An Automated System for Sorting Plastics by Color

Tomris Nurdane Mortas

Abstract— Nowadays, color and color application science and technology have widely used throughout the world for a long time ever since such a need arose in the manufacturing industry. A color sorting system provides sorting out objects by different properties compromising shape, color and etc. Color sorting machines have been found working on the purpose to seperate materials in every type of industrial wastes. In this paper, it has been developed and built a multiple sorting electromechanical system on plastic materials on different colors as a prototype. The prototype in this study consists of hardware and software systems. Hardware system is designed by using conveyor belt, microcontroller and LCD display as the user interface unit, and also feeding the system.

Index Terms— **automated color sorter, LED, microcontroller, PIC16F877, sorting plastics, PIC C, Proteus**

1 INTRODUCTION

Waste, depending on the type of material, consists on unwanted materials left over from manufacturing processes (industrial, commercial, mining or agricultural operations,) or from community and household activities. Everyday, tones of waste are generated; causing a major problem to various cities and their municipal authorities due to the shortage of landfill to dump such waste. Therefore, recycling is becoming an important issue with the shortage of the landfill and environmental pollutions as well as its economical impact [1].

Waste, especially household and commercial waste, is a heterogeneous mixture of different kinds of products, containing reusable or recyclable materials, and their size/condition mainly depend on how the waste is collected and transported [1-3]. Plastic bottles, for example, are the main municipal waste and they are non-biodegradable materials (are chemically stable). In fact, plastic waste can be visible for months or years and is a serious environmental problem [1, 4]. Hence, the treatment of plastic wastes becomes a serious problem and it is necessary to develop an effective recycling process.

The efficiency and quality of all recycling process depends highly on the purity and accuracy of the sorted raw materials [1]. Waste separation is a critical component of any successful integrated waste management system [5] and several technologies are being developed (by size, shape, color, volume, etc.). The open literature presents several works for detecting and sorting different materials in order to sort them out and prepare them to be recycled [1, 4, 6].

Plastic bottles, for example, can be sorted into different categories based on their chemical resin, transparency and/or color, however, the last one is much more adequate [1]. In terms of color, the plastic bottles can be sorted by manual procedures or by sensor systems.

The first one presents some inconveniences relatively to the human capabilities, like: eyes capacity, fatigue, concentration and health. In these context automatic systems based on sensors appears in different countries and shows to be efficient facilities to separate the waste [3, 7, 8]. The most typical apparatus work with a high-resolution color sensor or a spectrometer to scan the near infrared spectrum. Color cameras have been used to sort materials into white, green, brown and opaque fractions or construction waste into different material classes [3, 9]. There have been studied automated sorting machines based on color using visible reflectance spectroscopy (VIS) [8] artificial intelligent systems using near infrared reflectance (NIR) measurements [1] and integrated systems [7].

Although of the higher technical capabilities of these equipments, their usage is not a guarantee of a good sorting process, purity and recovery of multiple resources. Therefore, the present study intends to improve the knowledge about automatic systems. For this purpose an automated sorting system is developed to support multiple plastic materials classification based on sensors.

Automated sorting system will be developed to support multiple plastic materials classification on the conveyor belt. Normally, sorting systems consist of a conveyor road for the separation and steadying of the material, a detector which is placed underneath or above the conveying belt and banks which blow out the material component that is to be sorted. The hardware consists of control section, the detecting section, and conveyor blocks. Microcontroller is used to perform connection to the peripherals units, and to provide the system's control. The PIC16F877 microcontroller is used in the design work. Sorting system has been developed to perform sending plastics into the correct banks by the conveyor belt. The block diagram of the system's hardware is shown in Fig. 1 and Fig. 2. Plastics with different colors, dimensions and shape are moving on a conveyor belt. For the sorting system, additional apparatus are necessary such as control card, sensor, lcd, bunkers for material feeding, platform for sorter, conveyor systems for inlet and outlets. Different plastic materials, with different colors, are scanned on the conveyor belt by detectors and will be deposited into different containers in function of their colors as shown on lcd as an interface for showing the actions of the system and displaying the necessary referrals to

• *Tomris Nurdane Mortas is currently pursuing Ph.D degree in Mechatronics Engineering, Sakarya University, Turkey and working at Abdullah Gul University, Kayseri, Turkey E-mail: tomris.mortas@gmail.com*

the user during the operation of the system.

