MATLAB – Arduino based Industrial Conveyor Belt

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ABSTRACT
The main intention of this project is to elaborate and simplify how different products manufactured in a factory can be put on a single conveyer for its proper distribution and data logging in a random sequence.

To upgrade this process, images captured by the webcam can be processed with image processing techniques using software like MATLAB. This image processing technique and color detection techniques are applied for the taken image and the appropriate output is obtained in this project.

The goal is to develop a conveyor belt which will play a vital role in small scale as well as large scale industries for distributing and logging the data, consequently reducing the cost of labour and multiple conveyors. The system leverages a conveyor belt with 2 motors, a mechanism to sort the products and a Webcam in proximity of the apparatus. The webcam is mounted in parallel to the assembly line focused on the products on the conveyors in order to have known the product and its sequence. The apparatus sends image processed readings and measurements over wires to a microcontroller for further processing. Code running on the microcontroller in conjunction with a code in MATLAB generates an output on the appropriate pins configured by user by a program, which controls the speed and direction of the conveyor belt. This quality in MATLAB image processing toolbox and Arduino has made it possible.

This research thus implements an industrial assembly line with methodology in image processing.

ALGORITHM
Color detection using thresholding techniques

Keywords
Arduino Board, Image Acquisition, Image processing, MATLAB, Conveyor belt.

1. INTRODUCTION
Elementary conveyor belts were used since the 19th century. In 1892, Thomas Robins began a series of inventions relating to conveyor systems, which led to the development of a conveyor belt used for carrying coal, ores and other products [1]. Recently conveyor belt systems are not only used in mining industries but also applied in cement industries, food factories, power plant, and production industries etc. So it is essential equipment for in house material transportation today[2].
A conveyor Belt is ultimate and widely used option in most of the manufacturing industrial applications where ever there is need for complete assembly line automation like chemical industries, bottling plant, food processing and packaging factories. The entire process from production to sort products for packaging is carried on a single conveyor belt and the

processes are done in between, while they are moving. So here, one such conveyor belt application is explained. Determining real time and highly accurate characteristics of small objects in a fast flowing stream would open new directions for industrial sorting processes[3]. This is

the project to build a single conveyor belt for multiple objects in a random sequence, for its proper distribution and data logging.
In this project efforts have been made to use a single assembly line for the classifying and sorting purpose of different objects using electronic systems, advanced sensors and image processing technique in MATLAB on the basis of physical and color characterization of each object. The project involves colour identification of an object which is done by a webcam acting as colour sensor which identifies the object's colour and sends the signal to the ATMEGA microcontroller. The microcontroller in response to the received signal; generates an appropriate control signal which is send to the circuit which drives the various motors and it also synchronizes the movement of the belt with the sorting mechanism. Based upon the color detected, the linear actuator pushes the object to the specified location. It aims in classifying and sorting the colored objects which are coming on conveyor belt by placing them in their respective pre-programmed place. The GUI based system helps to control and monitor the whole conveyor belt. With this it is possible to calculate the number of items with their respective colors and predefined weights which will make packaging much easier and controllable. Due to this only one conveyor is sufficient instead of many, Thereby achieving high accuracy and speed in the work; while eliminating the monotonous work done by human.
There are many different methods to detect object through image processing like surf, histogram, and matrix method and color detection using MATLAB image processing toolbox.

2. RELATED WORK
Now a day's Conveyor belt system are widely used in cement industries, power plant, food industries, production industries etc. So it is essential equipment for in house material transportation today. The modification and latest technologies or methodologies used in different applications to reduce failures, maintenance cost and equipment related a fatal accident occurs during operation.

By classifying the colored objects by its color, which are coming on the conveyor by sorting the objects in its respective pre-programmed place which drastically reduces the monotonous work done by human, increasing accuracy and speed in the work. In that the microcontroller sends signal to circuit which drives the various servo motors attached at specific location on the conveyor. Based upon the detected object, the servo motor rotates and pushes the object to its specified location, and returns to the original position [11].

In research applications on robotics and automation where there is need of powerful linear algebra tool, MATLAB is widely used software environment mainly because it has a very good collection of image processing toolboxes which supports in the detection of colours for sorting mechanism. Arduino IDE (Integrated Development Environment) is free open source prototype and environment for interfacing interactive analog and digital devices (electronic). Basically it is used for programming the microcontrollers. In this project we have made use of the Arduino library to interface the Atmega 328 microcontroller deployed on our board.

2.1. Conveyor Belt

Conveyor belt is a continuous moving band made from fabric, metal or rubber used for transporting objects from one place to another mainly within the industry. A conveyor system consists of a conveyor belt, two or more pulleys that rotate around in endless loop of the conveyor belt. One or both of the pulleys are powered which causes the belt and the material on the belt forward. The drive pulley is the powered pulley while the idler pulley is unpowered pulley.

