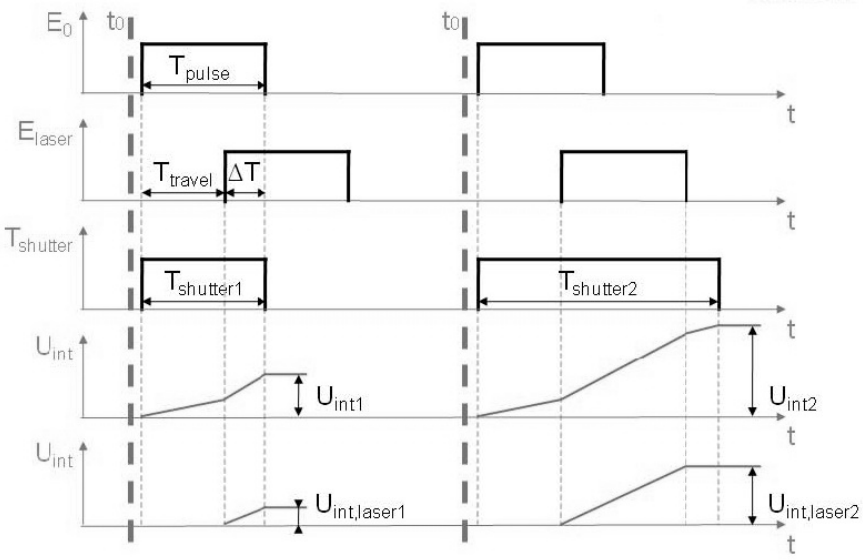

Fig. 1. Measurement Principle of the TriDiCam Technology

In the above diagram a considerable slope can be observed in the measurement curves after time T_{travel}, when the first reflected light of the laser reaches the sensor. Both curves represent the light integrated charges (the background light and the light of pulse) off the sensor. The results of the integrations are U_{int1} and U_{int2}. A third measurement (not illustrated) detects the absolute background light which falls on the sensor. This is subtracted from the values U_{int1}, U_{int2}, which enables the sole analysis of the reflected laser light. The measurement curves of this adjusted measurement values are shown in the last line of Fig.1. The corresponding integrals $U_{int.laser1}$ and $U_{int.laser2}$ are needed to calculate the distance with following formula.

$$d = \frac{c}{2} \cdot T_{pulse} \cdot \left[1 - \frac{U_{int,laser1}}{U_{int,laser2}} \right] \tag{1}$$

The deduction of the background-light causes a distance-calculation, which is independent of lighting conditions. Reflectance-independence is given due to the ratio of the two measurement values inside the above formula. The technology can be used in outdoor environments or environments without defined light- and object-conditions. This is relevant for nearly all security applications. Finally the use of CMOS-technology makes the technology very cost efficient.

2.2 The TriDiCam Technology

For the current TriDiCam 128×96 pixel sensor a Lateral-Drift-Field-Photo-Diodes(LDPD) technology has been invented. This type of technology enables smaller Time-of-Flight(ToF)-pixels and affords the possibility to develop array sensors. The current TriDiCam array sensor has a pixel size of $40\mu m \times 40\mu m$. The NEP value is about $0.7W/m^2$ to $1W/m^2$ and more than 1000 accumulations are possible. The advantage, compared to the standard photo-diode technology, is the enhanced light sensitivity by using drift-fields below the light sensitive area of the pixels. The light generated charge is more influenced due to the high intensity of the electrical field. Thus the charge is increased, which results in a better output signal. The technology is slower than the photo-diode technology. The expected frame rate is about 100Hz.

3 Applications in Security Business

3.1 Face Detection and Data Security

To protect delicate data, the use of face detection can help by identifying entitled persons. Thus a computer could recognize if the current user leaves the desk whereupon it locks important data for access of others. Only an authorized person could get access to the computer or to the data again. Moreover the computer could, for example, start the screen saver if important data is in use and an untitled person comes along the desk. The additional depth information, e.g. the depth of the nose or the distance between eyes and eyebrows, can be used as an additional biometric parameter for the algorithm which searches authorized persons. The reliability of such systems could be increased significant.

