SIGGRAPH 2012

USC Institute for Creative Technologies

Graphics Lab

A Cell Phone Based Platform for Facial Performance Capture

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 stepby-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.

Step by Step Breakdown

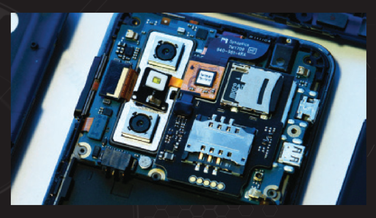
Here is how to remove the 3D stereo camera module from the LG thrill P925 smart phone and drive it outside the smart phone via an umbilical cable.

DISASSEMBLE PHONE

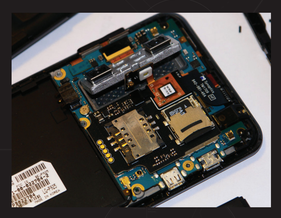
1. A brand new LG thrill P925 equipped a with dual 5MP stereo camera.

2. Take off the back to expose the pretty 3.7V Li-Ion battery. Use a #00 Phillips-head screwdriver to avoid stripping the screws.

3. Remove the speaker module first. With the speaker removed it is possible to unscrew the middle frame.



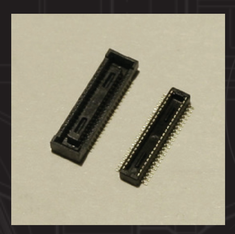
4. The camera is actually an independent unit connected by a ribbon cable to the motherboard. The dual-camera module is vertically embedded into the circuit boards with FPC connector on the side. An LED flash is coming from the other side and being laid on top of the camera module.



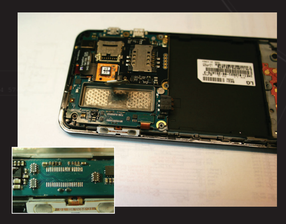
5. Pull out the camera module from its bed. This requires some efforts as the module is taped on its bottom and the outline fits the bed pretty tight.

7. Gently disconnect the FPC connector from the mother board and the camera module is completely separated

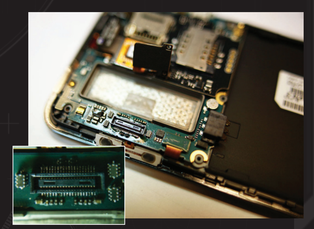
REPLACE THE CAMERA CONNECTORS



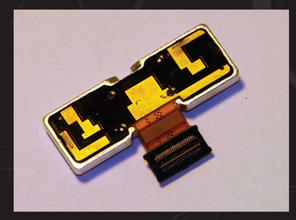
9. The original ribbon connector is a 40-pin, 0.4mm-pitch connector, part number "GB042-40S-H10-E3000" from LG. Unfortunately, it is very difficult to find mating connectors for this component. Instead we replace the connector with a more standard part available from Digikey. The new part numbers are "DF40C-40DP-0.4V(51)" and "DF40C-40DS-0.4V(51)" manufactured by Hirose.



10. Replacing the 40-pin, 0.4mm-pitch connector is not a trivial job. It requires some desoldering / soldering skills. We recommend Chip Quick's Removal Package "SMD1" for components removing. Here is the photo of the LG thrill after the camera module connector has been removed from its mother board.



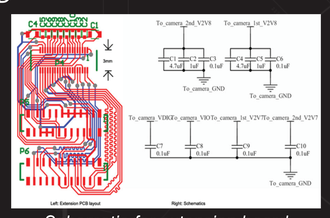
11. Soldering a new connector is considerably easier than removing. Here is the photo with the new installed connector.



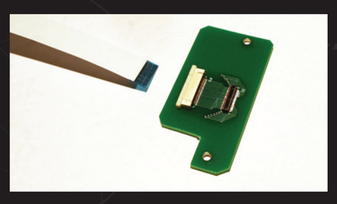
12. We also replace the connector on the camera module. When both sides have been upgraded with the new connectors, a function test should be carried out. Simply plug in the camera module back into the new socket and turn on the cell phone. Make sure everything still works after the replacement procedure.

BUILD THE UMBILLICAL CORD

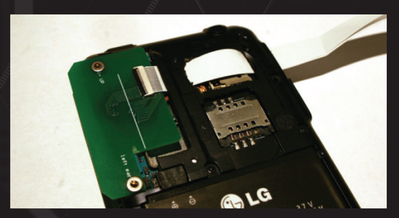
13. We designed a small, low cost circuit board to function as extension cable adapter. In designing the circuit board it is critical to tune each trace so that they match up to a common length. Any delay between clock and data, or between the two polarized channels of a differential pair is mostly like to cause an error.



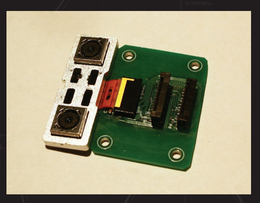
Schematic for extension board



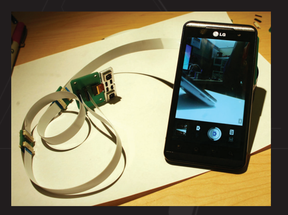
14. Here is the motherboard adapter with soldered connectors. White cables are 0.5mm-pitch, 20-conductor FPC jumper ordered from Arrow. FPC BackFlip™, Easy-On™ connectors are from Digikey.



15. After the adapter is finished, plug into the mother board and tighten the screws to the phone body. Since the PCB is little big, we had to trim off the inner plastic frame to make it fit.

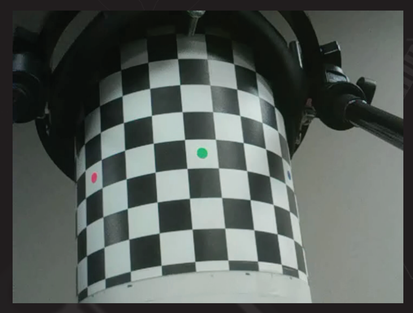


16. We also build a camera-side adapter. The vertical FPC connectors are from Digikey. There are a series of bypass capacitors being mounted close to the camera connector. These bypass capacitors are critical for the extension to work since the camera module is a high-speed digital device requiring large current to switch between logic low and high at high frequency. When the camera module is extended away from the mother board, it also leaves its "energy storage" on the mother board. Bypass capacitors supply the surging current and avoid voltage drop, which will cause the device to fail.



17. Everything is ready for the final assembly. Make sure cables are connected tightly and turn on the phone. The camera module is working outside the body now!

Calibration & Software



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.

In keeping with a "point and shoot" philosophy cell phones 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].

Four views of a face captured with two head-mounted cell phones.

References

ADAMS, A., TALVALA, E.-V., PARK, S. H., JACOBS, D. E., AJDIN, B., GELFAND, N., DOLSON, J., VAQUERO, D., BAEK, J., TICO, M., LENSCH, H. P. A., MATUSIK, W., PULLI, K., HOROWITZ, M., AND LEVOY, M. 2010. The frankencamera: An experimental platform for computational photography. *ACM Transactions on Graphics 29*, 4 (July), 29:1–29:12.

BEELER, T., BICKEL, B., BEARDSLEY, P., SUMNER, B., AND GROSS, M. 2010. High-quality single-shot capture of facial geometry. *ACM Transactions on Graphics 29*, 4 (July), 40:1– 40:9.

Svetlana Akim Andrew Jones Xueming Yu Jay Busch Graham Fyffe Paul Graham Paul Debevec

USC Institute for Creative Technologies

http://www.ict.usc.edu/

USC Institute for Creative Technologies