ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 5, Issue 1, January 2016

An Optimized Embedded System for Automated Paper Bag Production

Mangesh M. Daundkar, Mrs. Bhairavi N. Savant
Department of Electronics and Telecommunication Engineering
MIT Academy of Engineering, Alandi (D), Pune, India

***Abstract*— Despite of all known hazards of plastic pollution, it's prevalent and pervasive in India. Plastic bags are one of the worst and most unnecessary plastic polluters of the earth. Plastic bags are used on a large scale by retailers for a simple reason that plastic bags are much cheaper than paper, cloth or other eco-friendly bags. Also plastic bags are available in huge quantity in the market. We present here a system to automate the procedure of recycled paper bags production so as to make its production cost comparable to plastic bags and also increase its production rate so as to fulfill ever increasing demand of the bags. We have used micro-controller based design approach which has kept the cost of the system significantly low as compared to PLC based designs.**

***Key Words*—Paper Bag, Paper Bag Automation.**

I. INTRODUCTION

Plastic, although considered as one of the greatest inventions by virtue of its use in carrying things has become a major element in polluting the environment. A single plastic bag can take up to 1000 years to decay completely. Since, plastic bags are not bio-degradable, the only way to get rid of them is to burn up which releases the toxic fumes into environment. Plastics are not only choking our environment but also irreparably damaging the sea and marine life. The nearest eco-friendly competitor of the plastic bags is paper bags. Surveys show that the chances of paper bag getting reused are higher than that of plastic because the plastic bags are made of petrochemicals, a non-renewable source of energy [1].

Paper bags and packaging have become the need of the hour for environmental reasons than using them to make a style statement. Paper is increasingly recognized by consumers and governments as not only natural but a renewable and recyclable resource from which to manufacture high performance packaging. The plastic bags are preferred over paper bags because of lower cost and better availability. The average cost paid by retailers per bag legally is 35 paise. However the illegal plastic bags (with thickness smaller than legal regulations) are sold at price as low as 20 paise/bag. We target to beat this price eventually by optimizing our system [2].

Conventionally recycled paper bags are made with hand by pure human labor. Human labor increases the cost and reduces the production rate. We focus on this pitfall and try to automate paper-bag making procedure. Even an unskilled labor can easily operate the machine successfully by making operation and adjustment very simple and quick. The change of size is very easy and can be done in few minutes time. We imagine a set up as a typical production line with different units (Paper feeder, Glue dispenser, Paper cutter actuators, Paper folding and pasting unit) operating in a sequence. Like a typical production line, after each stage finishes its task, the paper would move to the next stage. The rollers in the system are automatically driven. Micro-controller is used for the operation and the control of automatic paper bag production system.

The recycled paper products have strength equivalent to that of virgin products and requires less processing. One must also keep in mind that most paper bags are readily recycled thus saving millions of trees. The problem originates from inefficient production methods of recycled paper bags. Today, there are no production setups which aim at least possible cost production . Also, most of the existing paper bags production systems are handled manually. It requires the skilled manpower and consumes more time. Thus human labor increases the cost and reduces the production rate. We focus on automating the paper bags making procedure.

II. LITERATURE SURVEY

There are very few historical attempts to automate paper bag making. An attempt by Peng and Yin is very interesting and provides complete solution to automate paper and yarn bags however they use Siemens PLCs and a proprietary software called WinCC Flexible to design the system, which is too costly and this application seems to be under-utilization of these tools [3]. We provide a micro-controller based system design approach which is less expensive. We chose simple Atmega 16 as our central controller to design the system. It provides numerous advantages like low power consumption, open source development tools, low cost, handy peripherals like timer, counter in various useful modes, analog to digital converter, various communication modes etc [4]. Its feature are ideal for our use-case.

Bag Master is an Indian brand, making paper bags. Its manufacturing involves partial automation and needs predetermined format of the paper. It still needs human to complete to finish the carrying handle. It also focuses on aesthetics of the bag, which adds to the manufacturing cost. The system is capable of producing 1000 bags per hour with the help of three persons [5]. Unlike them, our aim is to make an economy class, usable paper bag at higher production rates and disregard the aesthetics.

III. DESIGN & IMPLEMENTATION

A. *System Architecture*

A recycled or used paper of approximately A4 size is fed into the system with the help of the rollers. The rollers are equipped with rubber grip which allows a paper to pass through it very smoothly. Two infrared sensors are placed to detect the starting edge of the paper. One of the two sensors is used to start the flow of adhesive on to the paper via linear actuator, other IR sensor is used to detect center of the page and to start the folding mechanism.