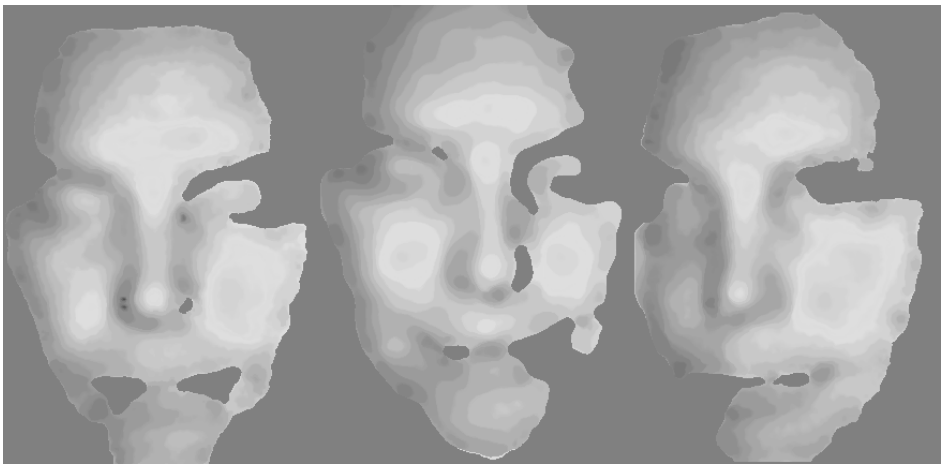

Fig. 2. 3D pictures prepared for face detection

3.2 Code-Spying and Skimming

The image below shows how a 3D sensor can protect bank costumers while using the cash dispenser. If the person which comes up behind unseen would not be detected, it could get knowledge of the PIN code, the account status and how much money has been withdrawed. This detection is only possible using lateral resolution. Other technologies, like radar- or ultrasonic-sensors, are lateral too inexact for most of these applications.

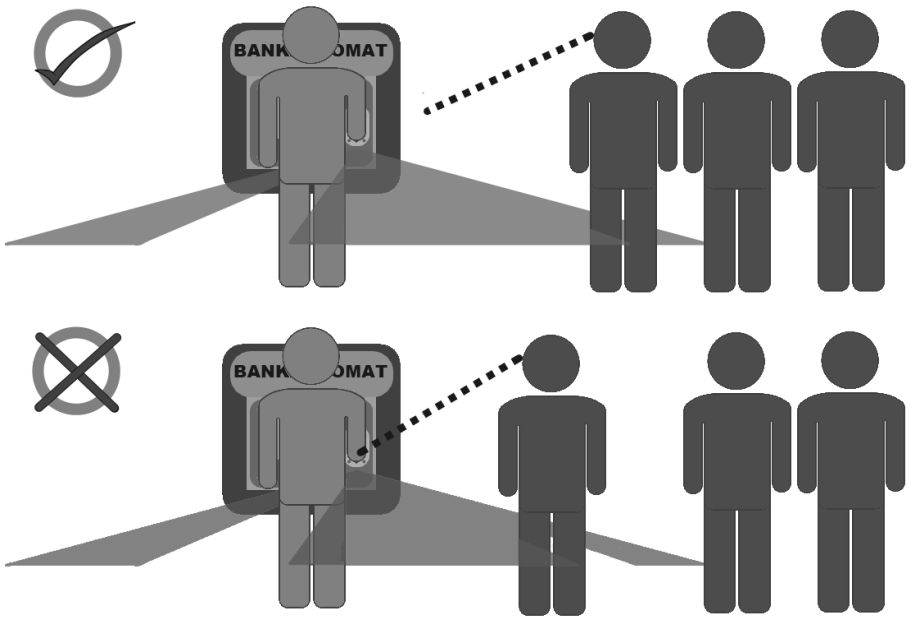

Fig. 2. Possible integration of 3D technology in a cash dispenser

3.3 Car Alarm System

In contrast to a normal motion detector, 3D technology allows observation in a given distance. Inside a car this could be used to observe especially the interior of the car and would allow less false alarms.

4 Conclusion

The technology, which is offered by the TriDiCam GmbH, is an unique and patented method to determine distances. The measurement is independent of illumination and surface-reflectance. It can be integrated in various security systems including the protection of safety areas or the protection of important data. The additional 3D depth information allows an observation in exact dimensioned areas. This feature can be used for security applications in crowded places like events or pedestrian zones.