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IMPLEMENTATION OF MACHINE MONITORING SYSTEM FOR A PRODUCTION LINE

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ABSTRACT

Improper machinery and electricity usage is caused to incur undesired financial losses to most of the companies in Sri Lanka. This problematic situation cannot be resolved using an automated system which can be bought nowadays since such systems are very costly. So most often, manual checking is carried out in maintaining proper machinery and electricity usage. Machine Monitoring System is a cost effective system through which working states of the subjected machines will be displayed in the main indication panel. Radio frequency (RF) communication was used as the main communication technology in the Machines Monitoring System. In rapidly growing industry, undesired and unexpected costs should be cut down and productivity should be increased to sustain in the competitive industry nature. Using the developed system, machinery and electricity usage can be handled properly and financial wastage for machineries and electricity can be cut down to a minimum level while improving productivity of the company.

Keywords: Machines Monitoring System, Radio frequency (RF) communication, Microcontroller.

1. INTRODUCTION

Tos Lanka Co. (Pvt) Ltd currently possesses eighteen machines relevant to its productions. Most of them are used throughout the day. Switching on and off each machine is done by its operator. In this situation, some machines will be forgotten to switch on or switch off as predetermined. So improper machinery and electricity usage will occur and due to that huge maintaining costs had to be incurred by the Tos lanka Co. (Pvt) Ltd.

As a solution for this major problem of the company, automated machine's monitoring indication system was developed. The developed system can be divided into two basic parts. They are the main indication panel as the master and machine side circuits as the slaves of the system. The main indication panel contains controlling circuit though which communication is handle while producing digital signal to the LED indication panel through which final outputs are displayed. A machine side circuit is to observe the working state of the machine to which it has been attached and sending data to the main indication panel when the data is requested.

Through this system, company will benefited in various ways. Some of them are minimizing electricity wastage due to improper machine usage, reducing machinery maintaining costs while enhancing machine's life time with proper machine usage, reducing production delays while increasing productivity of the company.

2. EXPERIMENTAL

2.1 Used Technologies:

Radio frequency wireless communication technology, Microcontroller technology and printed circuit board technology were used as the main technologies for this system. nRF24L01 transceiver and nRF24L01+PA+LNA SMA antenna transceiver[1] were used appropriately for the radio frequency (RF) communication of the system. ATMEGA328P microcontroller[2] was used in each developed circuit of the system to handle RF communication, data processing and produce desired outputs. Printed circuit boards (PCBs) were designed using PROTEUS ARES software and PCBs were etched using Ferric Chloride ($FeCl_3$) chemical etching process[3].

2.2 Circuit Development:

When developing the system, necessary programs were coded step by step. Then necessary circuit layouts were designed. Designed layouts were printed using an inkjet printer on to shiny sides of dumping papers of sticker papers. Designs on the printed papers were transferred on to well clean copper boards. The paper was ironed for about 15 minutes to get the design of the paper on to the copper board using an electrical iron. Paper from copper board was removed and copper board was washed carefully. Ferric Chloride ($FeCl_3$) solution was used to etch the design. Unwanted areas of the copper board have been dissolved in the $FeCl_3$ solution completely, PCBs were taken out from the solution and washed with soaps.

Etched PCBs were checked for desired connectivities and functionalities using a multimeter. PCBs were drilled using a drill machine and components were soldered into the PCBs. Completed PCBs were checked for desired functionalities. Finally, developed programs were uploaded to the microcontrollers and circuits were used in the system.

2.3 Project Design:

Machines Monitoring System can be basically divided into two main parts as the master that is the main indication panel and slaves that are machine side circuits. The basic functional design of the system is shown in figure 1 below.