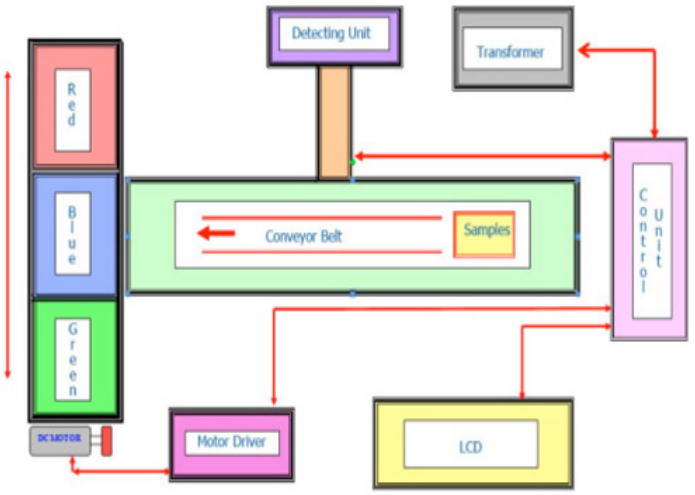


Fig. 1. Schematic illustration of automated sorting system

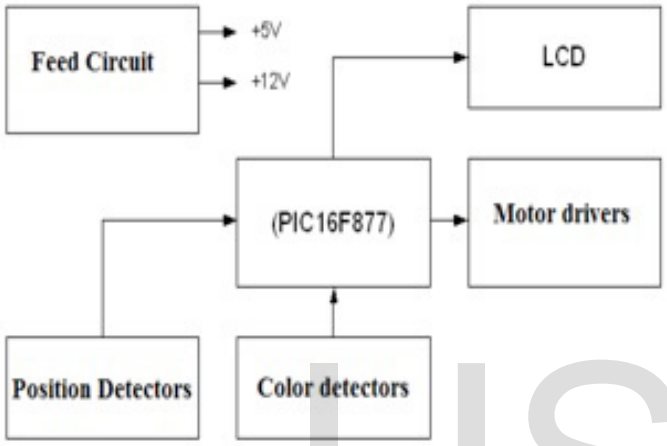
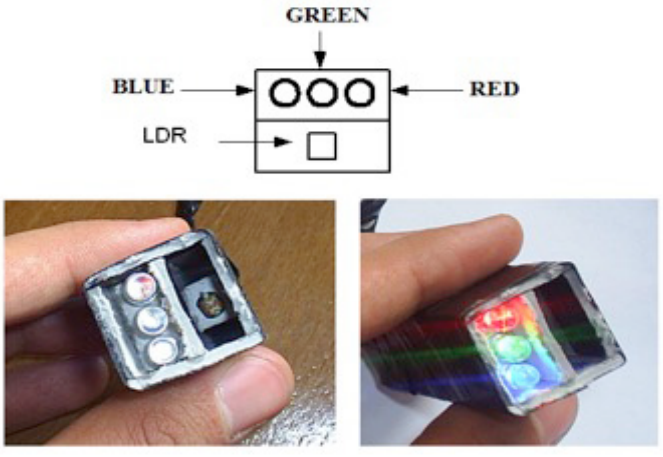


Fig. 2. Circuit diagram

Fig. 3. Design of detecting system

The detecting elements are made by hand. These elements makes the system to run by detecting the color of samples on conveyor belt with the distance 20-40 mm where it is used LDR to sense color. It is designed the detecting system as shown in Fig 3. with the usage of LDR. LDR should be insulated from the light through the color sorting system.



