(Industrial Sorting Project)

Introduction

Sorting in industry:

- **Sorting** is any process of arranging items systematically, and has two common, yet distinct meanings:
  ordering: arranging items in a sequence ordered by some criterion.
  categorizing: grouping items with similar properties.
- **Ordering items** is the combination of categorizing them based on equivalent order and ordering the categories themselves.

Common sorting algorithms:

- Bubble/Shell sort: Exchange two adjacent elements if they are out of order. Repeat until array is sorted.
- Insertion sort: Scan successive elements for an out-of-order item, then insert the item in the proper place.
- Selection sort: Find the smallest (or biggest) element in the array, and put it in the proper place. Swap it with the value in the first position. Repeat until array is sorted.
- Quick sort: Partition the array into two segments. In the first segment, all elements are less than or equal to the pivot value. In the second segment, all elements are greater than or equal to the pivot value. Finally, sort the two segments recursively.
- Merge sort: Divide the list of elements in two parts, sort the two parts individually and then merge it.

We will present one level of sorting process using some sensors like:

- Ultrasonic sensor
- Colour sensor
- Inductive sensor

Inductive Sensor(LM12-2004A):

surveillance of metal elements motion. They can also be used in other machine
systems applications as no contact control sensors for level of liquids, control
sensors for the speed and position of rotating chains, etc. They are developed on
the base of PNP and NPN transition. They have small dimensions and feature a
cylindrical metal shell resistant to vibrations and a plastic lid which is oil and
water resistant.

Electrical Specifications:

- Insulating resistance: ≥ 50 M Ω
- Gearing distance: from 2 mm to 7 mm
- Precision of repetition: 0.01
- Ambient temperature: -25˚C to +65˚C
- Gearing speed: 5mm/s
- Rated voltage: 6~36VDC; 90~230VAC

we use during calibration & practical working:

- Fixation of the target at 4,00mm from the capacitive sensor.
- Using relay 5VDC.

The circuit used in the calibration process:

Ultrasonic Ranging Module(HC - SR04):

- The basics of using ultrasound are like this: you shoot out a sound, wait to
hear it echo back, and if you have your timing right, you'll know if anything
is out there and how far away it is. This is called echolocation and it's how
bats and dolphins find objects in the dark and underwater, though they use
lower frequencies than you can use with your Arduino.

The principle of ultrasonic ranging

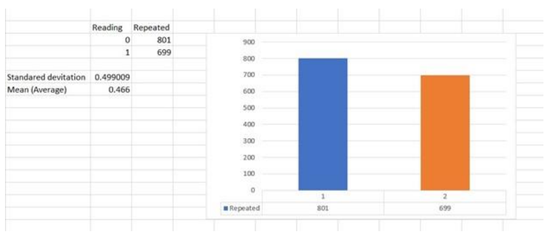
sound waves are reflected by obstacles, and the speed of sound waves is known, so it is only necessary to know the time difference between transmission and reception, and the measurement distance can be easily calculated, combined with transmitter and receiver. The distance of the device can calculate the actual distance of the obstacle.

Electrical Specifications

- Operating Voltage: 3.3Vdc ~ 5Vdc
- Quiescent Current: <2mA
- Operating Current: 15mA
- Operating Frequency: 40KHz
- Operating Range & Accuracy: 2cm ~ 400cm (1in ~ 13ft) ± 3mm
- Sensitivity: -65dB min
- Sound Pressure: 112dB
- Effective Angle: 15°

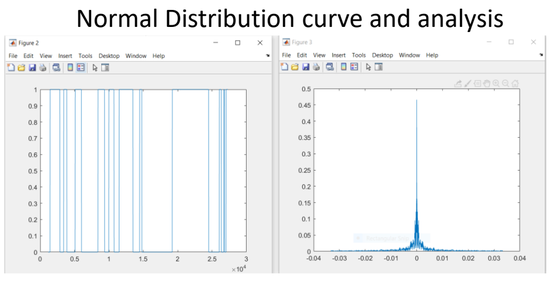
Datasheet details that we use during calibration & practical working:

- Fixation of the target at 10.7 cm from the ultrasonic.

