Electronic Circuit Design For Ensuring Safety Of Business in Band Systems

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Abstract: - In our developing and changing world increasing the effectiveness and efficiency of factories, it is important to adapt to changes in technology. In parallel to technological changes, security measures are updated in accordance with age. For example, a large number of conveyor belts in factories often used to transport raw materials. Here, as a security measure, only a one band is used to stop along the steel wire. With this type of system used a mechanical protection is not possible to provide complete security. In this study, steel wire standing next to a belt conveyor system was removed and instead of mechanical system, scanning laser system was placed across the entire band system. Thus, the system automatically stops when accident occur, to work whole system again someone must pres the reset button or intervention will be required from the automation center. This work; both employees and employers, in terms of prevention is very important to material and moral losses.

Key-Words: Conveyor Band, Security Systems, Laser

1 Introduction

Automation systems are basically formed in order to speed up and automatize the production. Automation systems which were mechanical at the beginning have become sophisticated including electric, electronic and computer fields in parallel to the improvements in industry. Although it was not welcomed at the beginning since it eliminates human factor, rapid improvement and demand in the product obliged automation. Thanks to automation systems, labors which are hard for people to do can be done easily and faster [1, 2].

A researcher called Theo Williamson invented "flexible management system" at the beginning of 1960's. With this system, a numeric control bench and a conveyor belt which were used for single purpose were combined and automatic transfer of pieces to be treated was enabled between machines. In 1960's, when robots were united with the improvements in material handling systems and computer control technologies, flexible production system which enables production of various pieces in medium and small size more economically [3].

As it is known conveyor belt system is a transportation which is stretched with some pulleys and moves with the help of friction force and continuously enables transportation of materials. In order to make transportation in more favorable ways and with less cost by making use of the advantages of linear materials moves in flow shop manufacturing, transportations which are done by using high power should be replaced with such automatic systems [4, 5, 6].

As necessary job security measures; tail-pulley protectors operate connected to stop switch pulled on a steel rope along the band. Moreover, loading and unloading chutes of bands should regularly be under inspection and monitor. In any case of blockage, bands should be stopped and intervened. Sometimes employees try to open blocked chutes and clean pulleys without stopping the band. Such interventions generally result in loss of organs (hand, arm) or deadly work accidents [7, 8].

As a security measure in band systems of factories, there is only stop switch (rop switch) with steel rope along the band. In case of danger, employee pulls the steel rope switch and the band and systems stop automatically. It is quite difficult for the victim of accident to do this in case of accident. Because he needs to pull the steel rope and stop the band without getting excited. He can survive if he succeeds in this [9].

In laser technology, atoms are used for reaching higher energy level as a result of absorbing energy. Photons that are formed in this energy transfer moves in the same way by reaching the same energy level and same frequency. Laser is stands as a very special source of light, it is directed, it has a narrow band and it is finely polarized. Laser systems are commonly used in fields such as security, military, health, heavy equipment automation. There are two types of lasers visible and invisible [10].

In this study, steel rope which is replaced near the band system will be removed and laser security system which scans the entire band system all along will be designed. During the study of band system; the system will automatically stop when any organ of the employee enters in the laser area which are in both sides of the band and necessary information will be conveyed to automation center. Intervention should be done form reset button or automation center in order to restart system.

2 Design Of Laser Sensor System

The laser area used in this study was created with invisible laser. The reason of using invisible laser here is to prevent the possibility of making the laser area visible for employee and try to remove or pass over the barrier. These laser areas were formed in both sides of the band. There will be one laser and receiver in both sides of the band. The laser area will be formed with mirror system. When the interaction between receiver and band is cut, the band will be deactivated.