As soon as the paper is detected at the first sensor, adhesive flow is started on the sides of the paper. Paper continues to roll inside adding glue till the starting edge is detected by the second sensor.

Once the second sensor is triggered it signifies that middle portion of the page is at the center of the other roller and a blade is applied to fold a paper into two halves and passed through a roller so that the glue placed on one half portion of the page gets stick to other half of the page which gives a nice half A4 size paper bag.

B. *System Design*

The basic work-flow of paper bag production automation is shown in fig. 1. The paper position is sensed at each stage using optical IR sensor.

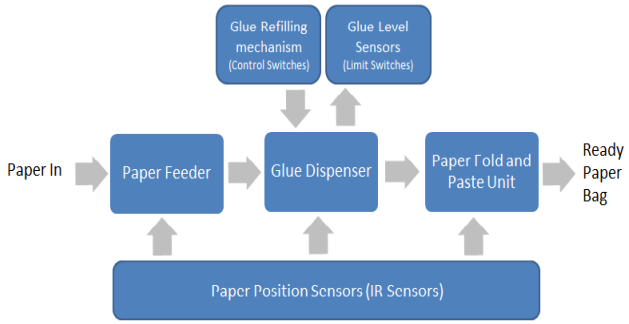


Fig. 1: Basic work-flow

There are three basic elements in the prototype model namely; the Micro-controller, the actuators and the sensors.

Micro-controller: AVR ATmega16, 8 bit micro-controller is used to control and co-ordinate all the module activities. Algorithm of the system is written In Embedded C and stored in the 16KB flash memory of the micro-controller. According to the algorithm micro-controller senses the sensor conditions and operates the linear actuators i.e. glue dispenser and partial paper cutter actuator.

Limit Switches: These are used to detect the level of glue in the glue dispenser as well as to adjust glue dispenser at initial position of the cycle. Limit switched are also used automatically while refilling the glue dispenser.

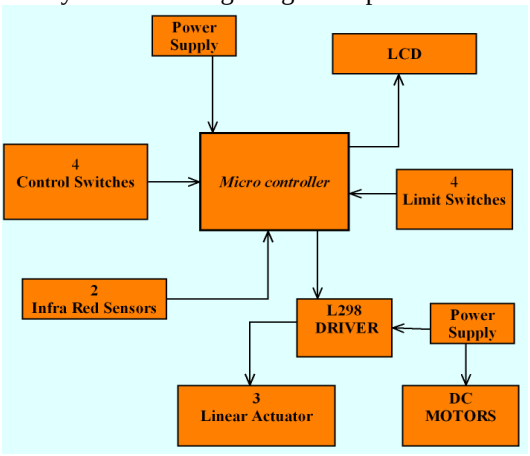


Fig. 2: Block Diagram

Control Switches: Two control switches are used to operate each glue dispenser individually with UP and DOWN motion. They are used when there is need of refilling the glue dispenser.

Infra-Red Sensor: Two IR sensors are installed on the mechanical assembly to detect the presence of the page at their respective positions. The color of the page and obstacle is detected by using infrared sensors - IR sensors (transmitter-detector pair). White surface reflects light significantly more than black surface. This property is used to sense presence of the page. The fig. 3 shows the detection of the page on the assembly.

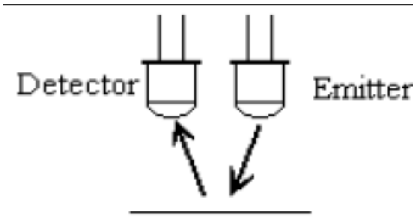


Fig. 3: IR Sensors

L298Driver: Two high current drivers are used to operate linear actuators since micro-controller cannot operate the actuators due to its low power sourcing capacity. These drivers can operate up to 40V, 5A actuators.

Linear Actuators: These are nothing but DC motors with mechanical head on it to convert rotational motion into linear motion. They are used in glue dispenser and partial paper cutting assembly.

DC Motors: DC motors are used in the both rollers so as to get smooth passing of the page in the system. They are directly operated by 12V DC power supply.

Power Supply: There are two power supplies used in the system. One is of 5V for the operation of the micro-controllers and peripherals and other is of 12V which

is used for the motors of rollers.

LCD: LCD is used to display the messages to the driver when he violates a traffic rule. The penalty incurred is displayed on the LCD and the reason for license suspension is also displayed. In our system we prefer to choose a LCD instead of LED or 7-segment display because of the following reasons:

- It has the ability to display numbers, characters and graphics whereas LED displays are limited to numbers and a few characters.
- There is refreshing controller in the LCD which reduces the overhead of the CPU.
- Ease of programming for characters and graphics.

