Demo: CELLI - Indoor Positioning using Polarized Sweeping Light Beams

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1. INTRODUCTION

Indoor positioning enables location-based services for a wide range of commercial applications [4]. Existing visible light positioning (VLP) systems [5, 7] leverage the high image resolution of a receiving camera to support high positioning accuracy. However, power-hungry cameras are not desirable in many scenarios, e.g., smart factories, where small objects need to be accurately located and tracked.

In this demo, we introduce CELLI, an indoor VLP system that only uses a single luminary as the transmitter and requires only a simple light sensor to achieve high accuracy with centimeter-level error. The key idea is to provide the spatial resolution capability from the transmitter instead of the receiver, so that the complexity of the receiver can be minimized. In particular, a small Liquid Crystal Display (LCD) is installed at the transmitter to project a large number of narrow and interference-free polarized light beams to different spatial *cells*. A receiving light sensor identifies its located cell by detecting the unique polarization-modulated signals projected to that cell, as shown in Fig. 1.

CELLI further incorporates several novel designs to overcome the technical challenges such as reducing the positioning latency, which is typically limited by the long optical response time of an LCD, and transforming a cell coordinate to the global 3D position using only a single light. We have prototyped our design using off-the-shelf optical and electronic components, and experimentally shown that CELLI achieves a median 3D positioning error less than 12 cm and a median 2D error less than 2.7 cm.

2. IMPLEMENTATION

We implement CELLI's transmitter using the Twisted Nematic (TN) Thin Film Transistor (TFT) LCD with a resolution of 320×240 pixels, featuring a short 4 ms response time, affordable price (less than $30 U.S. Dollar), and built-in controller [1]. The backlight LED used is a XLamp® CXA2540. The compact Tx prototype is shown in Fig. 2(a).

We built the receiver prototype with a microprocessor (MCU) [3] combined with a photodiode component [2] and a Liquid Crystal Cell (LCC) in front. The receiver provides a sampling rate up to 10 kHz and can perform real-time positioning, as shown in Fig. 2(b).

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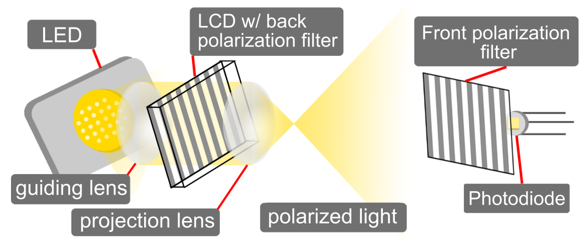
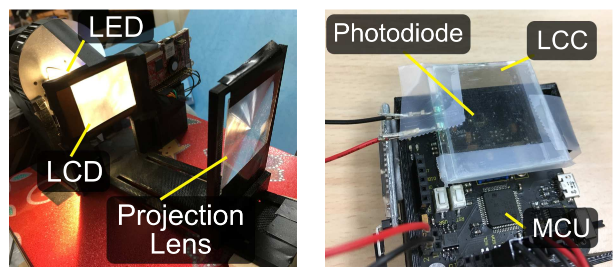


Figure 1: CELLI system design.



(a) Transmitter **(b)** Receiver

Figure 2: TFT prototype

More detailed information can be found in [6].

3. DEMO VIDEO

The demo video can be viewed at https://goo.gl/qTTo4i.

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