The challenge of touch-controller programming

Programmed Sensitivity

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Finger control via touchscreens is the rule nowadays – whether for ticket machines in car parks or for operating complex mechanical system. If touch-sensitive screens are to work reliably under all conditions, it is necessary to individually program the touch controllers.

By Stephan Meyer-Loges

Keyboard, monitor, computer – that's what a programmer's workplace looks like. Directly next to them are the printed circuit board of an embedded system, a screen module without a housing, a lot of cables and measuring equipment. Fully concentrated, the software developer presses on buttons on the development board. Taps in a few numbers. Presses the touchscreen module again. Yet there is one rather unexpected object in this picture: the hand of a developer. It is enclosed in a thick protective glove. However, the scene is in fact quite normal in the development offices at Garz und Fricke in Hamburg. This is where the software for the touch-controller is developed.

Touch-controller firmware is only rarely created as a separate programming task or individual project at the premises of the embedded systems specialist Garz und Fricke. Instead, it tends to be developed as part of an entire system – consisting of processor board, touchscreen and housing. And there is a good reason for this: almost all components of the system have an influence on the touch interface, which, as a core component, is crucial in achieving satisfaction for the client and user. Accordingly, the controllers are optimized on site in Hamburg. The Hamburg-based company is also involved in developing the drivers in many cases.

Before programming of the "touch" begins, all the ambient conditions have to be clarified. Where is the device to be used and what influences will it have to withstand? Will it be exposed to the forces of nature or influences from other sources? This, for instance, dictates how thick and impact-resistant the glass that will cover the touch interface has to be. In turn, the thickness and type of the glass together with the way in which screen and glass are connected determine the design and programming of the touch controller. A touch sensor that is designed for glass of 1.8 mm in thickness, for example, will only achieve inadequate touch results with a glass that is 5 mm thick.

Capacitive or resistive?

Touch-sensitive displays generally operate according to one of two functional principles: resistive or capacitive. The resistive technology reacts to mechanical pressure and transfers the values measured in analogue form to the controller via four or five cables. To achieve this, two films are installed, which are pressed against each other when a touch event occurs. During this process, the electrical resistance changes, which is then also measured.

In capacitive touchscreens electrically conductive layers are installed and a voltage is applied to them. When a conductive object, such as a finger, touches the surface, a small measurable charge transfer takes place. Projected capacitive touchscreens (PCAP) involve a special design in which two conductive layers are used. A pattern is affixed to these layers, via which the position of the conductive object can be calculated. This type of touchscreen is multi-touch-capable and can thus also be operated with more than one finger at the same time.

The type of touchscreen gives rise to benefits and drawbacks as well as special features in programming the controller. Resistive technology has the advantage that it can be readily operated with gloves and is not sensitive to electromagnetic interference (EMC). However, a monitor such as this is susceptible to vandalism. Even a cigarette lighter is capable of damaging the plastic surface. Resistive touch displays are also less translucent in sunlight and harder to read.

Designed for input with a bare finger and a glass surface, the capacitive touchscreen is very tough. However, input with gloves is impaired, a fact that requires consideration, particularly during programming. Capacitive technology confronts touch-controller developers with other tricky tasks – above all in outdoor use. Unlike resistive touch, it is here that raindrops and shallow water interfere with input. This is because, due to the method of function, a drop of water or even a small pool of water acts like a finger on the screen and produces a measurable change in capacitance. Without additional measures, the system cannot cope with this. Furthermore, the water on such a screen must not come into contact with the earthed housing as this will lead to a conductive connection.

Bonding as a factor of influence

The theme of bonding forms part of the discussion in matters of touchscreen at Garz und Fricke. Hidden behind this technical term, are various techniques of how to connect glass, touch sensor and display with one other. This is turn has effects on the touch itself and the programming of the controller.

