Design and Development of Black and White Object Sorting Robot

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Abstract – *In this fast paced world of automation, in many industries the basic process used for sorting the products is still conventional with manual efforts and we need to make this process more efficient, automated, with less time consumption and with an absolutely fine accuracy. To achieve the respective target, here we have focused on using sensors and mechatronics part to design a robot. Using this robot we can sort black and white objects without manual interface. The proper use of sensors and mechanical elements is carried out to achieve the sorting process. The implementation of technology has been done to differentiate the objects efficiently and more focus is done on automation. In the manufacturing industries there is a need to sort the products according to its shape, size, color and number of similar parameters. Here in this machine the objective of designed model is to do sorting of objects based on their color.*

*Key Words***:** automation, manual efforts, accuracy, sensors, mechatronics, robot, sorting process etc.

1. INTRODUCTION

The whole combination of servo motor, IR sensor module and the microcontroller MSP430f5529 will be used to do the sorting of black and white coloured objects. The main benefits of IR sensors are low power usage, their simple design & their convenient features. IR signals are not noticeable by the human eye. The IR radiation in the electromagnetic spectrum can be found in the regions of the visible & microwave. The IR sensor gives the input to the microcontroller. A microcontroller is a small computer on a single metal-oxide-semiconductor integrated circuit chip. A microcontroller contains one or more CPU along with memory and programmable input/output peripherals. The inputs from IR sensor are used by microcontroller to drive the Servo Motor accordingly. A servo motor is a type of motor that can rotate with great precision. Normally this type of motor consists of a control circuit that provides feedback on the current position of the motor shaft; this feedback allows the servo motors to rotate with great precision.

The objective of designing this robot is to sort objects based on its color. In industries we need to implement the basic process to differentiate material based on the color and so to meet that need of the sorting process, the Black and White object sorting robot is developed. The robot runs on real time application of sorting. Sorting is any process of arranging items systematically, and has two common, yet distinct meanings as ordering or arranging items in a

sequence ordered by some criterion, categorizing, grouping items with similar properties.

2. WORKING

We have used IR sensors whose main function is to detect colour of an object. Here we have given understanding of two colours to the system as Black and White which clearly describes the name of this robot. The IR rays are reflected from a white object and system gets activated where in another case when the object is black, there is no reflection of IR rays.

All data in a computer system consists of binary information. 'Binary' means there are only two possible values: 0 and 1. Binary information is referred to as machine language since it represents the most fundamental level of information stored in a computer system. After detection of an object, our robot gives digital one or zero form of output to the microcontroller MSP430f5529.

The servo motor rotates to either right or left according to the microcontroller MSP430f5529. If the object is black then it rotates servo motor to the right side by 90 degrees and if the object is white then it rotates the servo motor to the left side by 90 degrees.

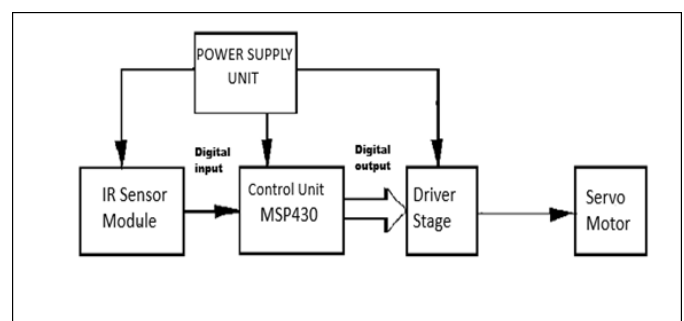Now connect Servo motor and IR Module to the microcontroller MSP430f5529 as shown in connection diagram.

Fig -1: Connection Diagram

2.1 MSP-EXP430F5529LP

This microcontroller features a powerful 16-bit RISC CPU, 16-bit registers, and constant generators that contribute to maximum code efficiency. The digitally controlled oscillator allows the devices to wake up from low-power modes to active mode in 3.5 μs.

The MSP430 LaunchPad development kit now has USB. The MSP-EXP430F5529LP is an inexpensive and simple

development kit for the MSP430F5529 USB microcontroller. It offers an easy way to start developing on the MSP430 MCU, with onboard emulation for programming and debugging as well as buttons and LEDs for a simple user interface.

Specification of USB-enabled MSP430F5529 16-bit MCU:
- Up to 25-MHz System Clock
- 1.8-V to 3.6-V operation
- 128KB of flash, 8KB of RAM
- Five timers
- Up to four serial interfaces (SPI, UART, I 2C)
- 12-bit analog-to-digital converter
- Analog comparator
- Integrated USB, with a complete set of USB tools, libraries, examples, and reference guides
- The eZ-FET lite emulator, with the application ("backchannel") UART. (Now open-source!)
- Ability to emulate and develop USB applications with a single USB cable, made possible with an onboard USB hub
- Power sourced from the USB host. The 5-V bus power is reduced to 3.3 V, using an onboard dc-dc converter.

2.2 IR Sensor Modules

1. IR LED Transmitter

An infrared light-emitting diode is a solid-state light-emitting device that produces light in the infrared band or range of the electromagnetic radiation spectrum. IR LEDs allow for cost-effective and efficient production of infrared light, which is electromagnetic radiation in the 700 nm to 1mm range.

