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Integration of Arduino as a slave system to LonWorks based System using I2C Interface

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ABSTRACT: this project involves in integrating touch screen displays with Arduino development board and also integrating the arduino boards to LonWorks based Building Automation System. This LonWorks based building automation system works with Nodes developed under LonWorks technology. These nodes are being connected to the echelon smart server that acts as a master. Integrating Arduino based tool kits to these type of LonWorks technology based systems involves in two challenges mainly the data transmission and the control operation. These two challenges are overcome by the implementing the connection using I2C bus.

KEYWORDS: LonWorks, Arduino, Building Automation System, I2C.

I.INTRODUCTION

Building Automation System is a closed loop system with monitoring and control based on the feedback and response from the sensors integrated with it. A Building Automation System is a replica and duplication of numerous numbers of room automation systems. A room automation system involves in controlling the electrical loads attached to it such as lights, Fans, Air Conditioners etc… An intelligent building automation system can manage many devices in order to balance the energy savings and comfort of the inhabitants. The strategy controlling devices has to be adaptive and learn to match users' needs [4]. To implement the control operation, one must first monitor the status of the electrical loads. Here, in this project several sensors like Smoke, Occupancy, Motion, Door/Window Status, Vibration, Multipurpose Sensors are included inorder to monitor the respective features like number of persons present in the living room, Number of persons entering and leaving the room, the daylight status of the room inorder to control the illumination, Vibration sensors inorder to measure the activity of breaking the glass/window etc… Modern building automation systems consist of up to 30,000 components (e.g. sensors, actuators, and controllers). Additionally, different assembly sections of the automation system, e.g. heating, ventilation, and lighting, are integrated in such a building automation system [1]. The data received by these sensors is collected and send to the master will implement the necessary control operation.Many different industries in today's automationcouldprovideinformationbymeansofdifferentsensors, but the ability to integrate this information is missing [5].

In this project, I have used LonWorks technology for implementing the total Building Automation System especially the monitoring process. Now, I'm using the Arduino based development boards inorder to implement the control operation with the help of relays and the data from the Arduino is sent to the Smart Server using I2C Interface.FT5000 development kit act as master and Arduino act as a slave. The communication between master and slave carried through I2C communication protocol. A wireless node is also added to the system which contain GSM and Bluetooth for remote communication. Wireless building automation systems are gaining momentum as they promise an easy installation in old and new buildings [7]. The Master in the system communicates to the node by their specific 8 bit address. Master decides which slave should be used in order to provide control action. However, the realization of slave address brings crucial challenge in developing this project.

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II.I2C INTERFACE

I2c is a protocol developed by Philips in 1982, in which multiple masters can be used to communicate to the slave. The i2c communication uses 2 signal line to communicate to slaves. These 2 signals lines are called Serial data (SDA) and Serial clock (SCL). Compared to SPI communication protocol I2C does not requires chip select pin. Using these two signal lines master can communicate to many number of slaves. Each slave connected to the I2C bus is identified by its own 7 bit address. The data transmitted in the bus is divided into 8 bytes. The master use control bits like start, end, direction and acknowledgments to control the flow of data. 3.4 Mbps, 400kbps and 100kbps has to be chosen for data rate,

