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Tea Algorithm Based Industrial Automation System Using Xbee's

V. Jagadish Kumar[1*], Bagadhi Sateesh[2], R. Kanaka Raju[3], K. Krishna Kumar[4]

[1,2,3,4]Dept. Of Computer Science ,Gayatri Vidya Parishad College for Degree and PG Courses(A), Andhra University, Visakhapatnam, Andhra Pradesh, India

**Corresponding author: jagadeesh.vkumar@gmail.com Tel.: +91-8919812425*

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***Abstract*—** Industrial Automation is a field that requires a vast involvement in the safety and the security aspects. The intensity towards this concept may vary according to the nature of the industry. The security feature must be more intense as compared to less complicated industrial plants [1]. Here we are proposing an idea that well suits the kind of industries formerly mentioned. The system is designed to handling the electronic devices (230V AC to 500v AC) and monitor two very important parameters – the fire detection and gas leakage detection. For this we are using basic Xbee module, Pic16f877 Microcontroller (MC), 1pole relays, gas leaking and fire detecting sensors. The Xbee modules provide the communication mechanism between the user module and server module by means if messages. xbee modules provides wireless communication so we have to provide security to the messages by using two mechanism's. One mechanism is encrypt the messages by using TEA Algorithm, another mechanism is changing the baud rate. Micro Controller will be responsible for handling the electronic devices and sending messages to the Xbee modules and EMBEDDED C programming to handle Micro Controller. The behavior of the system can examined experimentally.

***Keywords*—** Industrial automation, xbee, pic microcontroller, tea algorithm, fire detector, gas detector

I. INTRODUCTION

Automation can improve productivity and quality. Here to obtain these benefits, educating the workers on the machinery is necessary. Companies must contemplate their objectives of automating before incorporating any machinery. As industry automation technology becomes more determined, more purposeful and everywhere, its meaning and purpose take on many interpretations. Industry automation delivers increased product and process information, and of course, improves product quality. Technology is used in so many ways and for so many different ends that it is almost impossible to have a single definition that includes all the solutions factory automation delivers.

The project is about controlling equipments in industries or in home. Our main application is to control the devices and check the status of the device whether it is on/off and also monitors the safety status of Gas leakage and fire. If this is the situation then automatically heat varying device turns off and the message will sent to the authorized person by xbee. We even check the status of the device whether the device is in on or off condition. We are using TEA (Tiny Encryption Algorithm) for encrypt and decrypt the messages which are travelling between server module and client module.IAS (Industrial Automation System) contains so many modules and sensors, to communicate and cooperate each other (interoperability), scalability, usability and the ability to feed back information to client friendly and flexibility by which the attention of companies to enter quickly, it also represents a great research opportunity in engineering, architecture and communication. The presented paper introduces a friendly industrial approach automation that contains the client and server modules. the client module contains different operations programmed in embedded C language in the Industrial Automation System through main menu. The server module controls the operation of the industrial appliances controls the plant through micro controller and looks after the control of the plant which resided in the plant the controller is connected which controls the operation of the industrial appliances. The controller consists of Xbee module and a PIC microcontroller and sensors. The interfacing circuit consists of an opto-coupler and a static power switch (TRIAC).

Section I contains the Introduction, Section II contain the related work of Industrial Automation, Section III contain the Tiny Encryption Algorithm (TEA) Methodology, Section IV contain the Zigbee Technology, section V explain the system features, Section VI describes system architecture, Section VII contain the system operation, Section VIII contains the system components, and Section IX concludes research work with future directions.

II. RELATED WORK

Computerization or industrial automation or mathematical control is the use of control systems such as computers to control plant machinery and processes, reducing the need for human participation. In the scope of automation, computerization is a step beyond mechanization. Computerization greatly reduces the need for human sensory and mental requirements as well. We can monitor and control electrical/electronic devices remotely using Xbee modules to provide the communication mechanism between the user and the microcontroller system by means of message.