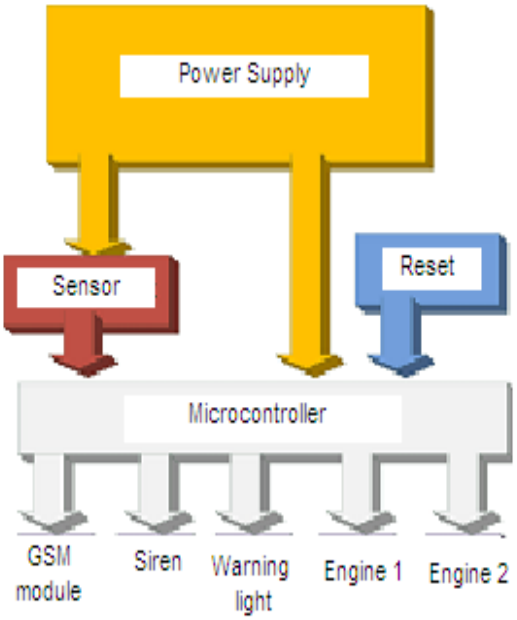

Figure 1. The working principle of circuit

In Figure 1, basic elements of the system are shown. The design circuit is composed of two layers.

Input Circuit:

The input circuit shown in Figure 2 was designed as the first circuit. This circuit was especially emphasized since any problem in this part influences the operation of all system. Main input circuit was formed the laser system which scans area of 180 degree at both sides and over the band. When any organ of the employee enters in this area the interaction between circuit and LDR is cut off.

LDR which is not illuminated eternalizes its resistance (around 18 Mohm). In this way it sends a pulse to 4017 integrated circuit. This pulse passes through integrated output from op-amp (UA741) and is conveyed to BC238-npn transistor. The current which arrives transistor acts like a switching element of transistor and enable output from emitter end (around 11.3 V). This voltage enables pull of relay switch and the buzzer at the output of relay gives audible signal.

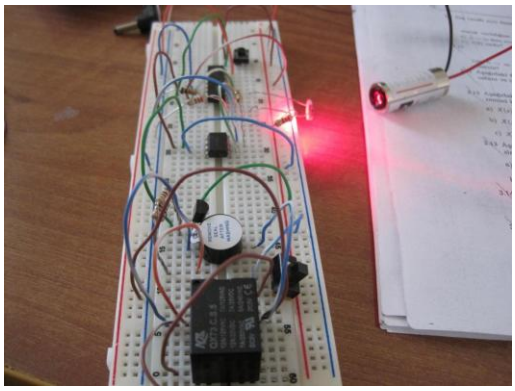

Figure 2. The input circuit

Stop/cut off circuit of engine:

As the second circuit, when there is an intervention to laser scanning area, a circuit was designed in a way that would turn off after relay and sustain operation until it is reset in order to stop the engine. When the relay switch is pull, 11.38 V value is observed on the discharge ends (input 12 V DC). When the switch is pulled buzzer gives signal. Switching element named IRFZ44 and LDR were used in engine stop circuit. In short while the input circuit is in operation, in case of any object, any hindrance that would interfere between laser and LDR relay is pulled, output is enabled and engine cutout circuit which is the second circuit is activated.

In the circuit of engine stop/cutout, there is a 5 mW laser module as shown in Figure 3. Laser module is connected to discharge ends of the relay and will be activated when relay is pulled and will pull down the resistance of LDR connected to GATE end of IRFZ44 switching element. The engine which is connected to GATE end of IRFZ44 will be turned off in case of drop of resistance value and system will stop operation until it is restarted. Input and engine cutout circuit are shown together in Figure 4.