We have used the 16 by 2 LCD that means that it can display the two lines containing 16 characters each. The pixel matrix is of 7 by 5 pixels that are each character can be displayed using 7 columns of the pixels and 5 rows of the pixels.

IV. SYSTEM IMPLEMENTATION

There are four stages in the pipeline- Feeding, Gluing, folding and pasting of the paper. Every stage involved motors and sensors along with the specific mechanism doing their tasks. Like a typical production line, after each stage finishes its task, the paper would move to the next stage. The paper position is identified to stop the paper at aligned position by sensing the paper edge using optical IR sensor. We imagine a set up as a typical production line with following simple units operating in sequence.

1) *Paper feeder:*

The automatic paper feeder is a feature which feeds the paper one page at a time into the system because it is easy to grab one paper which will automatically feed through the system. Paper feeders are described by speed, in pages per minute and capacity, usually in the range from 10 sheets to 200.

2) Glue Dispenser:

To put the glue on desired locations of the page the Glue dispenser is used. The Glue level sensor is used to detect the level of glue.

3) Partial Paper Cutter actuator:

The partial paper cutter actuator is used to give the cuts at specific points of the page coming from the paper feeder so as to ease the folding of the paper. The paper cutter will move up and down during the production of the paper bags.

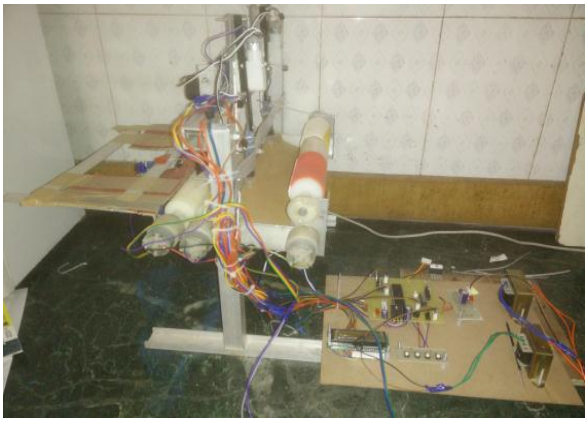
4) Fold and Paste unit:

After putting the glue on desired locations and giving fold mark by the paper cutter, the system automatically fold and paste the paper to produce the ready paper bags through second roller mechanism. After folding and pasting, the ready bags are automatically collected beneath the system.

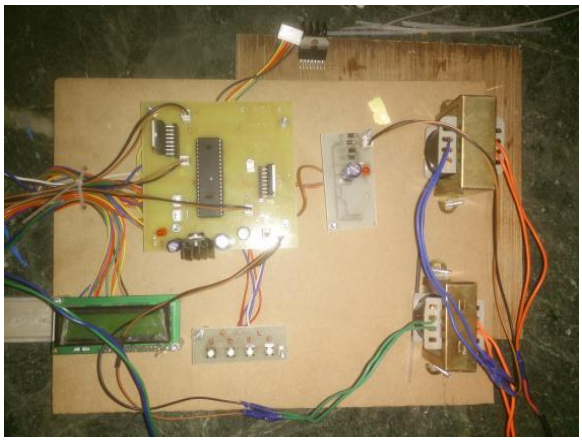
5) Refilling Mechanism:

The four control switches are used to manually operate the two glue dispensers individually. Once the LCD shows 'glue empty position', this mechanism is used to refill the glue dispensers.

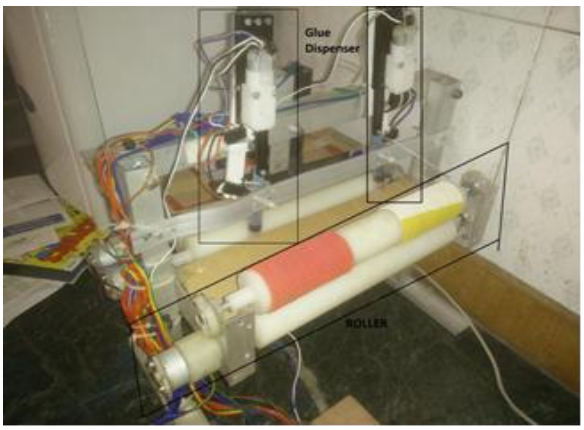
The Fig.4 shows the actual implementation of working prototype.