III. METHODOLOGY

The Tiny Encryption Algorithm (TEA) was first published in 1994 by Roger Needham [2], and David Wheeler from Cambridge University of the United Kingdom. TEA was initially designed to be an extremely small algorithm when implemented in terms of the memory foot print required to store the algorithm. This was accomplished by making the basic operations very simple and weak; security is achieved by repeating these simple operations many times. As the basic operations are very simple TEA is also regarded as a very high speed encryption algorithm. These properties have made TEA a choice for both weak hardware or software encryption implementations in the past as TEA can be operated in all modes as specified by DES as outlined in the specification. Tiny Encryption Algorithm has 32 rounds of simple processes which are shifts, additions and XORs. Tiny Encryption Algorithm has 128bitkey length and 64bit block size. TEA cipher key scheduling is simple anyway. It uses modulo 32bit addition by delta (∂) constant. However, that constant is derived from the golden number as follow:

$$\partial = (\sqrt{5}-1).\ 231$$

TEA cipher processes data block by block. Each block is consisted of two 32bit half block. A half block is processed and swapped iteratively and all operations are performed on modulo 32- bit big endian manner. The detail of TEA cipher can be described as figure(1):

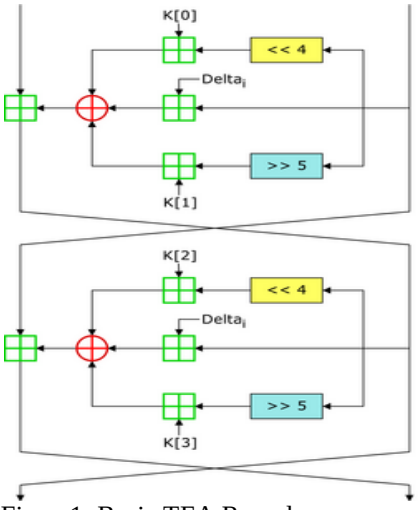

Figure1: Basic TEA Round

Implementation

It can be shortened, or made faster but we hope this version is the simplest to implement or remember A simple improvement is to copy k[0-3]into a,b,c,d before the iteration so that the indexing is taken out of the loop. In one implementation it reduced the time by about 1/6th. It can be implemented as a couple of macros. which would remove the calling overheads[3]

Coding and Decoding Routine

v gives the plain text of 2words.
k gives the key of words.
N gives the number of cycles,32are recommended.
if negative causes decoding N must be the same as for coding.
if zero causes no coding or decoding.
Assumes 32bit long and same endian coding or decoding

Encode Routine

Routine, written in the C language, for encoding with key k[0] - k[3]. Data in v[0] and v[1].

```
void code(long* v, long* k)
 {
unsigned long y=v[0],z=v[1], sum=0;
delta=0x9e3779b9;
n=32 ;
while (n-->0)
{
sum += delta ;
y += ((z<<4)+k[0]) ^ (z+sum) ^ ((z>>5)+k[1]) ;
z += ((y<<4)+k[2]) ^ (y+sum) ^ ((y>>5)+k[3]) ;
}
v[0]=y ;
v[1]=z ;
 }
```


Decode Routine

```
void decode(long* v,long* k)
 {
unsigned long n=32, sum, y=v[0], z=v[1],
delta=0x9e3779b9 ;
sum=delta<<5 ;
while (n-->0) {
z-= ((y<<4)+k[2]) ^ (y+sum) ^ ((y>>5)+k[3]) ;
y-= ((z<<4)+k[0]) ^ (z+sum) ^ ((z>>5)+k[1]) ;
sum-=delta ;
}
 v[0]=y ;
 v[1]=z ;
 }
```

IV. ZIGBEE TECHNOLOGY

3.1ZigBee applications

Though ZigBee implementation is still under development, the ZigBee expertise various applications. The most potential are:

- Residence Control: Safety, Heating, Ventilation, and Air-Conditioning (HVAC), Illumination, Access control, Irrigation,
- Personal health care: Patient observation, Healthcare monitoring,
- Industrial control: Asset management, Process control, Energy management, Environmental,
- Constructing automation: Automatic Meter Reading (AMR), Security, HVAC, Illumination control, Access control,
- Consumer electronics: Remote control,
- PC & peripherals: Monitor, Printer, Mouse, keyboard, Scanner, joystick,
- Environment: Environment monitoring.

