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Petrol Pipe Line Telemonitoring Design

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Abstract
Petrol pipe lines are subjected to different types of malfunction. The malfunction can happen due to technical faults or it may be due to a gangsters attack on the petrol pipes in order to hinder the petrol pumping operations.. The damage of the petrol pipes causes a loss of a large amount of petrol from the pipe lines. Petrol pipe damage also causes fires and pollution to the environments . Such operations causes a lot of loss in economy to the country concerned where the sabotage took place. This paper sheds the light on this challenging issue to steady and propose an intelligent electronic circuit design solutions to this problem. An electronic circuit design based on using a Field Programmable Gate Array (FPGA) is proposed as a processor to control the petrol pipe lines. A real time monitoring cameras are installed to fulfill this task .The system design is programmable (i.e intelligent) and hence the electronic actions established in the design can be modified easily..A personnel computer is used to capture the images from the cameras installed on the petrol pipe line. If any damage or attack is noticed a commands can be initiated to the electronic and electrical devices to stop the pumping operation and to close the petrol pipe line immediately. Many electrically controlled pipe closing valves are to be installed along the pipe line. These electronic closing valves are remotely controlled by the embedded system based on the (FPGA).

Keywords: FPGA, petrol pumping, petrol pipe line, interface circuit, wireless camera, personnel computer.

I. INTRODUCTION

Tele monitoring allows us to monitor remote locations using telecommunications technology. It provides more efficient use in multiple locations whenever and wherever they are needed without leaving our facility. Formally defined, tele monitoring is the use of captured images exchanged from one site to another via electronic ommunications to evaluate the remote location status. It includes growing variety of applications and services using two-way video, smart phone, wireless tools and other forms of telecommunications technology.

The paper is concerned with using the field programmable gate array (FPGA) as the main processor in the system design. The FPGA configuration is generally specified using a verilog hardware description language (VHDL), similar to that used for an application-specific integrated circuit (ASIC). FPGAs can be used to implement any logical function that an ASIC could perform.

FPGAs contain programmable logic components called "logic blocks", and a hierarchy of reconfigurable interconnects that allows the blocks to be "wired together"—somewhat like many (changeable) logic gates that can be inter-wired in (many) different configurations . Logic blocks can be configured to perform complex combinational functions, or merely simple logic gates . In most FPGAs, the logic blocks also include memory elements, which may be simple flip-flops or more complete blocks of memory.

There are numerous options for designers in selecting a hardware platform for custom electronics design, ranging from embedded processors, application specific integrated circuits (ASICs), programmable microprocessor, FPGAs to programmable logic devices (PLDs). The decision to choose a specific technology such as an FPGA should depend primarily on the design requirements. Therefore, if the hardware requirements require a higher level of performance, then the FPGA offers a suitable level of performance. The definition of the behavior of the FPGA is performed by programming it by a very high speed integrated circuit hardware description language (VHDL).

This paper deals with using the embedded system based on the FPGA as a means for remote control. The FPGA is programmed to offer real time remote control of petrol pumping , closing and opening the electronic valves on the petrol pipe in addition to activating an alarm siren when the situation needs such action to be taken. .In the normal petrol pumping operation , the FPGA plus the compute monitors the conditions of the petrol pumping pipe in order to offer security situation to the petrol pumping operation. IP address Wireless cameras are mounted on the petrol pumping pipe. The aim of the design is mainly to avoid pipes damage, explosion or fire due to malfunctions of

pumping in addition to the immediate closure of the pipe when any accident happens .

II. METHODOLOGY

Minimization of loosing petrol from the pipe is a challenging issue .A proposed solution is based on using a remote monitoring and control system based on FPGA . The embedded system gives a real time response based on the images captured from the wireless cameras mounted on the pipe . The high speed of processing of the FPGA offers an instantaneous response for any desired action.

This paper explains the approach for the design based on the FPGA platform .The aim of the complete design is to offer maximum safety for the petrol pumping process plus minimizing the loss of petrol from the pipes. A number of wireless cameras are installed on the petrol pumping pipe . The wireless cameras provide us with an instantaneous images showing the status and condition of the pipe .The wireless cameras are linked to a personnel computer. According to this design the FPGA will be able to take action based on the captured images . Hence the embedded system design offers a semi-automatic real time control for the secure petrol pumping operation. Figure (1.a) shows the block diagram of the monitoring design and figure (1.b) shows the basic parts of the block diagram for the control design.

Figure (1.a) Block diagram of the monitoring design.