IR LED emits light, in the range of Infrared frequency. IR light is invisible to eyes as its wavelength (700nm – 1mm) is much higher than the visible light range. IR LEDs have light emitting angle of approx. 20-60 degree and range of approximately few centimetres to several feet; it depends upon the type of IR transmitter and the manufacturer.

2. Photodiode Receiver

A photodiode is a semiconductor p-n junction device that converts light into an electrical current. The current is generated when photons are absorbed in the photodiode. ... Many diodes designed for use especially as a photodiode use a PIN junction rather than a p–n junction, to increase the speed of response.

Photodiode acts as the IR receiver as it conducts when light falls on it. Photodiode is a semiconductor which has a P-N junction, operated in Reverse Bias, means it start conducting the current in reverse direction when Light falls on it, and the amount of current flow is proportional to the amount of Light. This property makes it useful for IR detection.
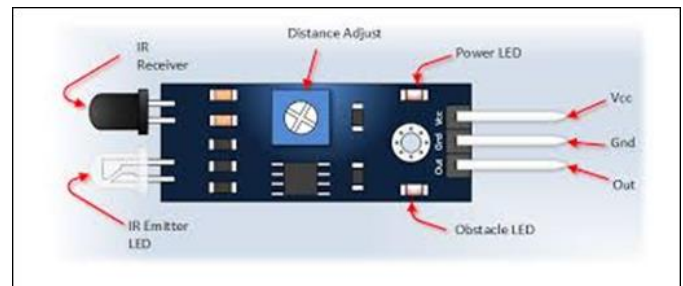

Fig -2: Sensor Modules

Specification of sensor modules:
- 5VDC Operating voltage
- I/O pins are 5V and 3.3V compliant
- Range: Up to 20cm
- Adjustable Sensing range
- Built-in Ambient Light Sensor
- 20mA supply current
- Mounting hole

2.3 Servo Motor SG90

Micro Servo Motor SG90 is a tiny and lightweight server motor with high output power. Servo can rotate approximately 180 degrees - 90 in each direction, and works just like the standard kinds but smaller. You can use any servo code, hardware or library to control these servos.

A servo motor is an electrical device which can push or rotate an object with great precision. If you want to rotate and object at some specific angles or distance, then you use servo motor. It is just made up of simple motor which run through servo mechanism.
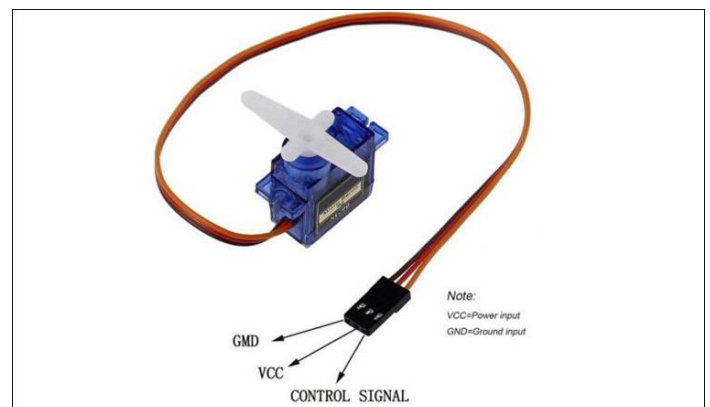

Fig -3: Servo Motor SG90

Specification of Servo Motor SG90:
- Operating Voltage is +5V typically
- Torque: 2.5kg/cm
- Operating speed is 0.1s/60°
- Gear Type: Plastic
- Rotation: 0°-180°
- Weight of motor: 9gm
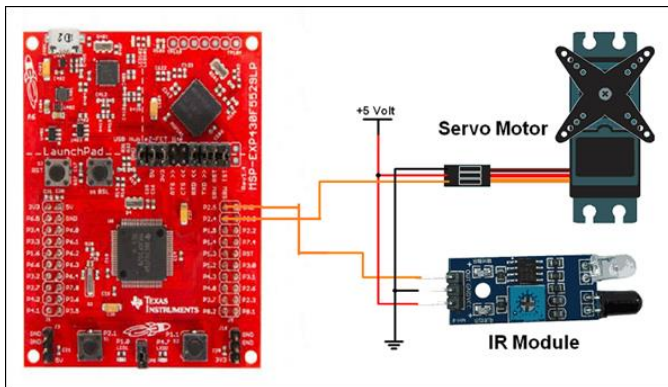
- Package includes gear horns

Fig -4: Schematic Diagram

3. IMPLEMENTATION, TESTING AND DEBUGGING

In the implementation and a successful run of the project IR sensor is used to detect color of the object, whether it is black or white. If the object is white then it reflects the IR rays and gets detected and when the object is black, there is no any reflection because black color does not reflect any light rays.

It gives digital one or zero form of output to the MSP-EXP430F5529LP and this ultimately leads to activation of Servo Motor and rotate in 90 degrees either to the left or right.

The testing and debugging is done on ENERGIA IDE.

4. CONCLUSIONS

i.   The manual interface can be completely eliminated by using this robot, making the object sorting process in the industries totally automatic.

ii. The robot has made the use of microprocessor in real time; also the working of the servo motor is justified.

iii. Using ENERGIA IDE for an implementation of the code in the best possible way is a challenging task.

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