Powerful expansion in wireless sensors technology will facilitate the growth of ZigBee.By 2008, 100 million wireless sensors will be used and more than 500 million nodes will dispatch for wireless sensor technology Harbor Research reports[6] says.

3.2 Advantages of ZigBee

low cost,
It can be used worldwide,
very low power utilization,
interoperability among manufacturers,
ease of performance,
chip vendor independence,
appropriate range operation (30 – 100 m),
appropriate bit-rate: 250 kBps (at 2.4 GHz),

reliable data transfer,
unswerving,
easy to install,
supports large number of nodes,
mesh Networking,

3.3. ZigBee versions

The first version of ZigBee was authorized in 2004[4]. While the design of the zigbee should supports up to large number of nodes(65536)on a network, the first practical developers' understanding show that the larger networks become unbalanced over time. That is since initially ZigBee used a tree arrangement for addressing. In 2006 stipulation, a random addressing scheme with built-in address conflict resolution is used [4]. That will be a key to large deployments of ZigBee in industrial markets because it allows much more network nodes.ZigBee2006 is mismatched with previous version. Developers in the industrial market may still be waiting for the ZigBee PRO stack which will include features aimed at manufacturing and business and engineering computerization, such as higher levels of security and improved frequency hopping[5].The ZigBee union announced a series of "ZigBeePRO" additions to the original set of features published in 2006[6], which is now known as the ZigBee Feature Set.

V. SYSTEM FEATURES

The system allows the user to control (On or off) devices and can be expanded to many devices without adding any component (depending on the microcontroller programming and structure).
Controlling a high voltage devices.
Knowing the devices present state (On or off) at any time with readable message.
The system will communicate with user, and gives information about device's state after controlling (on or off) with readable message.
Can add multi users to control this system this feature refer to user choice.
If there is no keypad pressed for more than 30 seconds, the controller closes the line automatically.
This system contains fire detection, gas leakage sensors, which can sense and can give its status in the form of user readable message and also a buzzer alarm near client location and also near server location as desired.
Xbee modules providing communication between the server and client modules, so we didn't pay money for communication.
We can use two techniques for the security of message transferring and receiving, namely, encryption and changing the baud rate (bits/second) .
The total system cost will be very less than GSM based automation system, and there will be no maintenance cost.
The entire system is in user friendly environment. If we want a device to be on/ off for a time period, example 30seconds time period using keypad input.
Can add multi users to control this system this feature refer to user choice
Server Module has a password at least 4 digits.

VI. SYSTEM ARCHITECTURE

The proposed system block diagram shown in figure(1). The System mainly consists of two modules one remote module which called master module (xbee module and pic microcontroller) which controls the operation of the remote industrial devices, this module also contains lcd display which shows the status menu of the industrial devices this module programmed by embedded c language; and the another module which is called server module it is fixed at the remote industrial devices this module also contains xbee module and pic microcontroller.The remote industrial devices are controlled by the server module which operates according to the user commands received from the master module via server module the control circuit which connected to the server module and there is two sensors which are fire sensor and gas leaking sensors also contained at server module the server module consists mainly: xbee module, microcontroller, sensors, relays, message feedback circuit.

