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Research Article

Detection and Distinction of Colors Using Color Sorting Robotic Arm in a Pick and Place Mechanism

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Color sorting Robot is one of the useful, costless and fastest systems in Industrial applications to reduce manual working time and provides less human mistake when manual system is undertaken. The objective of this project is to design an efficient, microcontroller based system that pick up right color of objects and put it down at right place to optimize the productivity, minimizing the cost of the products and decreasing human mistakes. In our system the TCS34725 is interfaced with the Raspberry Pi A+ board on its 2nd I2C interface channel, running Linux OS. The values are read using python script by calling the python I2C libraries. The color sensor requires a light source to illuminate the sample and a 5500K color temperature white SMD LED is used for this purpose. The sensor assembly is housed in a circular black opaque plastic ring to avoid external light interferences. As per standard RGB schemes supported by most computers and operating systems the 16 bit value is converted to 8 bit and the resultant number of color which TC34725 can differentiate totals to 16.7 million colors. A low cost approach had been used to sense the size of the sample object, wherein the requirements are that the object should be opaque. The circuit is realized using a set of comparators – 8 x LM324 for each axis, and 2 x CMOS counter type CD4017 to generate scanning in both X and Y axis. The circuitry is controlled by an 8051 core MCU (AT89S52). And is interfaced by its UART to the Raspberry Pi A+ processor board. The communication is handled in high level by the pySerial libraries.

Key words: Undertaken, Industrial Applications, Communication, Differentiate

INTRODUCTION

Determining real time and highly accurate characteristics of small objects in a fast flowing stream would open new directions for industrial sorting processes. The present paper relates to an apparatus and method for classify in and sorting small-sized objects, using electronic systems and advanced sensors operating on the basis of a physical and geometric characterization of each element. Recent advances in electronics and printed circuit board technology open new perspectives for industrial application in this field.

The proposed system is an embedded system which will increase the speed of color sorting procedure, provide the accurate color sorting process, decrease the cost of color sorting process and optimize the productivity of an industrial object. The system comprises of color sensor, stepper & servo motors and microcontroller. By another way this project can be treated an automated material handling system & can be designed by following way. It synchronizes the movement of robotic arm to pick the objects moving on a conveyor belt. It aims in classifying the coloured objects which are coming on the conveyor by picking and placing the objects in its respective pre-programmed place. There by eliminating the monotonous work done by human, achieving accuracy and speed in the work.

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The project involves colour sensors that senses the object's colour and sends the signal to the microcontroller. The microcontroller sends signal to circuit which drives the various motors of the robotic arm to grip the object and place it in the specified location. Based upon the colour detected, the robotic arm moves to the specified location, releases the object and comes back to the original position.

LITERATURE SURVEY

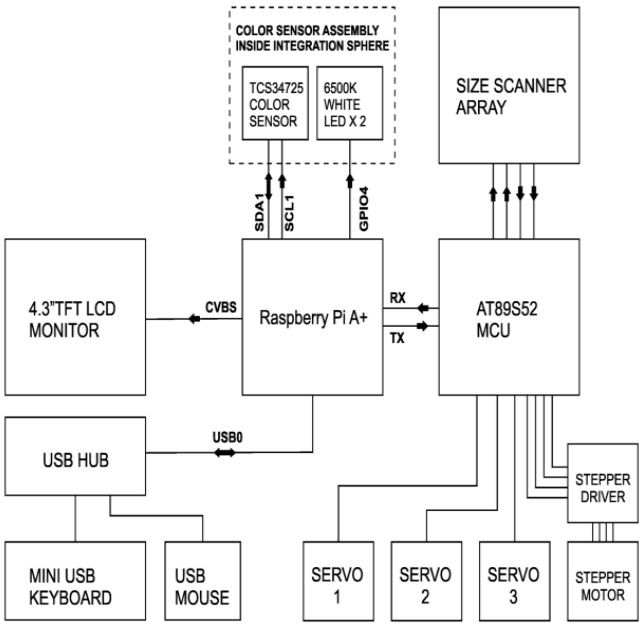
To reduce human efforts on mechanical maneuvering different types of robotic arms are being developed. These arms are too costly and complex due to the complexity and the fabrication process. Most of the robotic arms are designed to handle repeated jobs. In design of the robotic are different parameters are to be taken care.