If the touch display is installed in the air bonding process, the touch sensor is either fixed onto the display with special double-sided adhesive tape or is integrated mechanically with a specific gap. In what is known as optical bonding, the touch sensor is glued to the display over the entire surface. In all three processes, the developer of the touch controller has to pay attention to the individual dielectric constant which changes according to whether the touch sensor is surrounded by air or whether adhesive connects sensor and display. The type of adhesive also has to be considered during the programming.

In order to represent the final ambient conditions, the touch-controller firmware should always be first programmed when in the assembled system because integration into the housing may change the ambient condition for the PCAP. Whether a display frame is made of metal or plastic, for example, also makes a difference. This is why it is so important for manufacturers of such systems, like Garz und Fricke, to resolve the fundamental design and technical issues with the client in advance.

No touch-controller is quite like any other

This also makes it clear that there is

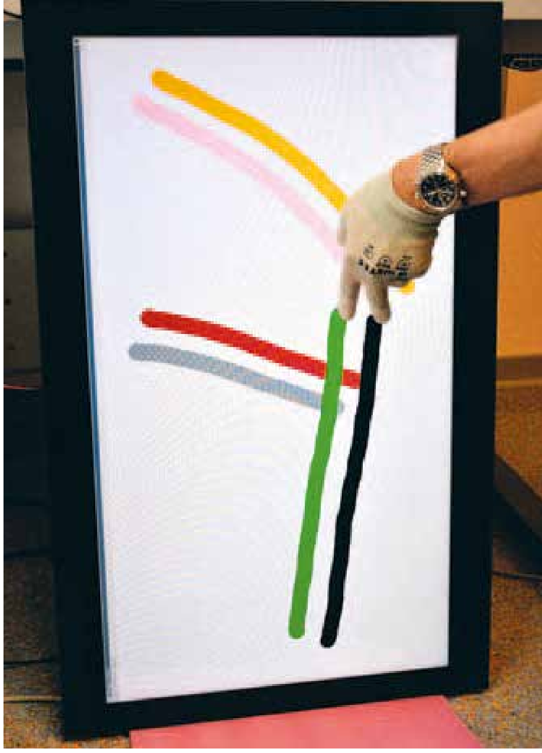


Figure 1. Targeted programming is able to optimize a touchscreen to specific types of gloves.

not one touch-controller firmware. Only individual adaptation to the entire device in its finally designed and assembled state is able to rule out the possibility of further changes that affect the touch controller – whether they be of a mechanical or electrical nature. This is because, for example, if the distance between display and frame were to change, then so too would the behaviour of the touch controller. Placing a metal frame around the sensor similarly changes the behaviour. In other words, every development operation is actually a separate development when considered in term of the entire device.

The greatest challenge in programming touch-controllers is that it is not a clear programming procedure. Inste-

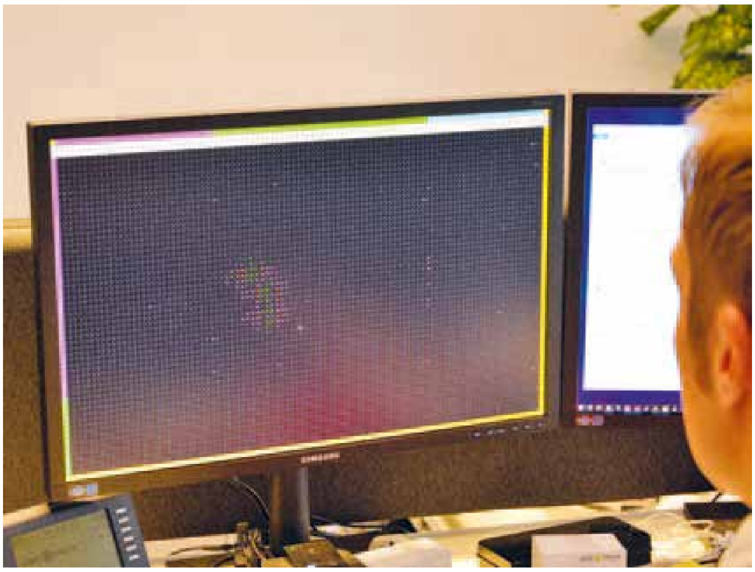


Figure 2. Water droplets, in particular, may irritate multi-touch displays. In this case, the touch sensor can be programmed so that it switches over to a single-touch mode. (Image: Garz + Fricke)