VII. SYSTEM OPERATION

The System operation can be Explained as below:
At the client module have some switches for sending the commands via xbee module to server modeled user can control the operation state of home appliances according to the following successive steps:
We have to assign the names to the switches as per their operation

Switch1: for knowing the status of the all devices
Switch2:for ready to changing the state of the devices
Switch3:for make the device 1 to be on
Switch4: for make the device 2 to be on
Switch5:for make the device 3 to be on
Switch6:for make the device 1 to be off
Switch7:for make the device 2 to be off
Switch8:for make the device 3 to be off
Switch9:for make all devices to be on
Switch10:for make all the devices to off
All the control states are feedback to the user by means of messages. which shows on the client side lcd display
We are using two sensors for detecting for fire and gas leaking if any accident can occur .The server module raises the buzzer immediately at the location of the accident and also sends the message to the client of that accident
At this time the client module also raises the buzzer immediately

VIII. SYSTEM COMPONENTS

The system consists of the following components, namely;
PIC Micro controller
Xbee/Zigbee Modules
Lcd display
Controll Circuit
Sensors

A.PIC Micro Controller

we are using two pic controllers one controller located at client side another controller located at server side. Client controller responsible for receive the user request and make the request as a message with encryption then it will send to the server module through xbee's.inetially client module didn't give access to control the devices located at sever side. we have to enter the 4digit password. then the client device will give access. Now the server side controller responsible for receives the messages which are sent from the client and decrypt the message then control the devices and send the feed back message as a encrypted message to the client when client module receives the message client controller also decrypt the message. controller display that message on liquid crystal display (LCD) at client module figure 2 shows the pin diagram of pic controller.

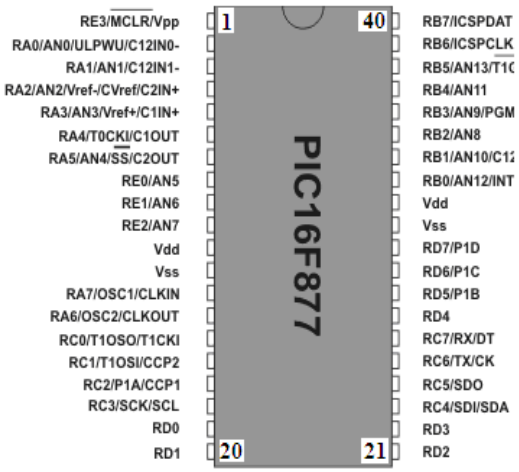

Figure 2. Shows the pin configuration for the pic16f677.

B. Xbee/Zigbee module

We are using two Xbee/Zigbee devices. These devices are transceivers. One at Master module another device at server module. Now we explain the xbee device which is located at master module.This device used for communication between master module and server module. It receives messages from micro controller and sends that messages to the server module and also receives the messages from server module and sends to micro controller .This module plays very important role in this project . The XBee RF Modules were engineered to meet IEEE 802.15.4 standards and support the unique needs of low-cost, low-power wireless sensor networks. The modules require minimal power and provide reliable delivery of data between devices. The modules operate within the ISM 2.4 GHz frequency band and are pin-for-pin compatible with each other. It shows in figure 3.

Figure 3. Shows the Xbee Module

C. Liquid Crystal Display (LCD)

This device used for display messages .this devices shows device statuses on the screen .This device is simplifies work to handle the controller. A liquid crystal display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. It is often utilized in battery-powered electronic devices because it uses very small amounts of electric power, It shows in figure 4.

Figure 4. Shows the Liquid Crystal Display

D. Control Circuit

Control circuit used for control the AC devices using DC voltage which is given by controller at server side, which shows in figure 5. TRIACs are widely used in AC power control applications, They are able to switch high voltages and high levels of current, and over both parts of AC waveform [9].This makes TRIAC circuits ideal for use in a variety of applications where power switching is needed. One particular use of a TRIAC circuits in domestic appliances on/off and control of ac motors. In addition, in most applications TRIAC over comes the main problems of the use of electromagnetic relays and contactors in spite of it is simple to control its operation comparing with TRIAC which requires an additional electronic circuit to control it. TRIAC BT136 is used in this system. For providing isolation between BT136 and controller we are using MOC3011 IC.the components of the control circuit mentioned below