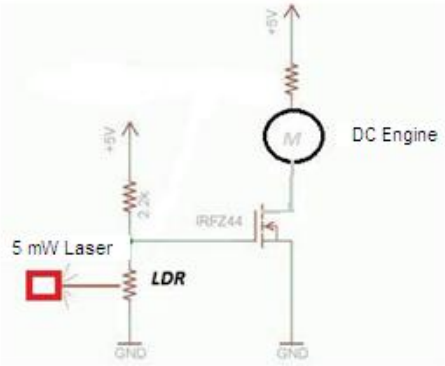

Figure 3. The LDR engine cut-off circuit

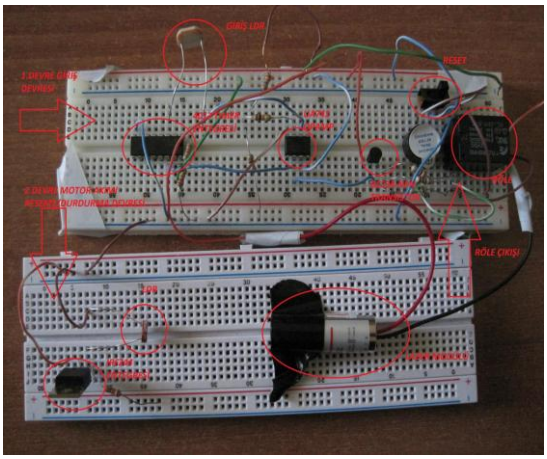

Figure 4. The input circuit and engine cut-off circuit

3 Design Of Wireless System

Wireless communication is a type of communication which is compatible with 802.15 of IEEE and carried out with the help of bluetooth modules. The main reason for choosing wireless communication is flexibility [11]. Flexibility was chosen since it provides easiness when any device would be included later on without needing cabling. Since Zigbee module receives IP, it is easy to include in automation and system [12, 13].

In the study apart from Zigbee modules, KEYMAR RF modules were also used in order to show that the cost of wireless communication can be reduced, and the results were analyzed and compared. ZigBee modules displayed high performance and data transmission (9600 bps). However, keymark modules have underperformed in the sense of both programming and performance (1200 bps). Moreover, while data is easily conveyed with ZigBee modules during programming, communication with keymark modules were difficult [14, 15].

Two pieces PIC 16F877 were used while designing the circuit. In PIC 16F877 first of all the program was written and then it was communicated with ZigBee modules. PicBasic and CCS were chosen as the best programming language for wireless communication. There is a unit called UART in PIC 16F877 in order to do hardware serial communication. Data transmission and import was made with UART-RS232 protocols and TX-RX pins.

The basic logic of the program is as such:

- Information obtained from relay output will be transmitted to PIC 1 (logic 1),
- When the input is logic 1, PIC 1 will give output,
- Output will be TX and receive logic from PIC 2 RX,
- When RX pin of PIC is at the position of Logic 1, PIC 2 will give output to LCD and terminal.

It must be tested that how the designed circuit operates, what kind of results are obtained under which circumstances and whether the written program works or not. The fastest and most effective way for this is simulation. There is the simulated circuit in Figure 5 and wireless communication and cutout circuit installed on board in Figure 6.