The design of mechanical structure with enough strength, optimum weight, load bearing capacity, speed of movement and kinematics are important parameters. In electronic design the specification of the motors, drives, sensors, control elements are to be considered. In the software side there configurability, user interface and implementation and compatibility are to be considered.

In simple term, the reference sources emphasize on few aspects like sorting of different colored objects can be done by using camera, but here in this project deals with sorting of both different colored objects and different size objects with the help of advanced color sensor TCS34725FN.

PROPOSED SYSTEM

BLOCK DIAGRAM OF THE SYSTEM



A. Working Principle of the whole System

The system sorts different size and colored objects by making measurements on a fixed start point where the sample object is placed. Depending on sorting criteria – Color, Size, Color & Size, the object can be picked and placed by the robotic arm at different location or different bins placed in a circular path around the robotic arm.

B. Color Sensing

The color sensing is carried out by a semiconductor type reflective color sensor manufactured by Austria Micro Systems – TCS34725FN, the device features a 4 channel color sensor with built in Infrared filter to cut off unwanted infrared radiations pick up from surrounding light sources. The device consists of an internal A-D convertor for light to digital value conversion and each channel can be read using its I2C interface bus as a 16bit digital value. These values are read by the host micro-computer or processor to analyze the RGB values and represent them or process as per requirement. In our system the TCS34725 is interfaced with the Raspberry Pi A+ board on its 2nd I2C interface channel, running Linux OS. The values are read using python script by calling the python I2C libraries.

The color sensor requires a light source to illuminate the sample and a 5500K color temperature white SMD LED is used for this purpose. The sensor assembly is housed in a circular black opaque plastic ring to avoid external light interferences. As per standard RGB schemes supported by most computers and operating systems the 16 bit value is converted to 8 bit and the resultant number of color which TC34725 can differentiate totals to 16.7 million colors. As with any instrumentation device a range calibration is always required and the same for this color sensor is done by making measurements of known color patches from shade cards, and substituting an error value computed by inverse matrix multiplication of three different elements Red, Green, and Blue measured by the sensor, thus any other color measured will be multiplied with an error matrix to get compensated color values reproducing real color of the sample scanned. The error mainly occurs due to light source used for illuminating the sample, the spectral distribution of the light source and its color temperature, combined with the IR cut off filter present in the color sensor lowers the color temperature and thus the scanned colors reflect a blue tinge, however after error correction the sample color and scanned color can be rated with a delta E value of 1.5 to 2.0 which is very close to the real color.

C. Size (Dimension) Sensing

A low cost approach had been used to sense the size of the sample object, wherein the requirements are that the object should be opaque. An array of 8x8 IR phototransistors and LED's are used to scan for an object in X and Y axis and evaluate the size in steps of 3-3.5mm, as each component's diameter is 3mm. The circuit is realized using a set of comparators – 8 x LM324 for each axis, and 2 x CMOS counter type CD4017 to generate scanning in both X and Y axis. The LED on one axis is scanned in a stepped manner and the return signal is monitored at the photo transistor end, which is converted to a logic level signal by the comparator. Thus any blockage of the IR light falling from source to target represents the X and Y axis area occupied in multiples of 3mm by the sample. The circuitry is controlled by an 8051 core MCU (AT89S52). And is interfaced by its UART to the Raspberry Pi A+ processor board. The communication is handled in high level by the pySerial libraries.

D. Pick and Place Control

The robot is controlled using 3 x servo and 1 x stepper motor for complete pick and place operation. The servo motors take PWM pulses from the AT89S52 MCU for varying and maintaining their position, the stepper motor is controlled by a transistorized circuit based on a TIP 127 PNP darling ton pair power transistor. The stepper motor is used to rotate the arm to required angle in 3.75 degree step. An optical slotted switch is used to sense home position and end position to stop the motor movement at both ends. The complete mechanical assembly is cut out of an acrylic 6mm panel with laser cutting process and same is joined using fastening screws and cyanoacrylate adhesive. The specific material is used based on its light weight and high tensile strength.