MOC3011

BT136

1)MOC3011: MOC 3011 is a optically isolated triac driver devices, These devices contain aGaAs infrared emitting diode and light activated silicon bilateral switch[10],which functions like a triac.this series is designed for interfacing between electronic controls and power triac to control resistive and inductive loads for 120vac operations

2)BT136: This is a Triac bt136 is Glass passivated triacs in a plastic envelope, intended for use in applications requiring high bidirectional transient and blocking voltage capability and high thermal cycling performance. Typical VDRM Repetitive peak off-state applications[10],include motor control, voltages industrial and domestic lighting, heating and static switching.

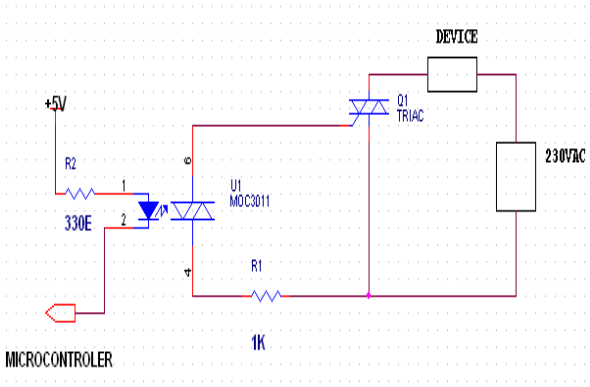

Figure 5. Shows the Control Circuit

D. Sensors

We are using two sensors which are

1. Fire Detecting Sensor
2. Gas Detecting Sensor

Fire Detecting Sensor

Fire accidents are common anywhere due to careless handling inflammable substances like gases, petrol and sometimes due to short circuit in power line. Fire accidents cause huge loss of money, properties, life's also. Due to poor management of fire monitoring and detection no quick action is taken to prevent fire. Traditional fire warning methods such as smoke alarm, contact fire detection, heat sensor are failure to give indication of fire with in time because smoke alarm detects smoke not fire and heat sensor alarm only activates when large amount heat produced by fire in area. So here we present highly effective, sensitive and active method of detecting fire by using infrared photo detector and sensitive comparator[11]. When any substance caught fire it produces large amount of infrared radiation which are directly detected by IR sensor which increases the reference voltage at pin of comparator to produce output to activate the alarm and this output also given to the controller. So the controller receives the signal and immediately produce message and send that message to the master module by Xbee module.figure 6 shows the gas detection circuit.

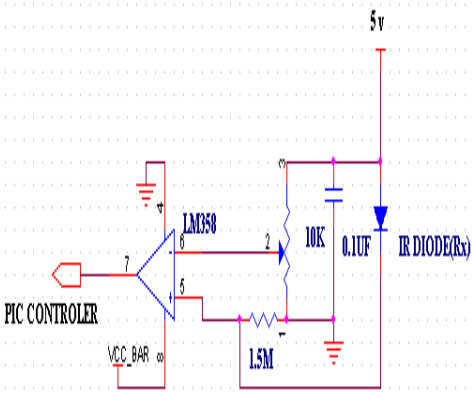

Figure 6. Shows the Fire Detecting Circuit

2) Gas detecting sensor:

Gas detector is a device which detects the presence of various gases within an area, usually as part of a safety system. This type of equipment is used to detect a gas leak and interface with a control system so a process can be automatically shut down. A gas detector can also sound an alarm to operators in the area where the leak is occurring, giving them the opportunity to leave the area. This type of device is important because there are many gases that can be harmful to organic life, such as humans Gas detectors can be used to detect combustible, flammable and toxic gases like LPG, and oxygen depletion. This type of device is used widely in industry and can found in a variety of locations. Detection Range 100-10,000ppm it is iso-buttane, if Gas was leaking in industry which are directly detected by MQ6 sensor[12],which increases the reference voltage at pin of comparator to produce output to activate the alarm and this output also given to the controller. So the controller receives the signal and immediately produce message and send that message to the master module by Xbee module. figure 7 Shows the Gas Sensor circuit diagram.