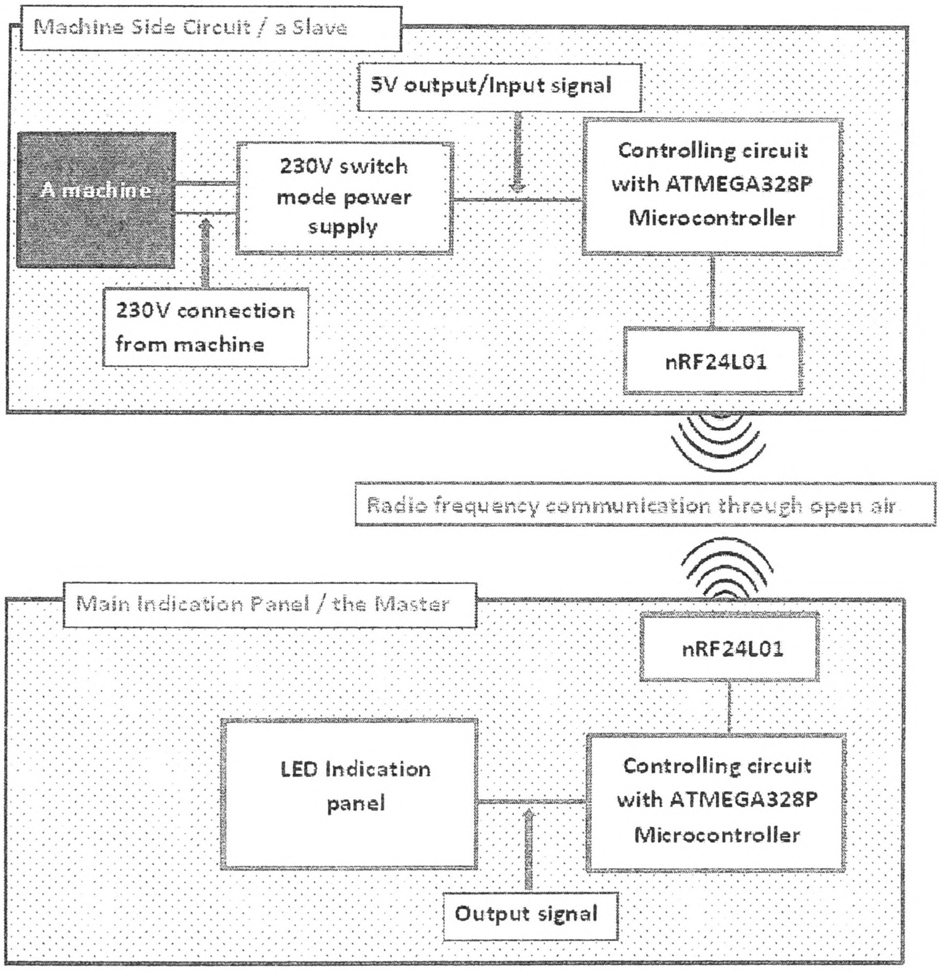

Figure 1: Schematic diagram of basic functional design of the system

In addressing technique, the master of the system was assigned the identity number 10. All machine side circuits were assigned multiples of 10 starting from identity number 20 that is main power (a slave). The RF communication of the system was configured to communicate a data bundle with three parameters at a time. Figure 2 explains the communication pattern of the system within the RF transceivers.

Identity number of the sender Data = A multiple of 10	Identity number of the receiver. Data = A multiple of 10	Machine's working state information. Data = 5 or 250
First parameter	Second parameter	Third parameter

Figure 2: Communicating data bundle structure

To enhance the system functionalities while increasing system reliability and dependability, auto reset feature was added to each microcontroller program. If a circuit is get stuck functioning while in the communication, the circuit will be automatically reset after 8s.

Further, this system is able to handle power interruption situation properly. For that, main indication panel was powered using an uninterrupted power supply (UPS). At a power disturbance, main indication panel will indicate availability of main power as "NO SIGNAL" while keeping the other indications at working states of other slaves just before the interruption was occurred.

Developed system is consisted with three different circuits. They are LED indication panel, main indication panel controlling circuit and machine side circuit. The circuit designs of the system are shown in figure 3, figure 4 and figure 5 respectively.