Description of Hardware Components and Software

This part of the paper is showing the main idea of the working principle of each components connected in the circuit to achieve the needed aim and objectives.

COLOR SENSOR TCS34725FN

The TCS3472 device provides a digital return of red, green, blue (RGB), and clear light sensing values. An IR blocking filter, integrated on-chip and localized to the color sensing photodiodes, minimizes the IR spectral component of the incoming light and allows color measurements to be made accurately. The high sensitivity, wide dynamic range, and IR

blocking filter make the TCS3472 an ideal color sensor solution for use under varying lighting conditions and through attenuating materials. This data is transferred via an I^2C to the host

FEATURES

- Integrated IR blocking filter
- 3.8M:1 dynamic range
- Four independent analog-to-digital converters
- A reference-channel for Color Analysis (Clear channel photo-diode)

BENEFITS

- Minimizes IR and UV spectral component effects to produce accurate color measurement
- Enables accurate color and ambient light sensing under varying lighting conditions
- Minimizes motion / transient errors
- Clear-Channel provides a reference allows for isolation of color content

COMPARATOR LM324

The LM324 series consists of four independent, high gain, internally frequency compensated operational amplifiers which were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage. Application areas include transducer amplifiers, DC gain blocks and all the conventional op amp circuits which now can be more easily implemented in single power supply systems. For example, the LM324 series can be directly operated off of the standard + 5V power supply voltage which is used in digital systems and will easily provide the required interface electronics without requiring the additional – 15V power supplies.

FEATURES

- Internally frequency compensated for unity gain
- Large DC voltage gain 100 dB
- Wide bandwidth (unity gain) 1 MHz (temperature compensated)
- Wide power supply range: Single supply 3V to 32V or dual supplies – 1.5V to – 16V
- Very low supply current drain (700 á A) — essentially independent of supply voltage
- Low input biasing current 45 nA (temperature compensated)
- Low input offset voltage 2 mV and offset current: 5 nA
- Input common- mode voltage range includes ground
- Differential input voltage range equal to the power supply voltage
- Large output voltage swing 0V to V+ - 1.5V

MICROCONTROLLER 8051 (AT89S52)

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the indus-try-standard 80C51 instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory pro-grammer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications. The AT89S52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89S52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning.

IR PHOTOTRANSISTOR

The ITR9908 consist of an infrared emitting diode and an NPN silicon phototransistor, encased side-by-side on converging optical axis in a black thermoplastic housing. The phototransistor receives radiation from the IR only. This is the normal situation. But when an reflecting object close to ITR, phototransistor receives the reflecting radiation.

SOFTWARE REQUIRED PYTHON

Python is a general-purpose interpreted, interactive, object-oriented and high-level programming language. Python was created by Guido van Rossum in the late eighties and early nineties. Like Perl, Python source code is also now available under the GNU General Public License (GPL). Python is extensible: if you know how to program in C it is easy to add a new built-in function or module to the interpreter, either to perform critical operations at maximum speed, or to link Python programs to libraries that may only be available in binary form (such as a vendor-specific graphics library). Once you are really hooked, you can link the Python interpreter into an application written in C and use it as an extension or command language for that application.

APPLICATIONS

The system has many applications in various fields, as this system provides the sorting of objects, in flow of objects by multi sensing. Mainly this finds the important application in agriculture field where it can be used to sort the different agriculture products like grains, lemons, almonds, grapes, and different kind of fruits. For human beings it becomes comber sum task to sort out the objects with high quality also the possibility of accuracy is less. In industry it can be used for sorting of various objects and tools with different sizes. By this way the proposed project can be used. It finds application in enormous way in agriculture, industry.

Conclusion

The present work when implemented provide good re-search knowledge on robot arm modeling and embedded based control hardware and software implementation provides an

easier access to exercise robot manipulation using the functionalities and programming abilities of the real robots for mounting different industrial applications. The objects with different color can be determined by using advanced color sensor TCS34725FN and objects with different size also can be determined by arrary matrix .Finally all the objects are picked and placed by pick and place robot with efficient manner. It reduces the time and cost of investment is also very low as compared to other robots.

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