ad, the programming of touch controllers involves changing parameter sets. A normal touch controller has between 90 and 200 parameters, which are specified by the hardware manufacturer of the controller. This means that there is no programming of the microcontroller itself, but instead it is actually only a matter of changing the parameters used in the algorithms. The programming regulations for this are not clear. For instance, there is no one value that has to be increased to raise sensitivity, but instead the optimum comprises up to ten different parameters.

Even in the analogue sign, developers can activate various methods of amplification. They can employ digital amplifications in the algorithm chains or intervene in the evaluation of the algorithms and set thresholds, for instance. The latter can be useful in adapting touch sizes, in which the number of nodes is specified for a touch to be recognized so that it really is subsequently reported as a touch in the operating system.

The challenge of gloves

The complex chain from the analogue front-end, via digital filters in the back-end, through to the evaluation filters makes programming a touch controller difficult. At the end of the day, it all leads to the input image and to trials. Developers define specific gloves, for example. They then put on the gloves and operate the touch (Figure 1). At the same time, while operating the screen, they change the parameters in order to finally find a set of parameters with which the defined glove operates.

The adaptation of capacitive touchscreens to glove operation takes place in a range between high sensitivity and high resistance to interference. High sensitivity is useful for operation with a glove, but does make the touch more prone to electromagnetic interference. As a result, electromagnetic compatibility (EMC) suffers.

The challenge of water

Water droplets on the surface of the display are a particular interference in multi-touch displays. Developers employ a number tricks to get around the problem at software level in the controllers. When developing the firmware, Garz und Fricke works together closely with the manufacturers of the touch controller. Fine tuning then takes place on site in Hamburg, with special attention being given to the mechanical design and the thickness of the cover glass for the display module. The procedure for adaptation to water is similarly interactive to that for glove operation.

In this case, the device is actually placed on the table and the developers spray water or even an entire pool of water onto the sensor glass. They then view the analogue values. Using these values, they set the corresponding threshold values (Figure 2). One option is that beyond a certain level, above which the water achieves values that might erroneously be identified as a touch, the touch controller can switch to an insensitive mode in which operation may be severely restricted. The device, for instance, is switched from multi-touch to single touch.

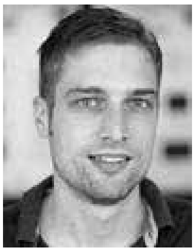
At the same time, various filters can be set by the programmers such as the touchdown filter. The result of this is that the finger has to be recognized for a somewhat longer period before the touch is triggered. With the aid of a further filter, the driver software classifies the static signals or those with a minimum movement as non-fingers and works out the interference signal. Only when the display control system recognizes that something is clearly moving on the surface will the touch be triggered.

Holistic approach

Modern capacitive touch controllers that work on the PCAP principle include inherently high EMC resistance values, offer the option of being operated under the influence of water and can be controlled when the user is wearing gloves. At the end of the day, though, the combination of these requirements does make the programming very difficult.

Touch controller development is one but by no means the only field in which specialists such as Garz und Fricke are able to exploit their strengths because the company sells complete solutions and designs the entire device in collaboration with the customer. Accordingly, the developers are familiar with all the restraints that may influence the solution and take this into account when developing the human-machine-interface and programming the touch controller. Added to this is the fact that Garz und Fricke works interactively and in close coordination with the customer. The result is the elimination of multiple tedious dispatch runs across continents.

Stephan Meyer-Loges



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