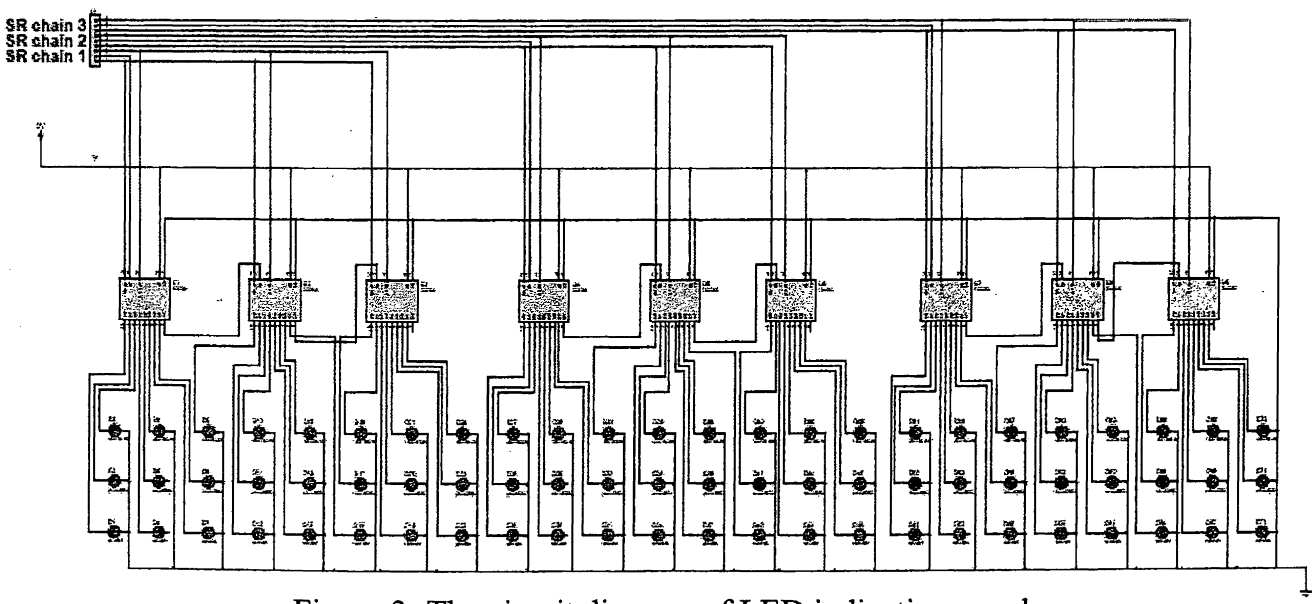

Figure 3: The circuit diagram of LED indication panel

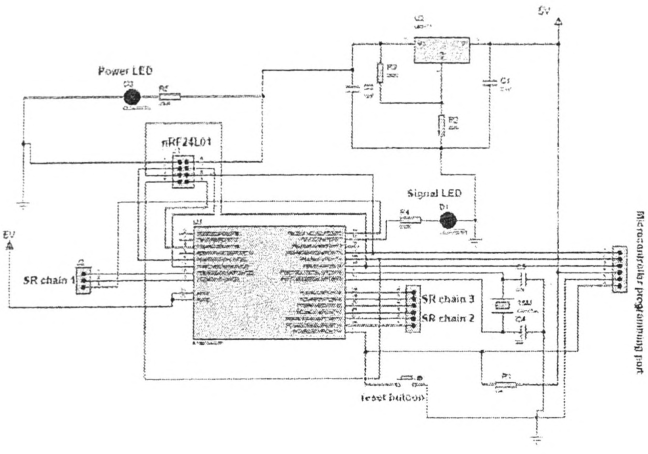

Figure 4: The circuit diagram of the / a machine side circuit panel controlling circuit

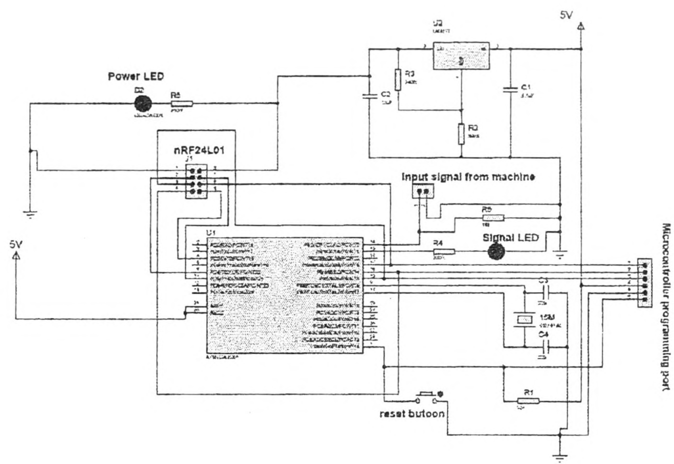

Figure 5: The circuit diagram of a slave / main indication

3. RESULTS AND DISCUSSION

3.1 Results:

After compiling and launching the system, main indication panel was functioned properly as expected. The "OFF" state of a particular machine is indicated in green colour LED, the "ON" state of a particular machine is indicated in red colour LED and the "NO signal" state is indicated in orange colour LED in the main indication panel.

3.2 Strengths of the project:

- No need to visit each machine to check the working states of the machines and those can be observed at the main indication panel.
- Cost effective
- Time saving
- Improve productivity
- Ease of use

3.3 Limitations of the project:

- Panel indication has a 3 second delay after the working state of a particular machine has been changed.
- If another building with machines will be added to the company premises in the future, this system will not serve new machines since communication range of used RF modules is not sufficient.

- Only 24 machines can be served by developed system since main indication panel has spaces only for 24 machines.
- Indications on main indication panel can only be seen for couple of distances due to its inappropriate small size.

4. CONCLUSION

Machine Monitoring System is a cost effective solution for the problem of improper machinery and electricity usage. Working states of the subjected machines can be seen clearly using the developed system. With this solution, the company will be benefited financially by cutting down undesired expenses while improving the productivity.

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