2.2. Arduino

Few years ago the Arduino development team designed a AVR microcontroller board and released it under an open source license. Arduino is a registered trademark—only the official boards are named "Arduino". So clones made by other manufacturers usually have names ending with "duino" [4]. The Arduino developers have created a simple but useful integrated development environment (IDE). This project is intended to design a microcontroller circuit board of its own similar to that developed by Arduino team and make use of the open-source Arduino environment (IDE) and its libraries to make it easy to write code and upload it to the I/O board. The Boot loading package of Arduino IDE is used to burn programs into the Atmega IC [9].

2.3. MATLAB

The name MATLAB is abbreviation for MATrix LABoratory. MATLAB contains various high performance computation and visualization software packages. It is also a interactive environment which includes hundreds of built-in functions for technical computation, animation, and graphics which provides flexibility with its own sophisticated programming language [5][6]. The proposed project uses MATLAB in conjunction with the Arduino for digital image processing to classify each object on the basis of physical and color characterization.

2.4. Project Key Features
- A single conveyor belt for the entire process.
- Conveyor belt can be configured to fit almost any application.
- PC to microcontroller communication.
- Object color and shape identification using MATLAB.
- Reduce production cost and labour hours.
- Conveyor system improves reliability, efficiency & production.

2.5. Applications
- In small and large scale industries to sort the products based on the various parameters.

- Medicine and wine industry use this technique to sort the bottles of various sizes.

- Food industries make use this system to identify the rotten or damaged fruits.

- It can be used to sort the different agricultural products like almonds, grains, lemons, grapes, and many more in agriculture Industries.

- In Robotics application like artificial robotic intelligence.

2.6. OBJECTIVES
- The general objective of this project is to elaborate and simplify how different products manufactured in a factory can be put on a single conveyer for its proper distribution and data logging in a random sequence.

- To develop a conveyor belt which will play a vital role in small scale as well as large scale industries in lower cost.

- To implement an industrial assembly line with methodology in image processing.

- Reduces production cost and labour hours.

- To improve reliability, efficiency & production.

3. METHODOLOGY
3.1. Design Flowchart
The figure 1 and figure 2 shows flowchart of a system. The basic theme of this project is that the object moving on conveyor are first sensed, and then sorted depending on their colour and size. For this, webcam is used as input sensor, which is mounted on PC, and will be connected to PC via USB. The webcam will take a snapshot and it will send it to PC for colour processing [7]. In PC; MATLAB is used for processing on colour, depending on the detected colour an appropriate signal will be given to microcontroller Atmega 328. In turn, the microcontroller will control the linear actuator and servomotors by PWM signals. These servomotors and linear actuator will place the object in its respective place depending on its colour and size. This is full automatic process no manual support is needed. The MATLAB-Arduino platform supports the microcontroller for its optimum use [8].

Fully functional multi-object sorter mechanism can be implemented on a single conveyor belt in order to increase the overall throughput which results with a forecasted performance. The project can work successfully. The system can successfully perform station handling task, specifically sorting mechanism with help of sensors. Hence a cost effective Mechatronics system can be designed using the simplest concepts and productive result can be observed.

So this project presents a mechatronics colour sorting system solution with the application of image processing. The proposed system works in following three steps:

- Image Acquisition
- Image Processing
- Sorting Mechanism

3.2. IMAGE ACQUISITION

To start with when the object on the conveyor is detected by the IR sensors, image is captured by the camera and is sent to

the MATLAB workspace. The input image obtained from the webcam cannot be directly given for processing. Pre-processing is done on the image such as thresholding. Then only object image is converted in binary format. This final threshold image of object is now ready for processing [7][6].

