A FTIR based multi touch table using pulsed illumination for noise suppression

Uwe Hahne, Marc Alexa, Björn Bollensdorff, Ingo Bressler, Stefan Elstner,
Robert Lubkoll and Claudia Stripf
TU Berlin

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Touch Sensing based on Frustrated Total Internal Reflection (FTIR) is capable of sensing multiple touch points on a projection screen. Infrared light is totally reflected within a screen, and on touch diffusely reflected from the finger tip. This diffuse reflection is captured with a camera and fingertips are localized by blob detecting image processing. This approach suffers from surrounding infrared light and a small amount of light leaving the screen and illuminating the user – so far it can only be used in controlled lighting conditions. In our new approach, we obtain a dynamic background subtraction, which makes detection of fingertips possible even in the presence of non-constant, bright illumination conditions.

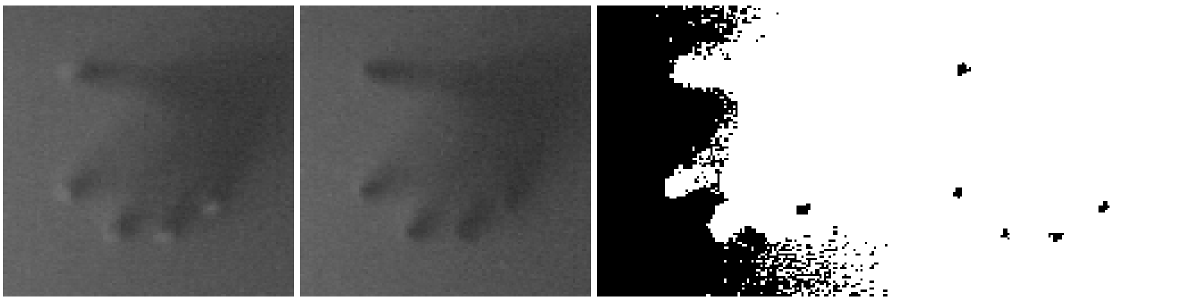

Figure 1: Two images captured with the illumination inside the panel switched off and on, with ambient light illuminating the hand touching the surface. Simply thresholding fails to capture the touch points (middle right), while subtracting the images and thresholding removes the unwanted parts (right).

The main problem with multi touch sensing panels is that light from within the panel, which is not totally reflected, as well as ambient light can make the detection of the FTIR effect difficult. A straightforward approach to suppress ambient light is to take a reference image before interaction starts. This, however, can only compensate for light that directly reaches the camera and as a result, multi-touch displays based on FTIR are usually used in rather dark environments. The main idea of this work is to generate the two images shown in Figure 1 in short succession during interaction. We generate a reference image for every captured image. Then, comparing (e.g. subtracting) the two images allows detecting the FTIR points easily. A reference image is generated by switching off the internal illumination of the panel. Consequently, the main point of our setup is switching the LEDs illuminating the inside of the panel on and off, in sync with the camera. As turned out by experiments, it is best to use a per frame signal from the camera. We connect this trigger a flip flop, which connects to a driver for the LEDs. Not only can such a signal be tapped from almost every camera, while cameras with trigger input are more expensive, also triggering the camera usually comes at the expense of frame rate. In our setup, the camera runs at its maximum frame rate – the flip flop and LEDs are much faster and easily switch at the necessary frame rates. The additional circuit (see Figure 2) consists only of few elements and has affordable costs.

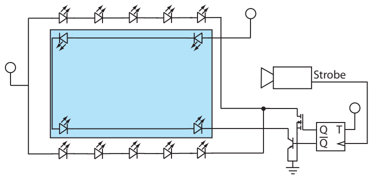

Figure 2: Additional circuit for switching the LEDs and setup of the LEDs

For identifying each frame as reference or blob containing, we place four extra LEDs in the corners that are inversely pulsed. These bright spots are locally fixed and hence easily detectable in the captured image. This makes the setup robust against undelivered images from the camera. Our blob tracking algorithm works as follows: The last reference frame is stored. For every touch sensing frame, this reference image is subtracted. Then, a simple threshold extracts the touch points, and counting the number of active pixels per touch point allows discarding noise.

Our touch sensing works under daylight conditions, while the additional cost for our setup is negligible; the main loss is frame rate, as touch points are captured only every other frame. We use a camera with 60Hz, leading to interaction at 30Hz, which works fine for many tasks except controlling time critical applications such as games. Also, if the touch points move at high speeds, the reference frame is inaccurate. Apart from losing touch points this can also lead to spurious ones. These effects might by resolved in future work by either predicting the blob movements by temporal differentiating as well as considering shadows in the images.