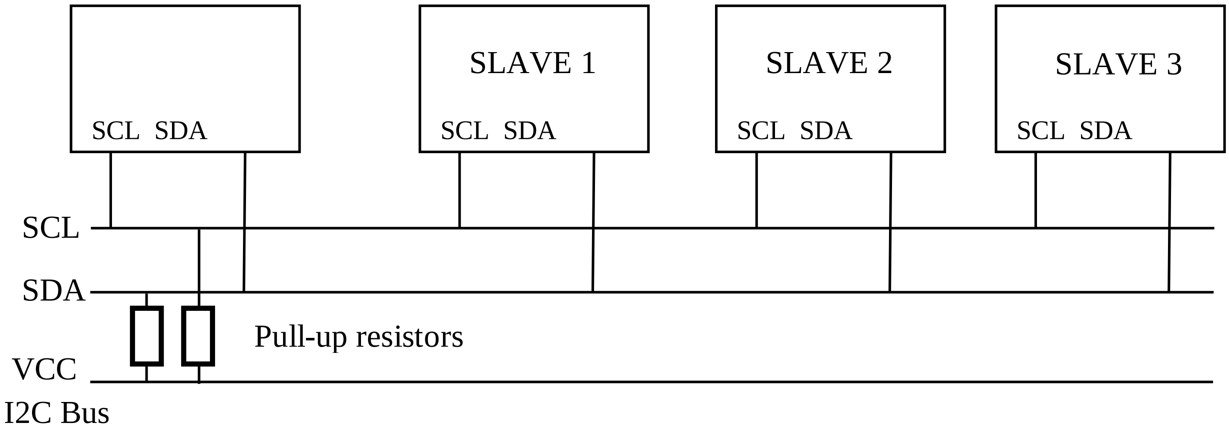

Figure 1: the figure shows 3 slave device connected to the master through I2C bus. Pull up resistors are connected from VCC to SDA and SCL.

In the above diagram the master is connected to its slave through 2 wire I2C communication, each wire is connected to Vcc through pull-up resistor. The wire from the master is identified as SCL and SDA. To communicate to the master the slave should have different address.

The master initiate the I2C communication with START condition. This is an Attention signal to slave device to listen for further incoming data. After the start bit, master send the address bit followed by the read or write bit it wants to access. All the device in the bus compare the received address with their own address. If the address matches the slave sends response signal called ACKNOWLEDGE signal. After receiving the acknowledgment, master can start receiving or transmitting data. After the transfer of data is done master sends STOP bit.

III. INTEGRATION OF ARDUINO AS MASTER-SLAVE

Two Arduino boards and I2C based display are integrated as a Single Master Slave system such that the commands from the master system are being sent to the slave. Now, the commands received from the master arduino board are being processed by the slave and it performs the necessary operation specified in the function of the slave.This task is performed in-order to just test the basics of I2C bus operation and the microcontroller integration. The commands to the slave board are sent from the inputs specified by the user on the Touch Screen. Here, 4 LED's are connected to the slave and small display is also connected to I2C network to display the status of the Loads connected to the slave. The master reads the touch pad data from the slave and write the same data to the load salve. The load slave take necessary steps according to data received from the master. The master write the status of the load to the 16x4 I2C display as well as to the LCD touch display. Further on integration with the LonWorks based building automation system, the commands are sent from the LonWorks master either from the echelon smart server or from other LonWorks based input device.

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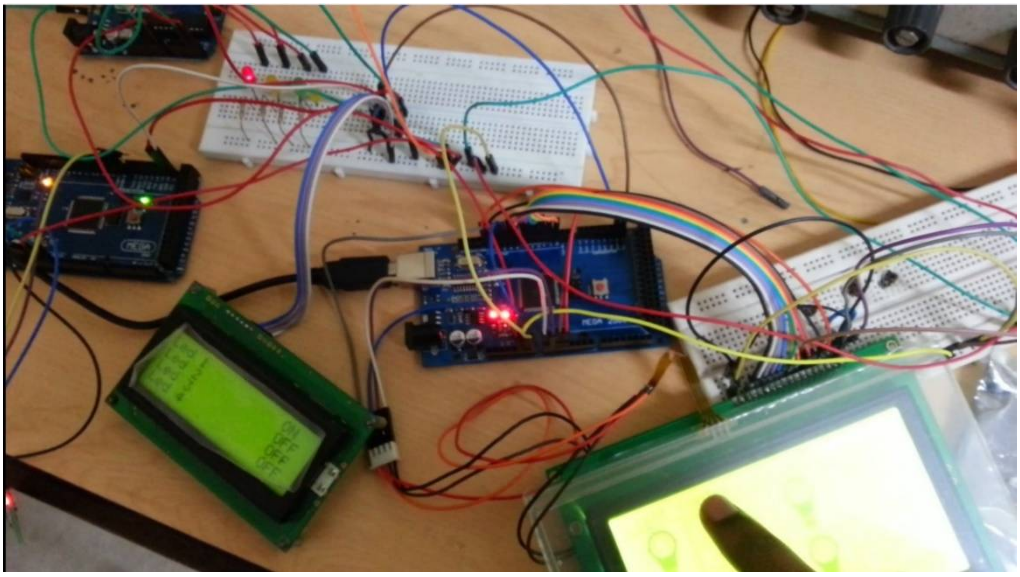