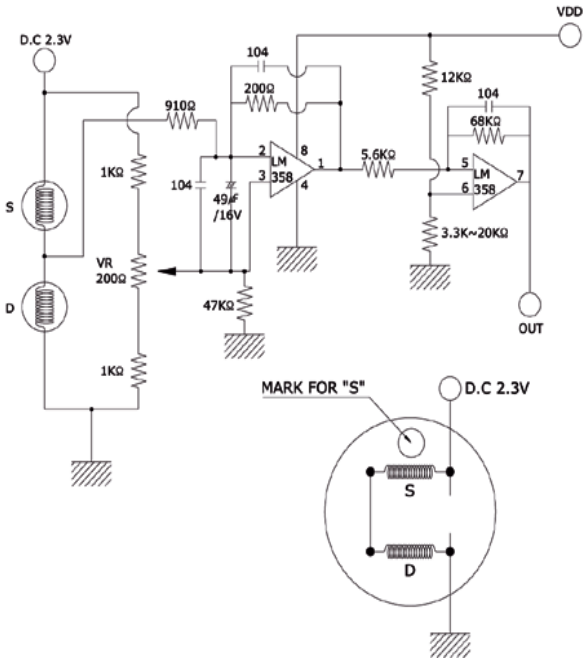

Figure 7. Shows the Gas Detecting Sensor circuit

IX. CONCLUSIONS

The presented Industrial Automation System in this paper is realized practically, tested for multi modes of operation and gave an excellent control of the Industrial appliances under test. The Proposed system presented in this paper introduced a friendly system to control the Industrial appliances remotely by the use of Xbee/Zigbee Modules these modules are used for wire less communication for communicate the both modules. The proposed system is characterized by its grand features required for the modern Industrial automation system such as flexibility, security, friendly, in addition to the existence of feedback on line messages to inform the master about the state of the system and the appliances, in this paper we are using tea algorithm for encrypt the messages and send that messages to the client server module and vice versa now both modules will decrypt the messages and controllers will take actions as per the messages .