3.3. IMAGE PROCESSING

The objects are sorted on the basis of color and predetermined shape. To identify the color, firstly the image is converted into gray format and then thresholding is done. After thresholding color components are extracted and the image is converted into black and white format which is called as binary format Find region properties & bounding box and the color are identified [6][13].
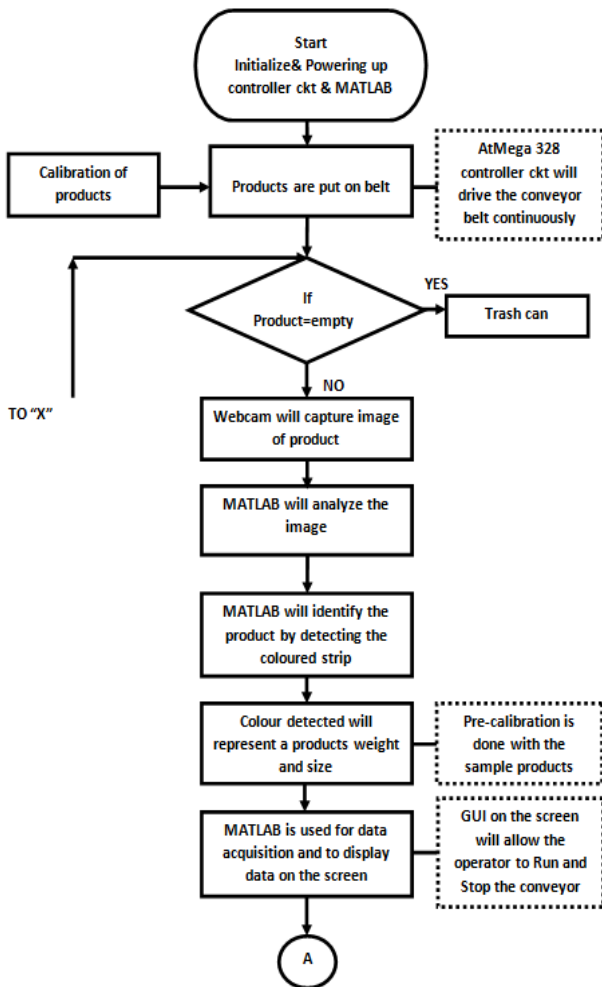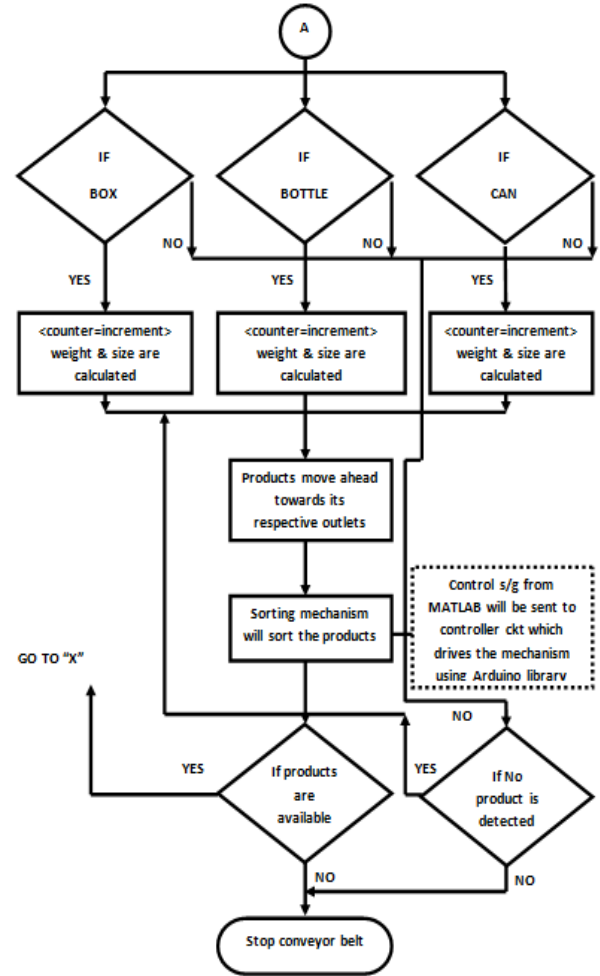

Figure 1: Block diagram part A

Figure 2: Block diagram part B

3.4. SORTING MECHANISM

The sorting mechanism consists of a linear actuator, servo motors and a conveyer assembly. After identifying the color with predetermined size, command will be sent to direct the linear actuator through COM port of the computer via the development board. Conveyor assembly is in OFF state for this period. According to the size and color the servo motors with help of linear actuator places the objects in their specified place.

4. TOOLS TO BE USED

4.1.1 Atmega 328: It is a single chip microcontroller used instead of Arduino board. The ATmega328 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. It has 32KB ISP flash memory with read-while-write capabilities & compatible with Arduino IDE [12].

4.1.2 Motor Driver IC: L293D is a dual H-bridge motor driver IC (integrated circuit). Since they take a low-current control signal and provide a higher-current signal which is used to drive the motors, it acts as current amplifier. [14].

4.1.2. FTDI Chip with UART: The UART (Universal Asynchronous Receiver Transmitter) converts parallel out to serial out and sends it with proper added bits for timing.

4.1.3. USB Connection: To form a connection between PCB and computer. Universal Serial Bus (USB) defines the various hardware cables and communication protocols used in a bus which are responsible for communication-connection

function and power supply between computers and electronic devices.

4.1.4. Crystal 12MHz: Standard frequency crystals - use these crystals to provide a clock input to microprocessor. Rated at 20pF capacitance and +/- 50ppm stability. 12MHz is good for use with devices that need USB.

