Bright prospects

Automated testing of car paint

According to the Federal Motor Transport Authority for Vehicles (KBA), silver and gray are still the most popular car colors in Germany. As such, in the first half of 2010, 480,000 vehicle owners registered cars with these colors, followed by the color black (approx. 440,000). The KBA then goes on to state that the fashionable color of ‘white’ has pushed ‘blue’ (with over 160,000 approvals) from third place on the ‘hit list’ of the most popular vehicle finishes. What most car owners however, are not likely to know, is that until the ‘object of desire’ is on the doorstep in the desired color, alone when it comes to the topic of vehicle paint, extensive quality tests using sophisticated sensor technology are necessary in order that the vehicle benefits from a visually sophisticated look.

Samples are not enough

Alone for one vehicle type in a specific paint shade, the car body assembly of a leading German automobile manufacturer is supplied with up to seven different components from different suppliers. However, with all components and the car body itself, exactly the same paint shade needs to be ensured throughout. As the supplied parts have already been subjected to a qualitative assessment, the automobile manufacturer concentrates on monitoring the vehicle body. As up until now, only one vehicle had been evaluated per sample per day, there is a risk that under certain circumstances, several hundred vehicles could be assembled in the final stages with defective paint. These would then have to be disassembled at a considerable cost and repainted.

High requirements for consistent paint testing

The solution to this dilemma: A complete automated paint testing system, running over a total daily production output of some 2,000 vehicles with different colors. The carmaker therefore sought a specialist who was able to present him a ready solution which was not just able to differentiate the different colors of the painted car bodies, but also recognize the color gradient of the individual colors and/or issue a fault signal above a certain color gradient limit value. In addition, the archiving of measurement data should be made possible in a database. Alone due to the high cycle times of the assembly line and the goal of 100 percent continuous measurement meant that the possible use of a camera system with a darkroom for eliminating of extraneous light influences was out of the question. For measurement, each vehicle would have had to have been driven into this darkroom especially.

Special challenges

With the sensor specialist ipf electronic in Lüdenscheid, the carmaker finally found a team of highly motivated engineers and technicians who wanted to meet the specific challenges of this project. The particular difficulties: Reliable color recognition of around 17 paint variants and their color gradients among shiny surfaces and color tones which in part are almost identical, as well as high repeatability of the measurements - and all this at a high measuring rate.

Linear unity ensures a high level of repeatability

ipf electronic recommended a color sensor from the OF35 series (Fig. 1) to the car manufacturer as a solution to the ambitious task. The sensor incorporates a polarizing filter which eliminates the sheen of the painted car bodies and as such, makes the reliable measurement of the color scheme possible.

In order to ensure a high level of repeatability, the distance of the sensor to the body surface must always be the same. Together with the car manufacturer, ipf electronic has developed a very special solution. The required measurement distance of 20mm to the painted surface is produced by means of a linear unit, the feed motion is controlled via a distance-measuring ultrasonic sensor. The ultrasonic sensor ensures a positioning of the sensor with a repeatability of ±1mm.