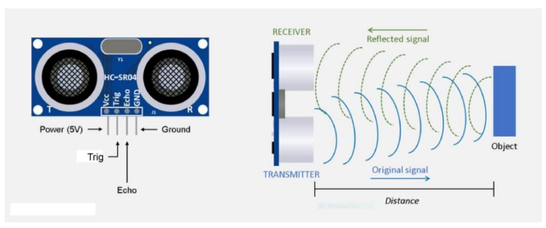


	Reading	Repeated
	0	801
	1	699
Standared devitation	0.499009	
Mean (Average)	0.466	

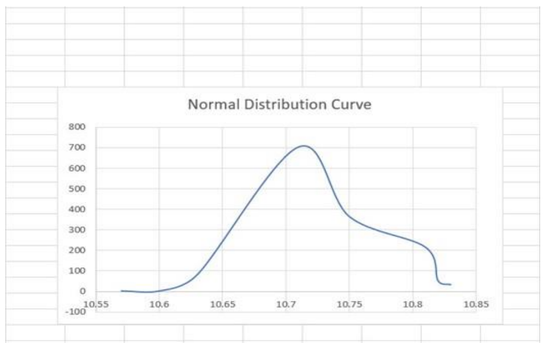
Normal Distribution curve and analysis



Inductive_Fourier series



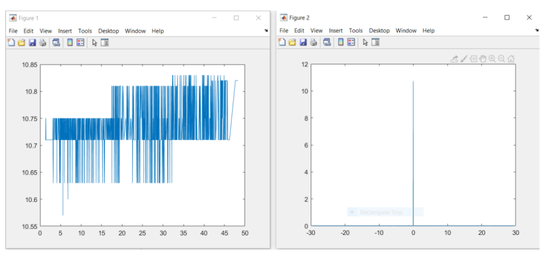
The principle of ultrasonic ranging



Ultasonic_Normal Distribution curve

	value	repeated	Accuracy	Precision
	10.57	1	0.98785	0.984475
	10.6	1	0.990654	0.987269
	10.63	81	0.993458	0.990063
	10.71	705	0.999065	0.997514
	10.75	364	0.995327	0.99876
	10.81	215	0.98972	0.993172
	10.82	50	0.988785	0.99224
	10.83	32	0.98785	0.991309
MIN	10.57			
MAX	10.83			
MEAN (avrage	10.73668737			
STANDARED D	0.047856682			
MEDIAN	10.71			
X_Actual	10.7			

Ultasonic_Accuracy & precision & analysis



Ultrasonic_Fourier series

Colour Sensor Module(TCS3200):

This Arduino compatible TCS3200 colour sensor module consist of a TAOS TCS3200 RGB sensor chip and 4 white LEDs. The main part of the module is the **TCS3200 chip** which is a Colour Light to-Frequency Converter. The white LEDs are used for providing proper lighting for the sensor to detect the object colour correctly. This chip can sense a wide variety of colours and it gives the output in the form of corresponding frequency. This module can be used for making colour sorting robots, test strip reading, colour matching tests, etc.
The **TCS3200 chip** consist of an 8 x 8 array of photodiodes. Each photodiode have either a red, green, or blue filter, or no filter. The filters of each colour are distributed evenly throughout the array to eliminate location bias among the colours. Internal circuits includes an oscillator which produces a square-wave output whose frequency is proportional to the intensity of the chosen colour.

The principle of Colour sensor working :

The TCS3200 has an array of photodiodes with 4 different filters. A photodiode is simply a semiconductor device that converts light into current. The sensor has:

- 16 photodiodes with red filter – sensitive to red wavelength
- 16 photodiodes with green filter – sensitive to green wavelength
- 16 photodiodes with blue filter – sensitive to blue wavelength
- 16 photodiodes without filter

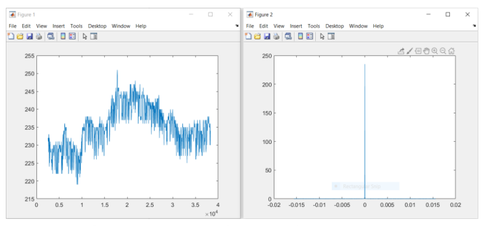
If you take a closer look at the TCS3200 chip you can see the different filters.
By selectively choosing the photodiode filter's readings, you're able to detect the intensity of the different colours. The sensor has a current-to-frequency converter that converts the photodiodes' readings into a square wave with a frequency that is proportional to the light intensity of the chosen colour. This frequency is then, read by the Arduino – this is shown in the figure.