4.1.5. Power Supply: To fulfill the power requirement of the components a power supply is used which is an electronic device that supplies electric energy to an electrical load. The role of power supply is to convert one form of electrical signal to another, therefore power supplies are mostly referred to as electric power converters.

4.1.6. Servo Motors: Servo motor have built in gearing and feedback loop control circuitry. They are basically DC motors. A servomotor is a rotary actuator that does not require any motor driver for precise control of angular position.

4.1.7. Conveyor Belt: It is mechanically movable belt usually made of polyester which is used for transporting the object. It has two or more pulleys, with a continuous loop of conveyor belt - that rotates about them. The drive pulley is the powered pulley while the idler pulley is unpowered pulley.

4.1.8. MATLAB: It provides high performance built in functions, reference-standard algorithms, and applications for the task of image processing, visualization, analysis, and algorithm development; and also used for object detection using webcam[10].

4.1.9. Arduino Software: Arduino software is used for the interfacing between board and MATLAB.

4.1.10. Webcam: It is a video camera that captures the images in real time to or through a computer to computer network.

5. EXPECTED RESULT

The conveyor system designed will only be efficient when it achieves higher degree of accuracy and its output is very close to the expected result. The initialization delay of the microcontroller in the beginning is expected and can be tolerated up to 4 seconds.

The Conveyor system is designed in an efficient way and expecting to work normally with provided power supply. The Matlab code has the option to modify the industrial and product parameters and can be recalibrated.

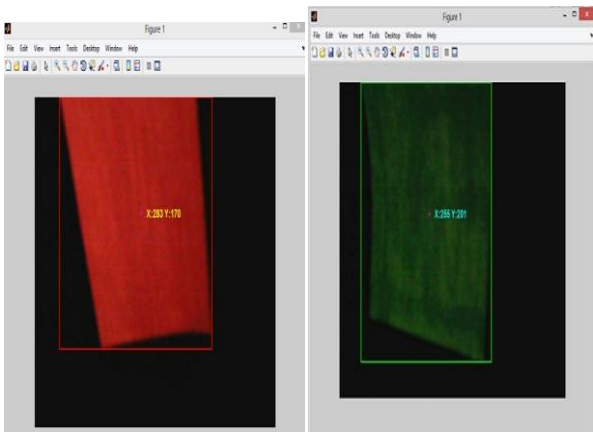There is still a lot of work being done on this project to achieve 'Expected Results'…
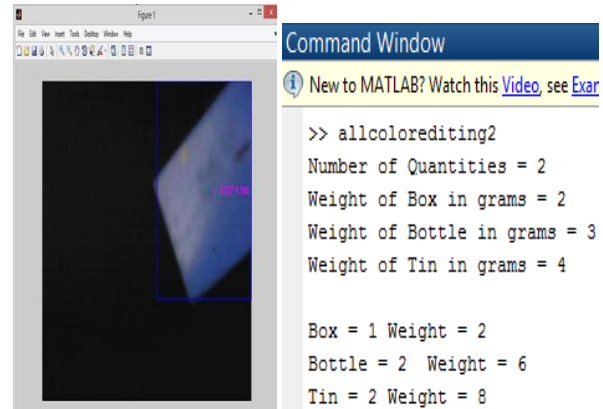

Figure 2. Red & Green colour detected

Figure 3.Blue colour detected & Output on command window

6. CONCLUSION

The Code is generated using MATLAB image processing in conjunction with Arduino.

The whole process is documented in the theory sections. **There are no more limits but your imagination. One can begin** to explore the more advanced functionality that the MATLAB-Arduino platform offers to understand as one progress further and further.

It was a valuable experience in making the project design, implementation, and testing of a system that involved digital components. More time was available for the circuit design and implementation, which was able to go through several designs before an acceptable one was reached. Ultimately the system accomplished its primary goal of motor speed control in a clear way.

7. FUTURE SCOPE OF THE PROJECT

Conveyor belts are designed for a systematic organization of workers, machines, and products. Mass production & distribution via conveyor belts is widely considered to be the reason which is responsible for the modern consumer culture leading to low unit cost for manufactured goods.

The conveyor belt designed today can be upgraded to automatically sort more number of products on a single conveyor belt and delivered at convenient distances with faster speeds. More precisely coded algorithm will be developed using image processing techniques and optimally planned logistics for creating a finished product much faster than with present methods.

The constant research & development has abled to improve other aspects of industry, so that the motion of the workers will be minimized to the extent possible in the future.

Instead of manual trucking all parts or assemblies will be handled by motorized vehicles such as fork lifts. Heavy lifting will be done by machines such as overhead cranes or lifts. Every worker typically performs one simple operation.

The future of conveyor belt will be large-scale development, expand the scope of use, automatic sorting, reduce energy consumption, and reduce pollution.

8. ACKNOWLEDGMENTS

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