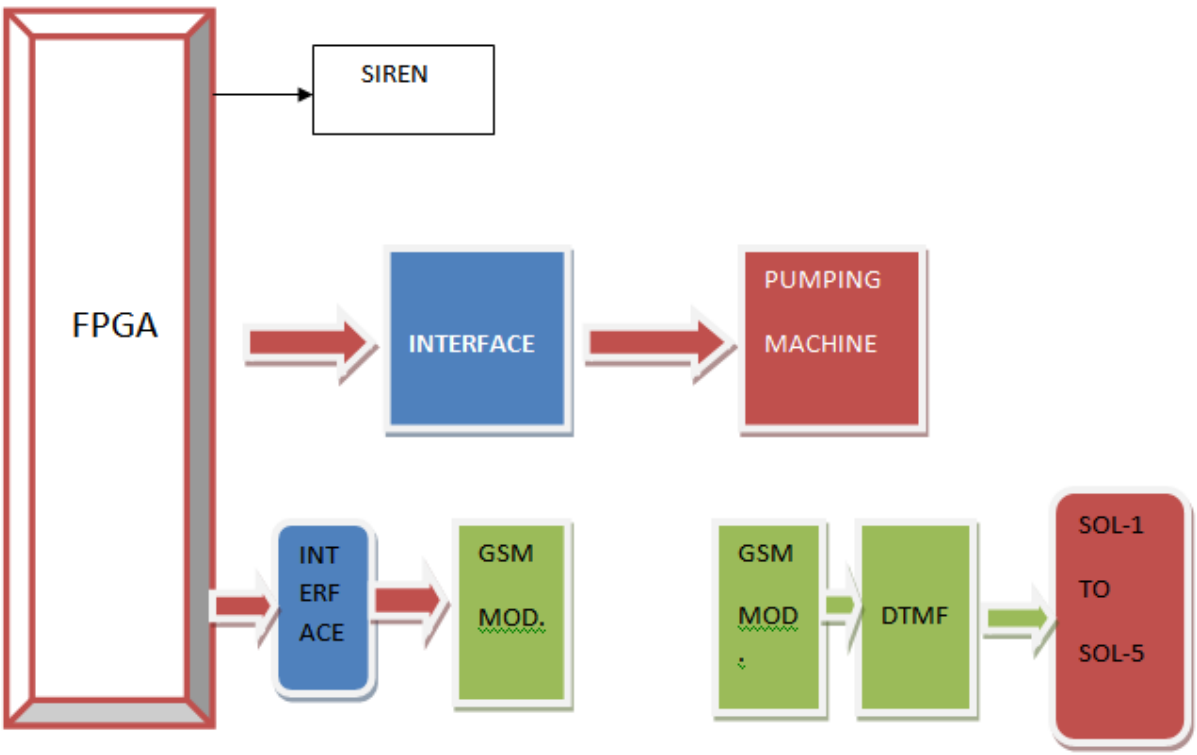

Figure (1.b) Block diagram for control of the petrol pipe.

The proposed model assumes the installation of five solenoid vales (SOL-1 to SOL-5) plus five IP wireless cameras (CAM-1 to CAM-5) on the petrol pumping pipe as shown on figure (2) below. The spacing between a solenoid valve and the other is assumed to be equal to one meter. The solenoid valves are controlled remotely by the embedded system. A (DTMF) electronic circuit is used to control remotely the operation of the solenoid valves. Once a malfunction is noticed, the system can respond by stopping the pumping and closing the solenoid valve required .The same thing happens when an accidental leakage in pipe happens.

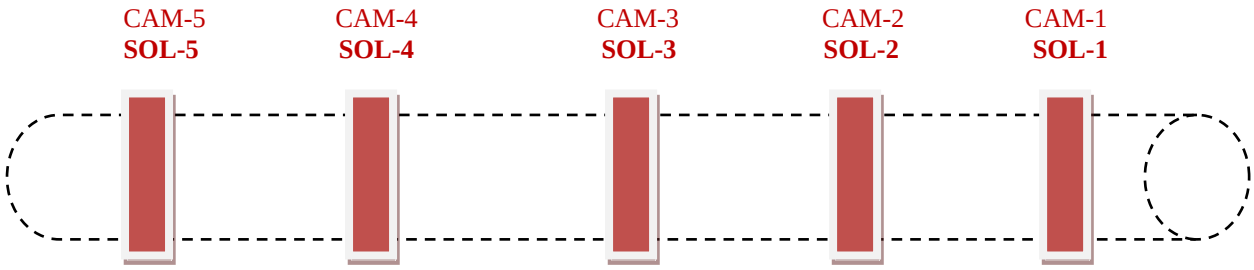

Figure (2) A pipe line model mounted with five solenoid valves and five cameras.

The electronic circuit components of the design are :

- Field Programmable Gate Array (FPGA) .
- Interface circuit to control the pumping machine (Buffer + Darlington amplifiers ULN2003).
- Interface circuit to control the electronic valves on the pipe line (Buffer + Darlington amplifiers).
- Dual Tone Multiple Frequency decoder (DTMF 8870).
- GSM modems.
- Solenoid valves.
- Pumping machine.
- Personnel computer.
- IP address wireless camera (TRENDNET)..
- Access point.
- Siren.

III. OBJECTIVES

The objectives of the design are :

1. Development of a computer program in VHDL language.
2. Downloading the program into the FPGA.
3. The task of the program is to perform control for secure pumping of petrol in the pipes based on the acquired images.
4. The embedded system is designed to take action on the pumping operation and closing the valves on the pipe.