Figure 2. The picture shows the integration of 2 Arduino mega and Arduino UNO using I2C communication

As you can see that the each arduino board and 16x4 I2C display are integrated to I2C network such that the touch screen display is integrated with one off the slave and the load are integrated to I2C network through Arduino. The master identify each slave by its predefined by address, in the case of I2C display the address if fixed. The master send status data to the touch display to view the status of the light and sensor.

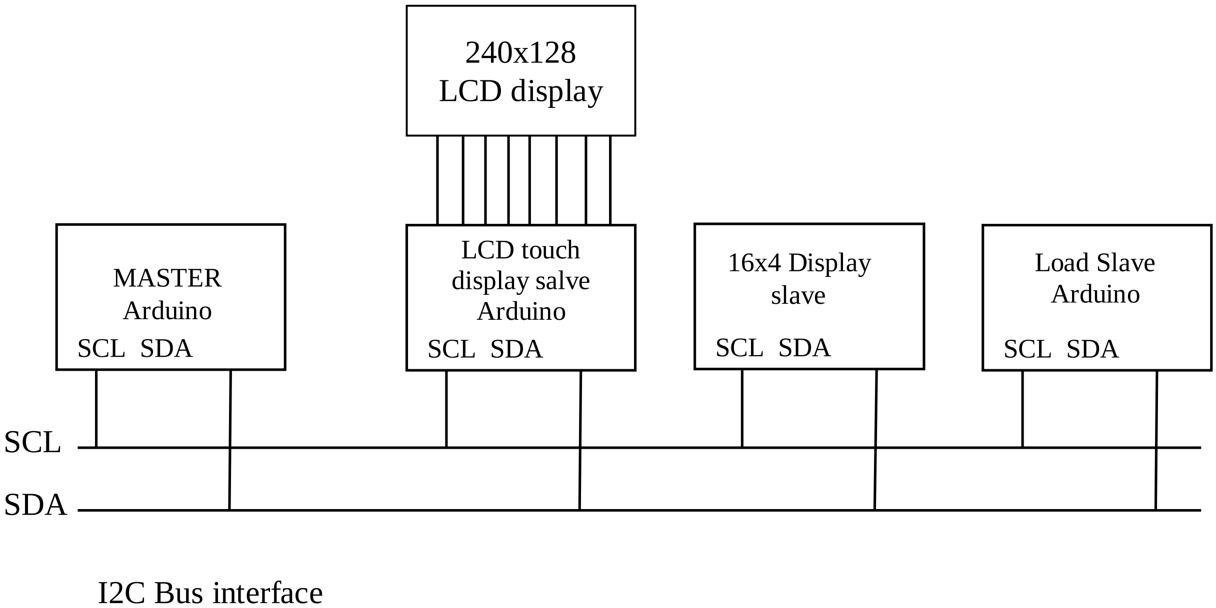

Figure.3: In the above block diagram shows the arduino the master and other slave device

In the above block diagram, master communicates to the slave through 2 wire system. It makes integration of further nodes to the network easy. The system can also integrate with multiple master for complicated control application. All the nodes can take power from the master with common ground