Features and Specifications:

- Input voltage: (2.7V to 5.5V)
- Interface: Digital TTL
- High-resolution conversion of light intensity to frequency
- Programmable colour and full-scale output frequency
- No need of ADC(Can be directly connected to the digital pins of the microcontroller)
- Power down feature
- Working temperature: -40oC to 85oC
- Size: 28.4x28.4mm(1.12x1.12")

Datasheet details that we use during calibration & practical working:

Detecting an object that have Red Colour



GREEN_Fourier series

Correlation:

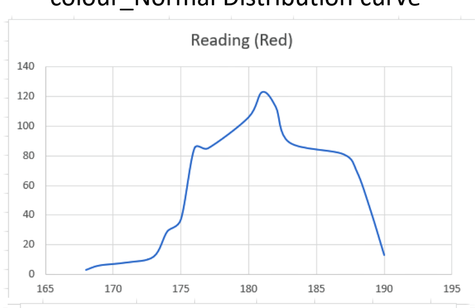
Ultrasonic_sensor_distance and Colour_sensor_frequency
Correlation at (distance <= 10)

Components:

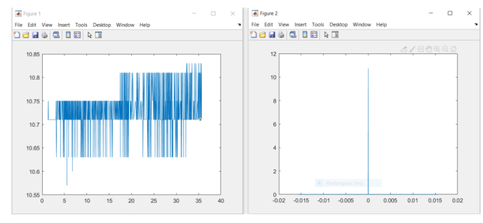
Arduino Uno
Ultrasonic Sensor(HC-SR04)
Inductive Proximity Sensor(LM12-2004A)
Colour Sensor
Stepper Motor(Nema 23)
Nema 23 Driver
Flexible Coupling
Conveyor Belt
LCD Screen
2 Battery (12 v)
Wood Plates
Relay one channel
Jumpers

Reading (red)	Repeated	Accuracy	precision	Reading (Green)	Repeated	Reading (Blue)	Repeated
168	3	0.938547	0.92672	219	3	168	3
169	6	0.944134	0.932236	222	17	169	3
171	8	0.955307	0.943268	226	19	170	19
173	12	0.96648	0.954301	227	40	173	15
174	29	0.972067	0.959817	228	45	174	29
175	37	0.977654	0.965333	229	52	175	60
176	85	0.98324	0.970849	230	54	176	63
177	85	0.988827	0.976365	233	64	177	66
180	106	0.994413	0.992914	234	80	180	100
181	123	0.988827	0.99843	236	87	181	118
182	113	0.98324	0.996054	237	94	182	120
183	89	0.977654	0.990537	238	53	183	86
187	81	0.955307	0.968473	242	44	187	85
188	69	0.949721	0.962956	244	44	188	72
189	43	0.944134	0.95744	245	28	189	33
190	13	0.938547	0.951924	246	12	190	19
				247	9	191	2
Standard Dev.	4.59520714			Standard Dev.	5.8039643	MEAN	181.1207
						Standard Dev.	4.811508
MEAN	181.2845745			MEAN	235.04078	193	2

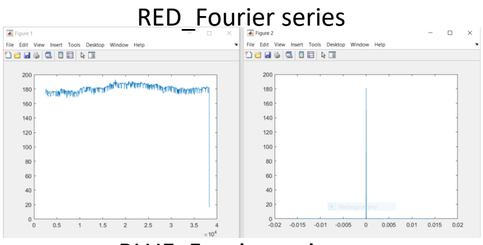
colour_Normal Distribution curve



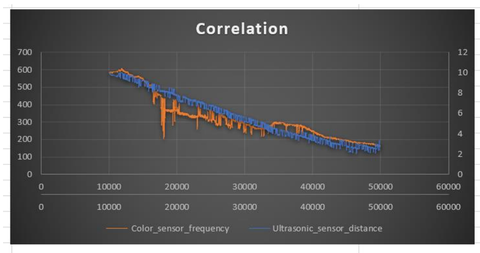
Normal Distribution curve



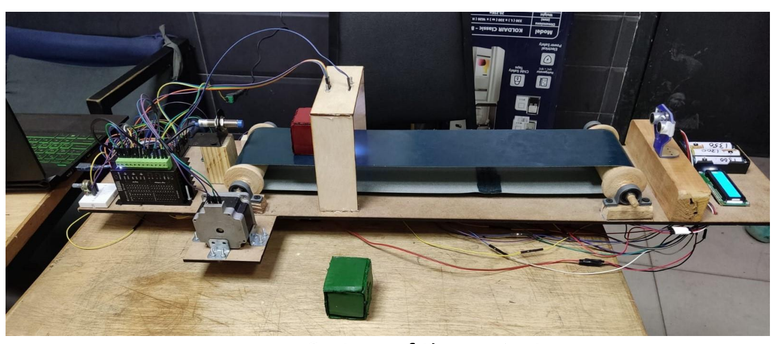
RED_Fourier series



BLUE_Fourier series



Correlation (Ultrasonic_sensor_distance and Color_sensor_frequency)	0.923325936



System of the project

Reference :

Alan S. Morris. (2011). Measurement and Instrumentation Theory and Application(second edition),
Ams Datasheet TCS3200,TCS3210
Elec Freaks Datasheet HC-SR04
Ital-sensor Datasheet LM12-2004A

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