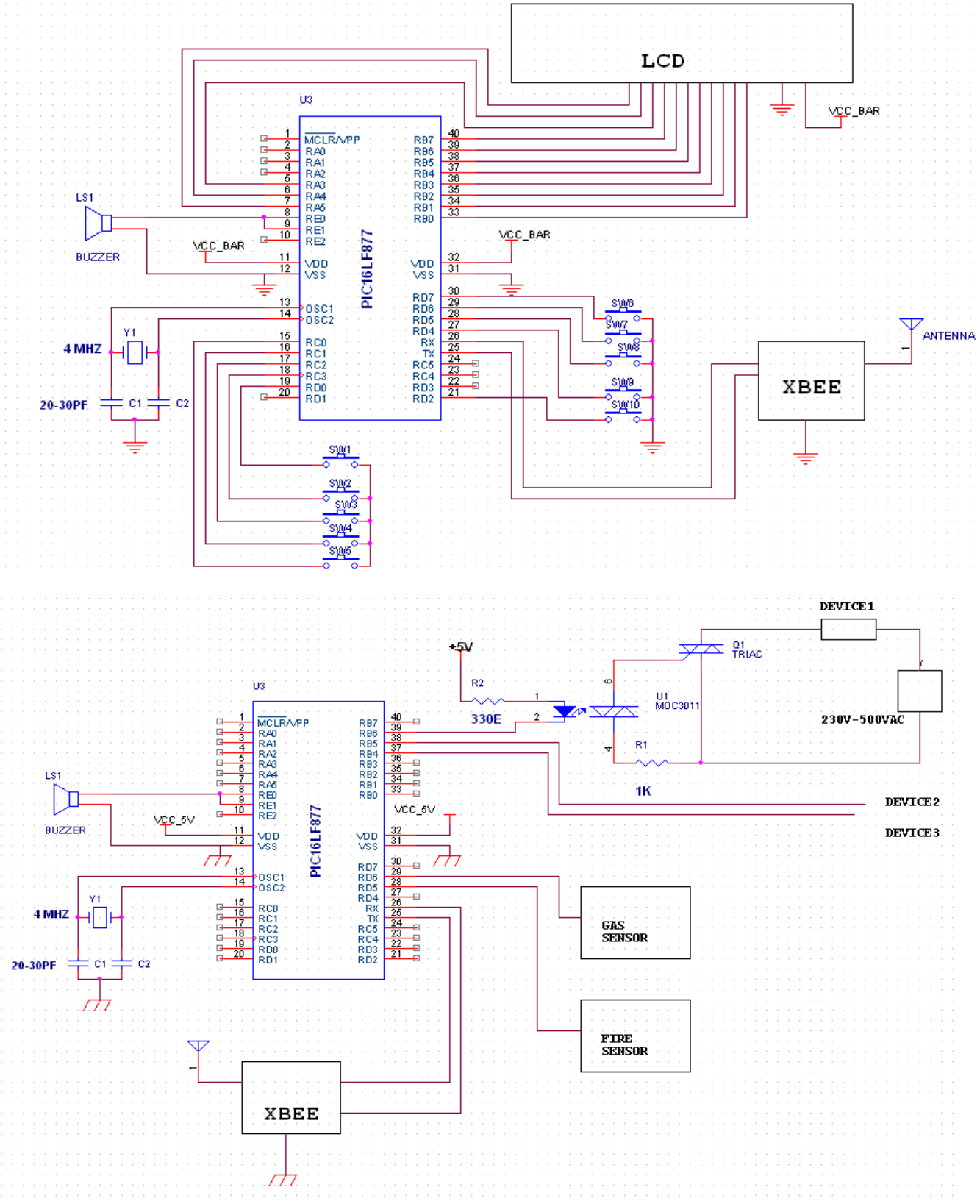

Figure 8. Overall circuit diagram of the proposed Industrial Automation System.

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Authors Profile

Mr. V. Jagadish kumar pursed Bachelor of Science from AndhraUniversity of India, and Master of Technology from JNTU Kakinada. He is currently working as Assistant Professor in Department of Computer Science, Gayatri Vidya Parishad College for Degree and PG Courses, India. His main research work focuses on Cryptography Algorithms, Network Security, Cloud Security and Privacy, Big Data Analytics, and Data Science. He has 5 years of teaching experience and 4 years of Research Experience.

Mr Bagadhi Sateesh pursed Bachelor of Science and Master of Science from Andhra University of India. He is currently working as Assistant Professor in Department of Computer Science, Gayatri Vidya Parishad College for Degree and PG Courses, India. His main research work focuses on Cryptography Algorithms, Network Security, Big Data Analytics, Data Mining, IoT and Computational Intelligence based education. He has 8 years of teaching experience and 2 years of Research Experience.

Mr. R.Kanaka Raju pursed Bachelor of Science and Master of Technology from Andhra University of India. He is currently working as Assistant Professor in Department of Computer Science, Gayatri Vidya Parishad College for Degree and PG Courses, India. His main research work focuses on Software Engineering, Cryptography Algorithms, Network Security, Cloud Security and Privacy, Big Data Analytics, and Data Science. He has 15 years of teaching experience and 3 years of Research Experience.

Mr K.Krishna Kumar pursed Bachelors Degree from Andhra University and Master of Science from annamalai university of India. He is currently working as Assistant Professor and Head of the Department in the Department of Computer Science, Gayatri Vidya Parishad College for Degree and PG Courses, India.
His main research work focuses on Cryptography Network Security, Cloud Security and Privacy, Big Data Analytics, and Data Science. He has 18 years of teaching experience and 5 years of Research Experience.