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IV. INTEGRATION OF FT5000 AS MASTER AND ARDUINO AS SLAVE USING I2C

The FT5000 development kit is a product of echelon that has inbuilt temperature & luminosity sensors, Display, Ethernet Interface, RS485 Interface, Rs232 port. I2C interface, SPI interface, in my project am using the I2C protocol for master slave communication, the I2C bus consist of a clock and data line. The master and the slave is connected to the ground for proper communication. One master can be connected to 255 slaves. The slaves cannot communicate each other. Each slave have a unique address which is known to master. The Arduino kit is integrated with the FT5000 development kit using the I2C Interface such that the control operations of loads are performed by the relay circuits. These relays get the supply of 5V as its input and this triggers the relay to close the circuit that is connected to the load.

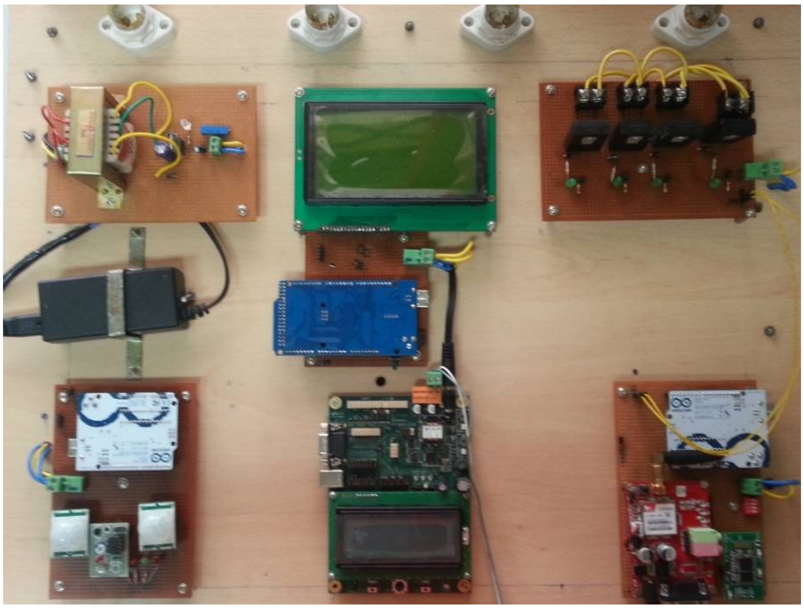

Figure.4: The entire standalone building automation system is displayed in the above diagram.

In the above diagram one ardunio kit on the left hand side has been integrated with sensors and the one on the right hand side has GSM modules, bluetooth in it. The ardunio in the top-center is integrated with display. The FT5000 kit in the bottom is networked with the LonWorks based building automation system. The arduino kit connected to the display is integrated with the FT5000 kit using I2C interface.

The relay module consist of four solid state relay which is driven by 5v supply and it can drive up to 5 Amp of load from 240v AC. It also have built in led indicator which shows the status of the relay. The wireless node consist of GSM and Bluetooth. Separate Bluetooth application is developed for control purpose. The relay node is connected to the wireless node through GPIO.

The block diagram shows the overall data exchange in the system. The master communicate to the salve through I2C communication. The slaves communicate to its devices through. GPIO pins. The slave store the value of the sensor and actuator in specific memory register. When the request from the master is receives then the mater access the values from the register. To read the values master send flag to slave, the flag contains the location of register of each sensor register. The slave compare the flag with the register, for the next request from then master it will send the value of the register stored for sensor status.