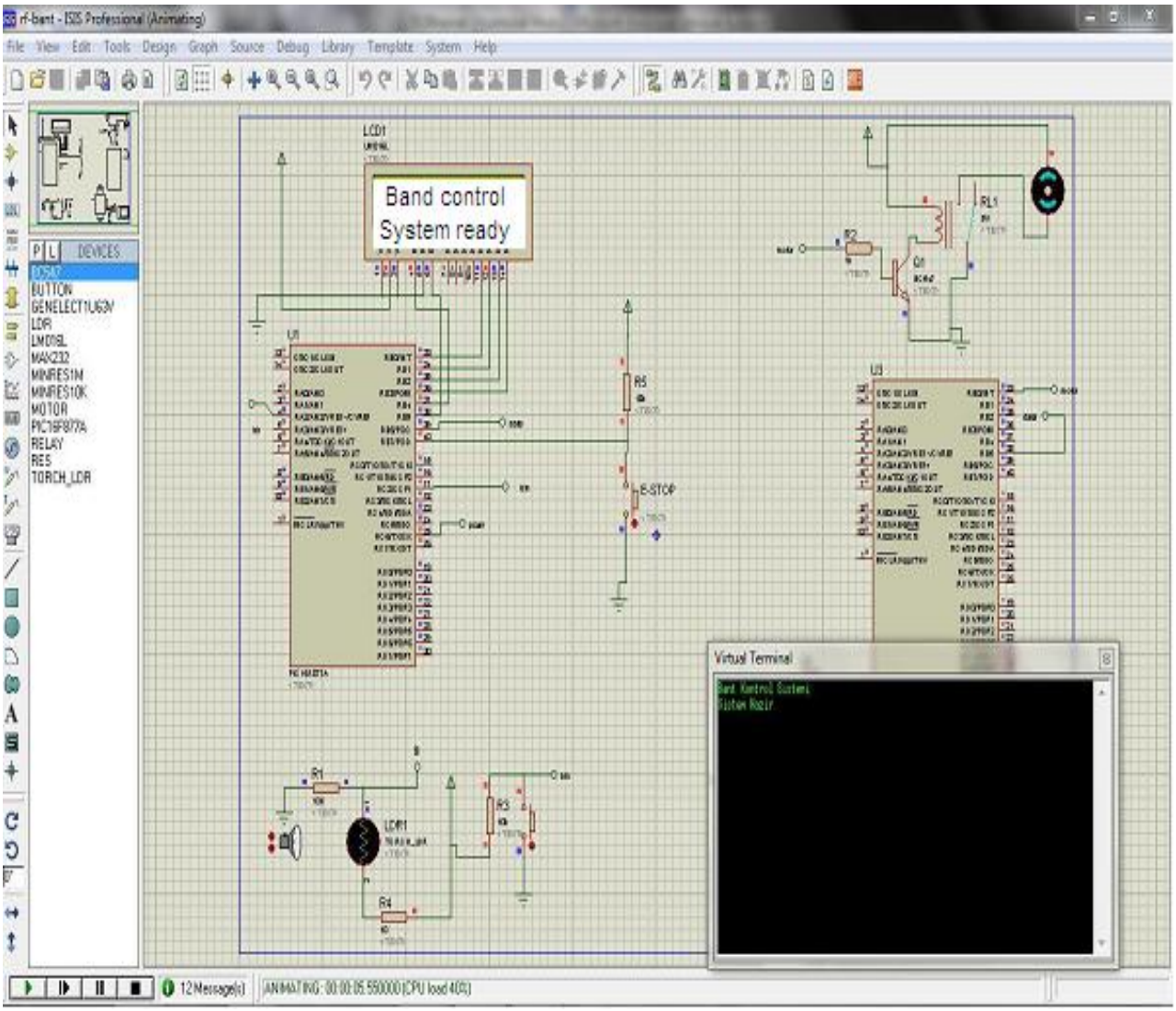

Figure 5. The simulation of circuit

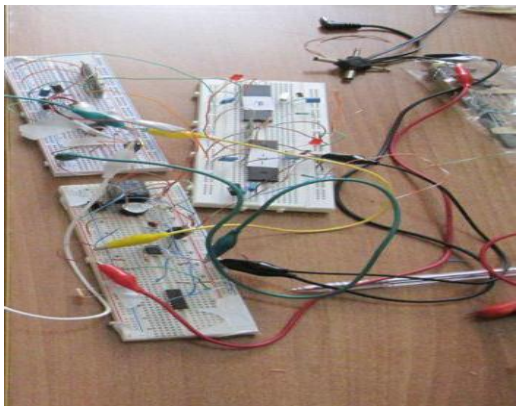

Figure 6. The wireless communication and cut-off circuit

4 Model Design

Model design is quite important since it shows how the circuit operates. For this, the operation of band systems in factories was analyzed first of all and when the necessary information is obtained, design process was initiated (Figure 7).

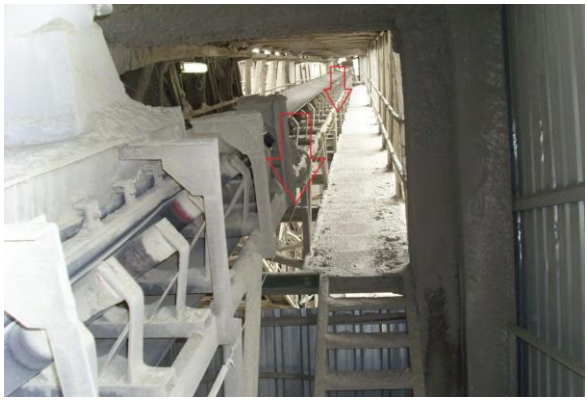

Figure 7. The band appearance and rope switch

In the design process, first of all the material to be used for the model and the material to be used when the base of the model is made were determined. In the design, the length of model is 60 cm, mirrors would be 25 cm and thickness of material would be 2 cm. When the base of model was made, the engine that would enable the movement of band is quite important. An engine with low-speed but powerful redactor should be used here. After model was designed and replaced in engine housing, location where circuits would be placed were determined.