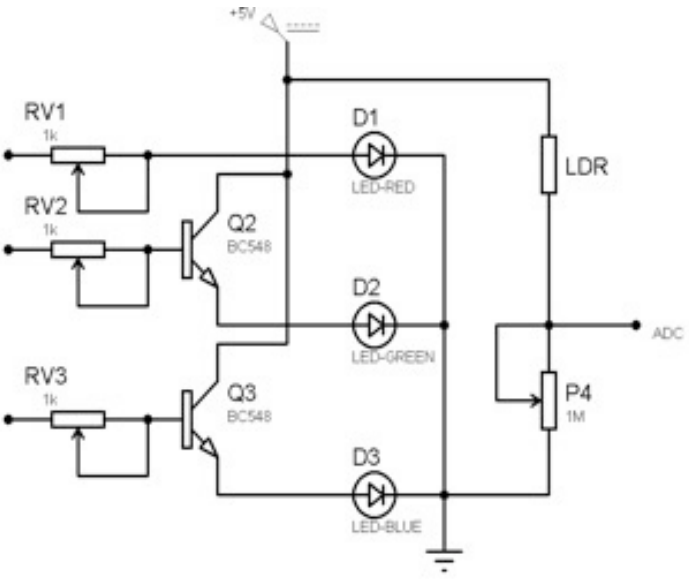


Fig. 4. Illustration of LED system

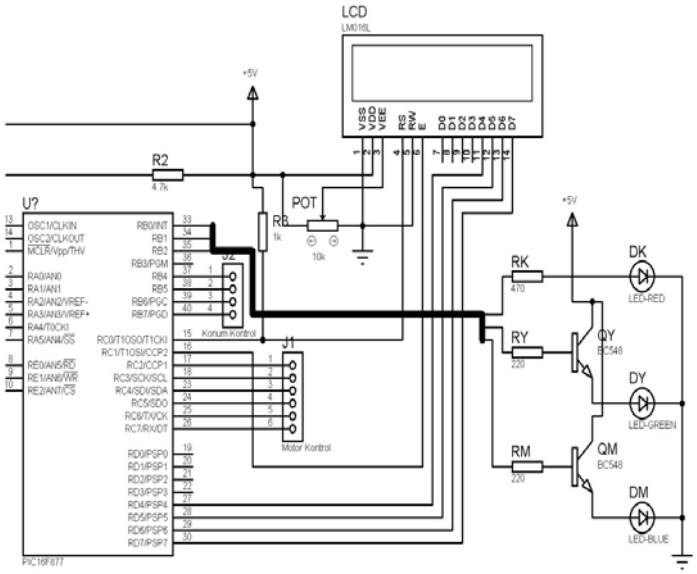


Fig. 5. Proteus simulation of circuit

Here, with the usage B port of microprocessor, it was intended to control of LED. When red led can be controlled through resistance conntected to microprocessor directly due to the need more current, others can be controlled BC548 transistors as shown in Fig. 4 and more about system configuration can be seen in Fig. 5.

At this stage of study, system software is discussed. Control program for the system is written in PIC programming language. It is programmed PIC C language with the part of this sorting system' software programming. The reason why is preferred PIC C language is that programs written in PIC C language are easier to write and have advantages in terms of efficient performance and similarity to machine languages. Control program that enables the transition from as a result of the branches in the decision cycles to sensor provides to contact with peripheral units, such as lcd and detectors. In this system decision mechanisms are processing by the control program without user intervention. While the main program is processing, frequently realization of some systems, such as sensing and sorting, disrupts the operation of the main program, thus the program completes a cycle time longer than expected. Needed processes to control all conditison can be done to minimize all adverse conditions and there can be provided the operation of the system more efficiently.

4 Conclusion

The required hardware and software were made for sending any number of data using a microcontroller via the detecting system. The system with microcontroller has been tested at first, and reached the conclusion that communication is successful from according to receiving data from detecting system. Communication between microcontroller and peripherals, such as LCD display, tested, and successful results were obtained.

Plastics material sorting technologies promote lower costs with higher performance when compared to the manual procedure. An automated detector system for recycling waste plastics with different colors was developed. This equipment can be adapted to different materials with the changing of the sensors, separating more than three colors and appliable on different needs.

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