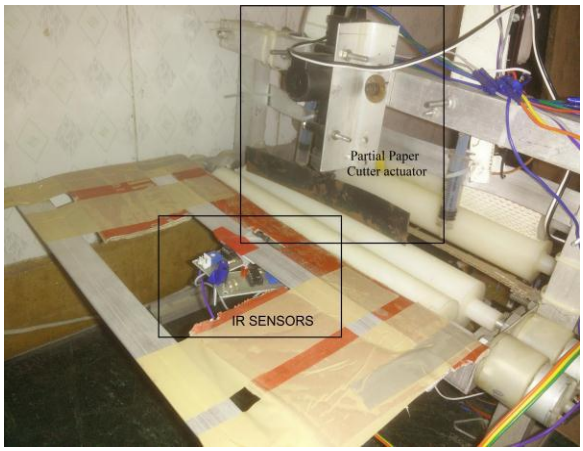
(a) Experimental Setup



(b) Test Circuit



(c) Paper Feeder and Glue Dispenser



(d) Paper Fold and Paste Unit

Fig. 4: Experimental set-up for paper bag production

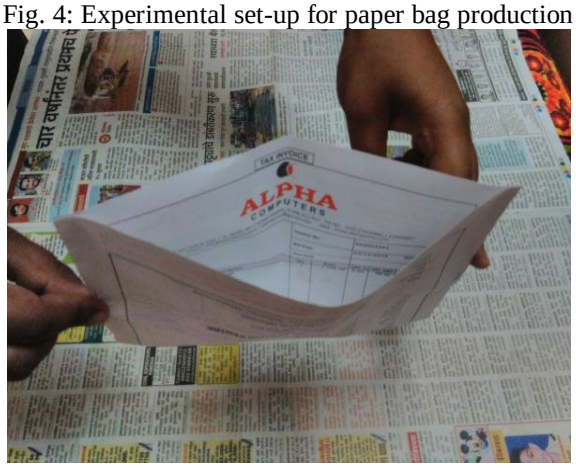


Fig. 5 Ready Paper Bag

V. Results and Conclusions

1. Automation of paper bag production is totally feasible.
2. It requires lees manpower than traditional method of manufacturing paper bags.
3. Any kind of paper quality can be used for production whether it is virgin or recycled.
4. Any size of paper bag can be produced by adjusting the roller length.
5. The rate of production can be increased by using such an automated process.

VI. Future Scope

1. Paper Feeder can be improved to accept papers of any size. Glue dispensers can be moved according to size of the paper to apply glue at appropriate place.
2. User can be given flexibility of adjusting speed of production using a keyboard interface. Speed can be adjusted using pulse width modulation in software using existing hardware setup [7].
3. A unit can be added to paste or print specific brand information to make bags more sell-able.

REFERENCES

[1] House of Commons: Environment, Food and Rural Affairs Committee, "Waste Strategy for England 2007", *Third Report of Session 2009-10, Volume 1*, Published on 19 January 2010.

[2] Mark J. Kirwan, "Handbook of Paper and Paperboard Packaging Technology", 2nd Edition, Wiley-Blackwell Publication, January-2013.

[3] Peng Zhen Rui, Yin Hong, "Control System Development of Paper and Yarn Compounding Bag-Making Machine", *Applied Mechanics and Materials*, Vols. 58-60, pp. 36-41, Jun.2011

[4] Kristian Saether, Ingar Fredriksen, "Introducing a New Breed of Microcontrollers for 8/16-bit Applications", *Atmel White Paper*, 7926A – AVR – 02/08, 2008.

[5] Bioway Packs Pvt Ltd - An Indian Paper Bag Making Company URL: http://www.bagmaster.in/

[6] Wei Li, Zhengduo Pang, Haitao Zhang, Guoying Meng, "Design of Multi-loading Control System for Belt Conveyor", *International Conference on ME-Product E-Service and E-Entertainment*, IEEE Conference Publications, pp.1-3, Nov 7-19, 2010

[7] Xueqin Lu, Shuguo Chen, Chenning Wu, Mingzhu Li, "The Pulse Width Modulation and its use in induction motor speed control", *The Fourth International Sypnosium on Computational Intelligence and Design*, Vol. 2, pp.195-198, Oct 28-30, 2011.

[8] Wang Xinxiang, Hu Guoqing, "Analysis and Study on a Novel Type of Fully Auto-cross Paper-Cutting Machine", *International Conference on Mechatronics and Automation*, pp.2155-2160, August 9-12, 2009