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DETECTION OF RECYCLABLE AND NON-RECYCLABLE PLASTIC BY SPECTROSCOPY ANALYSIS

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ABSTRACT

Plastic is widely used material all over the world. Use of plastic creates waste which is necessary to sort. Plastic waste must be sorted so as to recycle into its various types. This article presents idea of using microcontroller based near infrared spectroscopy system to sort the type of plastic waste. Near infrared spectroscopy is a spectroscopic method that uses the near infrared region of the electromagnetic spectrum of about 700nm to 2500 nm. A prototype model has been developed which is able to control LED'S (Various wavelengths) and detectors.

KEYWORDS: Near infrared spectroscopy, plastic sorting, detectors

I. INTRODUCTION

Currently, plastic sorting is done using the recycling codes i.e. manual method in which codes are imprinted on most plastics – this solution proves to be of high cost. The spectrum we obtain by analysis the received wavelengths from the samples is very different for every different kind of material. This spectroscopic technique of using near infrared region wavelengths gives higher accuracy for detection of the material.Near-infrared spectroscopy(NIRS) is a electromagnetic spectrum analyzing method which uses the near- infrared region of specific range (from about 700nm to 2500 nm). The basic principle behind NIR technology is measuring the reflected waves i.e. reflectivity of an object within a **wavelength range of 1.100 to 2.100 nm**

II. IMPLEMENTATIONS

System implementation

The sorting system which is presented comprise of the system for handling material and the system for detection. The device features an efficient microcontroller (msp430) which has 16-bit RISC CPU, 16-bit registers, and constant generators that assures maximum code efficient built-in 16-bit timers, analog comparator, up to 24 I/O capacitive-touch enabled pins, and built-in communication capability using the universal serial communication interface

The plastic material which is to be sorted or studied is passed over the conveyor belt which is driven by DC Motor. The infrared wavelength rays are passed over the plastic material. Depending upon the reflectance and absorbed wavelength received by the detectors, the data signals are processed and studied via microcontroller and computer.

The plastics and some other materials are studied depending upon the reflected and absorbed wavelength from the material being passed over the conveyor belt. All the recyclables shall be presented to the detector one at a time to maximize accuracy and therefore quality. The proto type system shall be able to handle, detect, and sort plastic recyclables of various sizes and types. There are various measurement modes we can opt for, but diffuse reflectance measurement, is the ideal measurement mode that can be employed in NIR spectroscopy. our system comes under micro sorting which is gaining acceptance in the plastic industry very fast. Since year 1990, the systems which sort the plastic automatically has started and soon within few years the first commercial system that can separate PVC from PET using X-ray technology was developed. Since then research and development work in this field has progressed tremendously, may be with increase awareness about recycling, reuse, remanufacture etc.

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Figure:

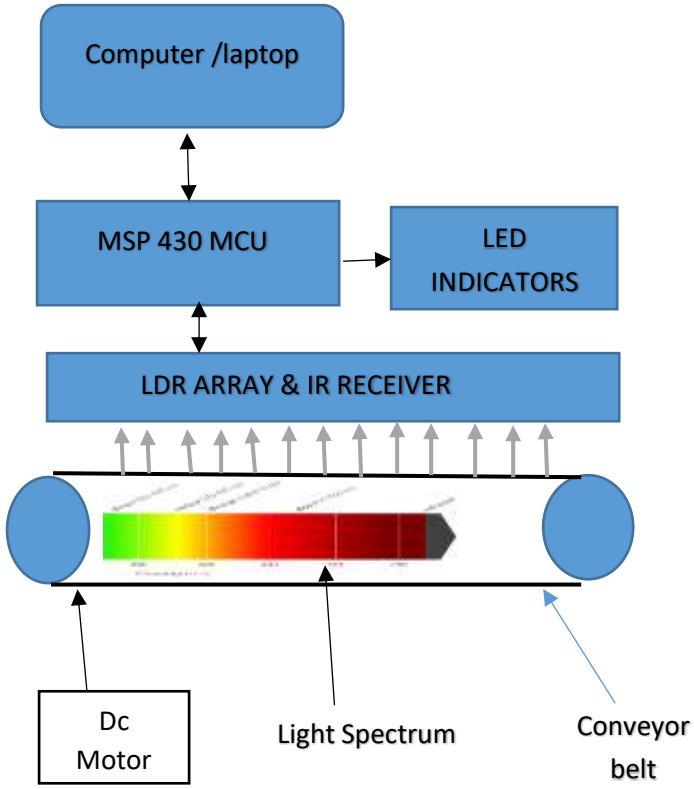

Fig1 : Implementation flowchart

III. RESULTS AND DISCUSSION

The radiation received from the diffuse reflectance occurring on the solid sample is studied and based on the various observations, conclusions are drafted, diffuse reflectance is more efficient mode then transmittance. Today, diffuse reflectance is one of the various possibilities for employing the NIR spectral region. Figure depicts the most common measurement modes measured by NIR spectroscopy