IV. SOFTAWE PROGRAM & ALGORITHM

To achieve the objective of the semi-automatic real time monitoring and control of petrol pumping operation and closing of the valves on the pipe when needed , we need to go through five steps as follows:

1. Step one is developing a VHDL program in the computer by using Spartan-3 software .
2. Step two includes VHDL synthesis in the design, which converts the design in the behavioral description file into gates. The synthesis tools figure out what gates to be used based on the VHDL program file.
3. Step three includes downloading of the program into the FPGA as shown in figure (3).
4. Step four includes integration of the embedded platform with the, interface circuit , solenoid valves and the pumping machine as shown in figure (1.b).
5. Step five includes testing and debugging the operation of the whole system .

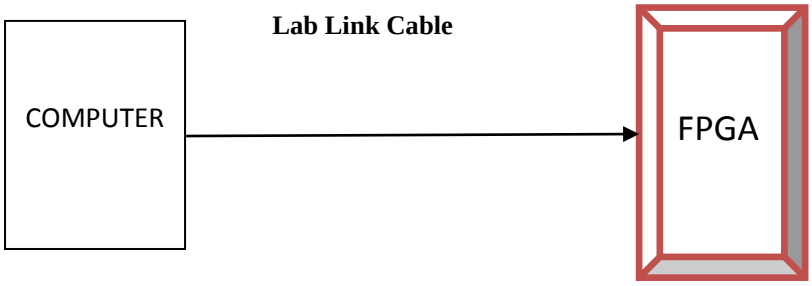

Figure (3) Connection for programming the FPGA

The algorithm for performing a semi-automatic real time monitoring and control of petrol pipe contains two subroutines . The condition for calling the subroutine depends on the acquired images from the IP address wireless cameras .If the images are normal ,standard subroutine will be called . If the images demonstrate an abnormal case due to petrol leakage , a shutdown subroutine will be called. The algorithm is:

Start
Initialization :
--- Clear all output control signals.
.
Check incoming images:
--- Check the incoming images from the IP address wireless cameras.
--- If the images are normal , then call standard pumping subroutine.
--- If the images are abnormal, then call shutdown subroutine.
--- Go to check incoming images .
End.

Standard pumping subroutine :
Start:
… Set the solenoid valves to OPEN status.
--- Set the petrol pumping machine to the standard RPM based on the specifications of the pipe (1000 RPM).
Return.

Shutdown subroutine :
Start:

--- Shutdown the petrol pumping machine (0 RPM).

Close solenoid valves:
-- Close solenoid valve (SOL-1).
-- Close solenoid valve (SOL-2).
-- Close solenoid valve (SOL-3).
-- Close solenoid valve (SOL-4).
-- Close solenoid valve (SOL-5).

--- Operate the emergency alarm siren for one minute.
Return..

FPGA connector A2 is programmed for data output to control the RPM of the petrol pumping machine.
FPGA connector B1 is programmed for data output to control the five solenoid valves on the petrol pumping pipe.

V. RESULTS

The FPGA is the right choice for the operation of petrol pumping process despite its high cost relative to other processors .The FPGA has huge facilities to control systems according to its ability to execute the commands in a parallel way. This criteria widens the range of controlled elements with less delay time. The same thing in VHDL language, in spite of its complicated language, but it is the right choice to program complicated control systems. It is suitable for a system that needs fast execution of commands.
The designed monitoring and control system is a semi automatic real time system. It operates and responds according to the images acquired from the IP address wireless cameras .
Table (1) below shows the results of operating the system.

Table (1) Results of operating the system under all possible conditions.

IMAGES	SOL-1	SOL-2	SOL-3	SOL-4	SOL-5	PUMP
NORMAL	OPEN	OPEN	OPEN	OPEN	OPEN	ON
ABNORM.	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	OFF

Note: SOL-1 = solenoid valve one , SOL-2 = solenoid valve two , SOL-3 = solenoid valve three , SOL-4 = solenoid valve four , SOL-5 = solenoid valve five.

Equation (1) shows the time taken for the shutdown action operation.

$$T_{shutdown} = T_{observation} + T_{FPGA\ processing} + T_{device\ response} \quad \ldots\ldots (1)$$

Now if ; $T_{observation} = 5$ seconds , $T_{FPGA\ processing} = 10$ msec. , $T_{device\ response} = 2$ msec.
Hence ; $T_{shutdown} = 5$ sec. + 10 msec. + 2 msec = 5.012 sec.

VI. CONCLUSION

Multiple solutions can be adapted to solve a problem , and a process can usually be controlled using different controllers based on different methods. Almost every control method has its merits and weaknesses. What is important is to use the right controller to fit the application at a minimum cost.

In the recent years, there has been a technical advances in the electronics industry, which has significantly developed the existing technologies in industrial control.

This technical development in the electronics industry have evolved industrial control into both real-time control and distributed control. Real-time control requires controllers to capture all the significant target activities and to deliver their

responses as swiftly as possible so that system performance is never degraded. This paper dealt with the implementation of an embedded system design for minimizing the petrol loss when an abnormal situation occurs .

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