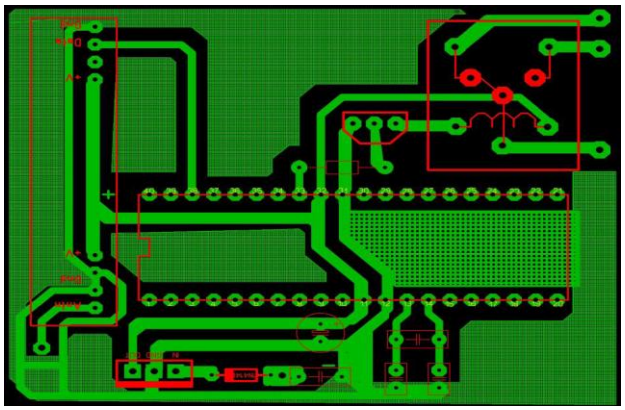

Figure 8. The printed circuit board receiver RX

Images of printed circuit receiver (RX) and printed circuit transmitter (TX) were shown in Figure 8 and Figure 9.

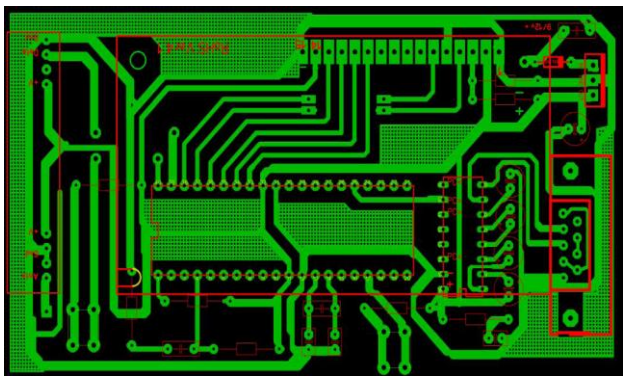

Figure 9. The printed circuit board transmitter TX

The biggest problem in the process of installation after print process of the circuit is called “Cold Solder”. To remove the possibility of cold solder, the copper surface should be heated well and paste should be used if necessary. As it is seen in Figure 10, after the entire communication circuit is controlled it was connected to the main circuit.

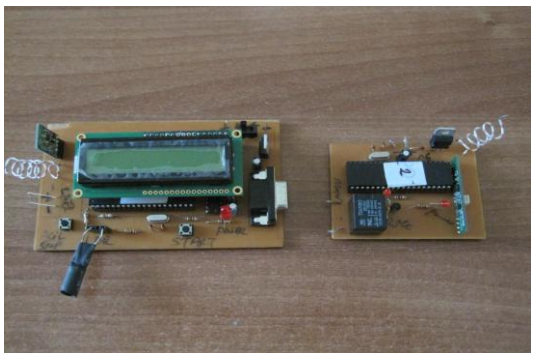

Figure 10. The prototype of a wireless transceiver circuit

To summarize the system we have installed;

- The circuit which we have made with 4017-UA741-BC238-Relay and other SMD elements is cut off when LDR is not illuminated.
- Transistor is communicated and relay is pulled. When the relay is pulley buzzer is activated and gives warning signal.
- A second laser module is connected to relay output, it is activated when the relay is pulled and dc engine which operates with circuit element called IRFZ44 is cut off when the light falls on LDR on 2. circuit and stops until the system is reactivated.
- Before the system is reactivated (with reset button), PIC 16F877 microprocessor is reactivated and sends wireless data to another PIC 16F877 microprocessor.
- The data (ZigBee module) is transmitted to the computer through Hyper Terminal in 2. PIC and observed in here.
- After everything is controlled and completed system is reactivated with reset button.

5 Conclusion

Today there are many factories which operate in different fields. Due to increasing work accidents in factories in recent years, an expert of job security should be present in the factories were more than 50 employees work according to Labor code no. 4857. According to the regulation of machine security, necessary measures should be set together with the machines in the sense of preventing material and moral loss of employers and employees in order to keep employees from working equipments.

Rapid increase and improvement of automation systems made the necessity of security systems prominent. In these systems; since the security is at maximum level, work accidents can be prevented considerably. Malfunctions caused by mechanic protection systems can be totally resolved.

In the study job security module which is easy to install and which works with full performance. For the additional security measure; system can be supported by determining the place of unauthorized movement in the system with the help of a motion detector apart from laser. In addition to these, remote monitoring of system enables faster intervention in the accidents. Monitoring of the system created in further studies through web would make the system more independent. As a result, electronic security systems are indispensable requirements of current and future era.

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