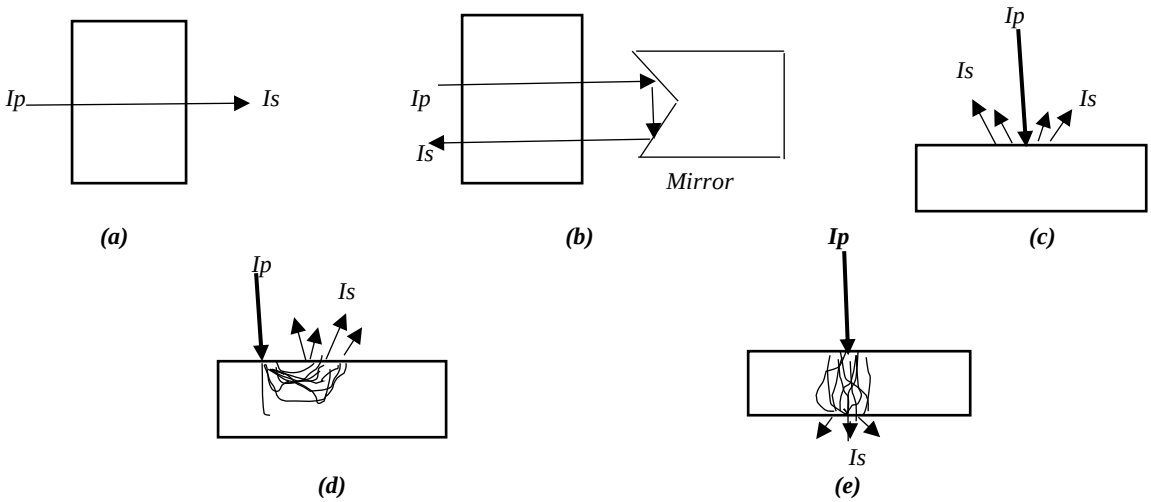

Fig: various modes of measurements for nir spectroscopy a) transmittance b) transflectance c)diffuse reflectance d)interactance e)transmittance through scattering medium.

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Following are some plastic types that can be sorted as recyclable or non-recyclable material by using near infrared spectroscopy:

1. Polyethylene terephthalate(PET) 5. Polypropylene 2. High-density polyethylene 6. Polystyrene 3. Vinyl 7.Other. including multilayer 4. Low-density polyethylene

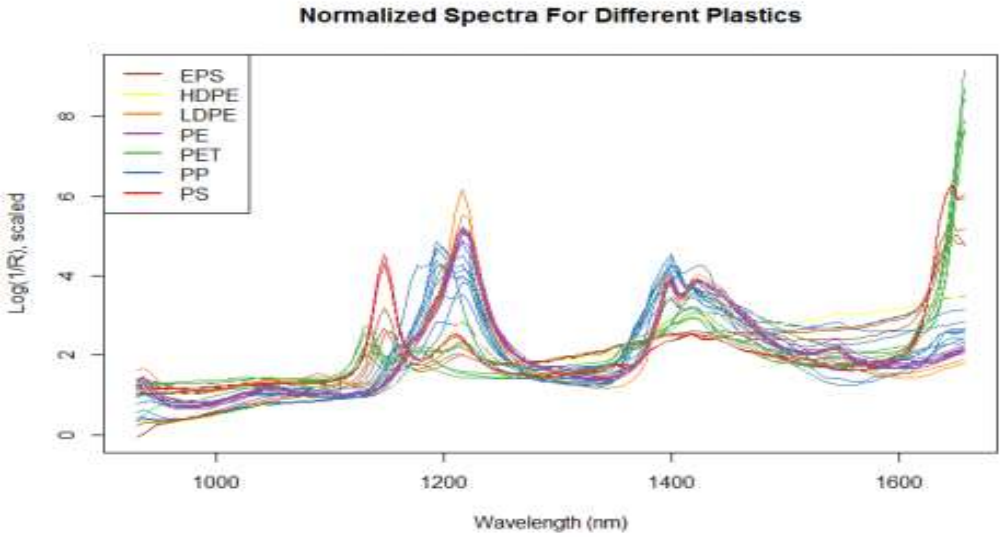

Fig 3: Normalized spectra for different plastics.

By detail analysis of the spectra of different plastics, we have analyzed and allotted threshold values as way to differentiate the type and recyclable or non-recyclable type of plastic material. Following table shows the plastic types and classification into recyclable and non-recyclable type of plastic: threshold value is 12. The materials above the threshold values are analyzed to be non-recyclable type of material or recyclable under advanced recycling processes.

Table 1. Result classification of plastic type

S r no.	Plastic material and other materials	Approximate Threshold value	Result
1	Polyethylene terephthalate (PET)	11	Recyclable but if multilayered PET then non-recyclable
2	High density polyethylene(HDPE)	12	Non-recyclable if hard plastic form else recyclable
3	Vinyl		Non-recyclable
4	Low density polyethylene (LDPE)	12	Non-recyclable but can be recycled if material is of low density
5	Polystyrene (PS)	21	Non-recyclable
6	Polypropylene (PP)	20	Non-recyclable
7	Other : BPA, Polycarbonate and LEXAN	23	Non-recyclable
8	Other : Paper, cardboard etc	10	Recyclable

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IV. CONCLUSION

NIRS method assures fast observation of plastic structural properties and thus we can identify and sort plastic. More Further, we can use wireless interface, that can control the NIRS instrumentation remotely, can be implemented for safety purpose.

V. ACKNOWLEDGEMENTS

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