ToF Timer RTL Implementation

Sheshu Ramanandan
Smartray GmbH, Wolfratshausen, Germany.
krsheshu@gmail.com

***Abstract*— Time of Flight (ToF) measurement technique measures the travel time of light wave to calculate the distance between the object and the sensor which emits the light radiation. This paper presents a simple ToF implementation in RTL by using timers which wait for a light reflection controlled by two signals in the implemented digital circuit.**

Keywords—ToF imaging, scanning, lidar

I. DESCRIPTION

In Time of flight imaging, a light source mounted on a camera emits modulated light which travels back after reflection and is detected at the source via a photodetector.

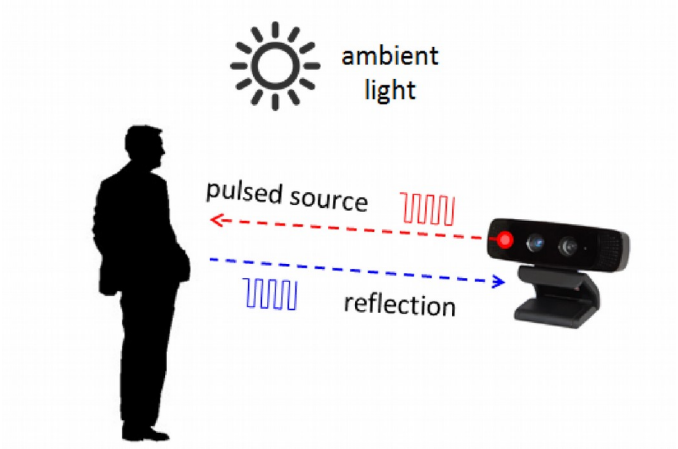

Fig 1. Time of Flight Principle

In the simplest form of implementation, a light pulse is sent from the camera after reflection is detected in the photo detector and the travel time is measured in hardware. The travel time is measured as

$$D = c \cdot t_d / 2$$

where D is the distance between the object and the camera, c is the speed if light and t_d is to and fro the travel time of the pulse which is sent and received by the camera.

II. IMPLEMENTATION

A simplest form of implementation is considered here where an FPGA based timer computes the to and fro travel time in clock cycles. The results is then processed further to find the real distance between the object. This implementation is a very basic timer implementation which starts a counter on rising edge of a start signal and captures the travel time on the rising edge of a capture signal. The start signal can be mapped to the reference time where a light pulse is fired and the capture signal can be mapped to the reflected ligh signal which is received by the hardware. The design can then be scaled to any number of detectors which can also be implemented as a 2d image array creating a 2d depth image. Fig 2 shows the design block diagram.

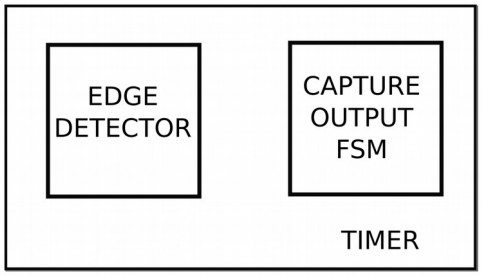

Fig 2. RTL Block Diagram

A simple state machine is used for the implementation and the diagram for the capture output fsm is shown in Fig 3.

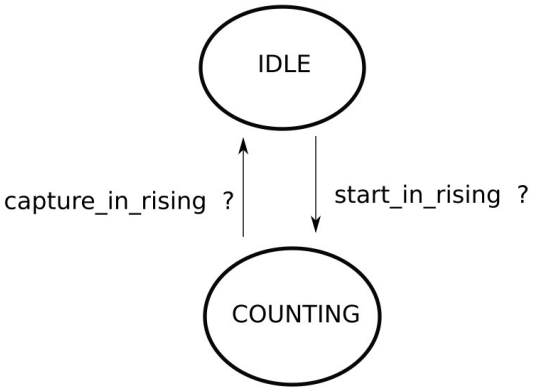

Fig 3. Statemachine for capture output

A counter is started on the rising edge of start_in signal and the counter counts until capture_in rising is reached and the counter output is then logged on the output pins on the RTL block. This counter value corresponds to the object distance

II. REFERENCES

[1] Time OF Flight Camera – An Introduction. Texas Instruments Technical White Paper. Jan 2014 revised May 2014

[2] Modeling distance nonlinearity in ToF cameras and correction based on integration time offsets. Claudio Uriarte et. al. 16th Iberoamerican Congress CIARP2011 Pucon Chile.