A Cell Phone Based Platform for Facial Performance Capture

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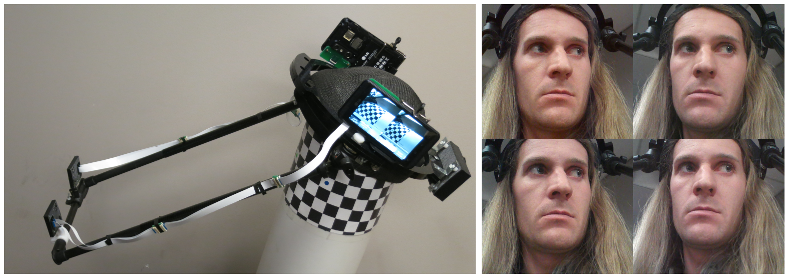

Figure 1: *(left) Photograph of apparatus and calibration object. (right) Photographs from our head-mounted cameras*

We propose a new head-mounted camera system based on stereo cell phone cameras. These cameras have the advantage of being extremely small, light-weight, and programmable. We provide step-by-step details on how to recreate this apparatus and also how to apply this data to multiple applications in facial tracking and reconstruction.   Our system is based on the LG Thrill, a 3D enabled cell phone that provides two synchronized stereo cameras in a tiny 4.2 gram module. We use two phones for a total of four cameras. However we do not want to mount the entire phone at the end of the helmet arm. Instead we designed a custom umbilical cord that allows the camera module to function at a large distance from the phone itself.

The LG Thrill's dual 5MP camera module is plugged into the mother board through a 40-pin connector, of which 7 pins are used to supply power of different voltage, 10 pins are paired into 5 differential signals to transmit high speed digital data and clock, whereas others are dedicated for low speed control signals or ground. Power channels and high speed digital signals must be handled with care when an extension cable is designed to connect the camera module from a certain distance away from the smart phone body.

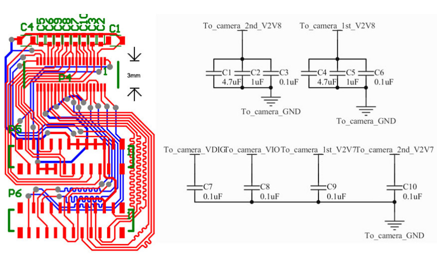

Figure 2: *(Left) Extension PCB layout (Right) PCB schematics*

In a high-speed environment, the digital circuit alternates between high and low logic at a very high rate. In order for the device to change state, a large output current must always be available from the power line in a very short period of time. This current is typically provided by a bypsss capacitor, placed between the power line and ground. When the camera module is extended away from the mother board, the distance from the the bypass capacitors also increases. The longer the extension cable is, the more it will limit the surging current from the bypass capacitors. In order for the extended camera to work even at a long distance away from the mother board, we place new bypass capacitors as close as possible to the camera module. Secondly, in digital circuitry, everything happens in discrete increments of time. Any significant delay between clock and data, or between the two polarized channels of a differential pairs is mostly like to cause error. Especially in the high-speed environment, since the signal travel as a very high rate, even a micrometer difference in the circuit trace will result in delay. In designing the circuit board it is critical to tune each trace so that they match up to a common length, even after additional capacitors have been added (Fig 2). Extension cable and circuit board designed with considerations of the above two factors work as far as 60cm long, and may worker for longer distances though this has not been tested yet. Without additional capacitors it is only possible to extend the camera 10cm.

In keeping with a "point and shoot" philosophy cell phone are typically designed to automate exposure, focus, color balance, and stereo convergence. We developed a custom camera application that uses the LG Real3D SDK to lock the convergence and Android SDK to set focus and color balance. In the future, lower level hardware control may be possible as with the Frankencamera SDK for Nokia phones [Adams et al. 2010].

Many 3D computer vision algorithms require accurate camera calibration. We developed a new single-shot calibration process using a 6" cylinder covered with a 2cm grid of black and white square (Figure 1). The cylinder's checkerboard corners can be detected quickly and automatically. Unlike techniques that rely on planar or spherical [Beeler et al. 2010] calibration objects, a cylinder provides points at multiple depths and more closely approximates the shape of a human face.

We are currently working on using this multiview data for stereo reconstruction and facial tracking. The cell phone also opens up the possibility of previewing video over the network and onboard image processing.

References

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