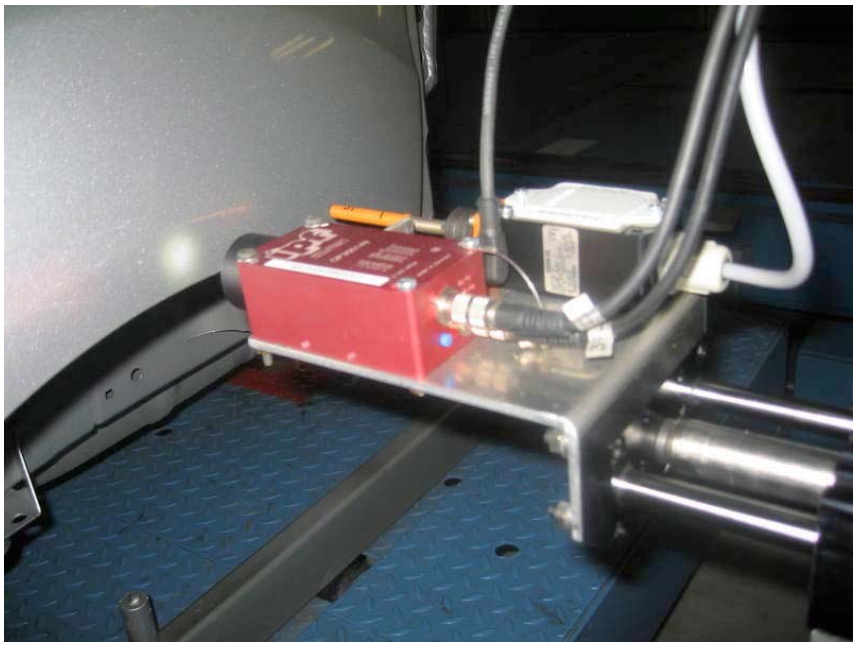

Fig. 1

Smart software for sensor parameterization

For exact parameterization of the color sensor, a software specifically designed by ipf electronic has been employed for challenging color recognition – with good cause. In particular, the very similar paint variants in the range of blues represented a special challenge. In order to be able to recognize minimal color differences, among other things, the light output of the device's white light source has to be precisely set. This takes place by means of the software (on the basis of a graphical representation among other things) a statement can be made about the quality of the receiver signal. In cooperation with detailed assessment algorithms and the option of specifying graded tolerance values, it has been possible to securely assess the paint colors and in addition, also the color gradient. Production department were actually tested at the automobile manufacturer's factory. As part of this process, the white light source that is integrated into the sensor and manipulable via the parameterization software was adjusted in its transmission power level to each of the color samples in such a way that the sensor was able to provide the desired optimum values. These measurements resulted in 17 different basic transmission power levels for the internal light source. On the basis of these transmission power levels specific for the respective paint shades, corresponding reference values (setpoints) were subsequently established for the color shade with the parameterization software and the intensity of the quantity of light reflected from the surface was evaluated.

In order that a conclusion could be drawn about the gradient of a color and/or the accuracy of the color by the production department, a color tolerance gradation was determined for each paint color. For this purpose, a 10-step tolerance classification was developed with the help of the parameterization software and its visualization capabilities, wherein each step results in a tolerance value. These established sets of parameters (transmission power levels, tolerance gradation, reference values in terms of color shade and intensity) were subsequently filed under corresponding reference numbers in a host computer.

For the use of the sensor solution of ipf electronic, the accurate identification of up to 17 available Color shades in the course of continuous production was indispensible. This was achieved by comparing the current measured values of the color sensor with the reference values for the color and intensity parameters which were worked out in advance with a paint shade-specific light source standard output and the tolerance grade that goes with it.The sensor only emits color errors if an incorrect color shade or a too large color shade change is recognized, wherein all values (target values/actual values) can be visualized by means of the parameterization software.

Exact identifying of color shades

If a vehicle is in the correct testing position, a linear guide unit positions the color sensor with the aid of the ultrasonic sensor at the required sensing range to the surface. The measurement takes place from both sides of the vehicle above the rear wheel arches, as with regard to the correct paintwork, this area is especially critical. The receiver signals are assessed by the sensor in the 'first hit mode'. For this, the measured values are compared using the ipf electronic software with the entries in the reference/teach value table and the first hit is emitted as a result, wherein, as the reference/teach value table reaches the higher values, the permitted color change tolerances become larger and larger.

Seamless communication with the main computer

The reference data and/or reference values for each paint type are stored on a main computer in the automobile manufacturer's paint test which is connected to the ipf color sensor via RS232/ethernet converter and/or gateway. The respective car body to be tested is identified via a bar code reading device (by the plant) so that the main computer can recognize which paint should be applied to the car body which is currently due to be tested.

In order to confirm this information by the color sensor, the main computer transfers the necessary test parameters (transmission output, tolerance grade, reference values for the color shade and intensity) to the sensor. This then compares the test parameters with the measured values and indicates whether these are within the boundaries for the color limits, the color change limits and the intensity limits. After this, the test results are transferred again via the interface to the main computer and stored.

Refinish never again

This example reveals: automated testing of different paint shades and with it, the perfect differentiation of different high gloss paints on each vehicle during a day's production is feasible. The conditions for this: A client with high demands for the required solution and a sensor specialist, which is not just able to provide special hard and software for implementing such a solution, but also has a highly motivated team of technicians and which, together with the client, is able to master all challenges.