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V. BLOCK DIAGRAM

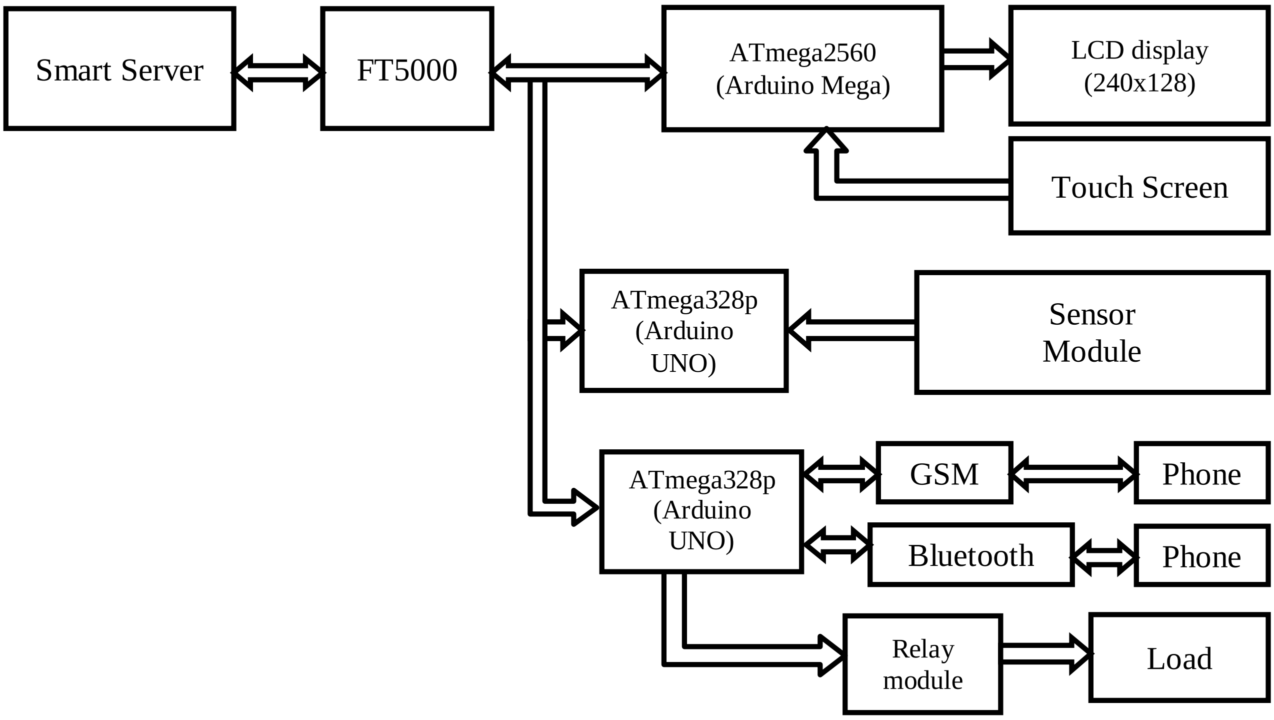

Figure.5: the above figure shows the block diagram of the developed system

In the above block diagram shows the data flow through the system. The master is connected to the slave through I2C bus. The slave connected to the end respond device through gpio pin. The also connected to the Internet through the smart server.

The master can also send a flag to the slave to store particular a value in specified location. In display node the master send out each flag along with its value which read from the sensor node and wireless node. Master do this process continuously without any delay make the system as a real time system. So the user can see the real time status of the loads and the actuator.

VI. FUTURE SCOPE

Furthermore, the dependency control algorithm is to be developed such that the input form the sensors and the control of the electrical loads are totally dependable on one another. The user interruptions can be totally avoided from this. By using time scheduler controller algorithm in lighting and air conditioning system the energy usage can be managed. One improvement that can be implemented in future, the system will be equipped with voice operated system with voice feedback. Another improvement can be done on sensors. Instead of using the wired sensors, the wireless sensors/ Bluetooth sensors can be easily integrating that saves the wiring and cable laying cost.

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VII. RESULT AND DISCUSSION

Figure 6. The above image shows the monitoring page of BAS system

In the figure 10, it shows the interface of the monitoring page. The display gives the real time status of the light load and sensor status. The graphic is designed and developed in arduino platform using GLCD library. The maximum delay time for image to change 0.8 seconds.

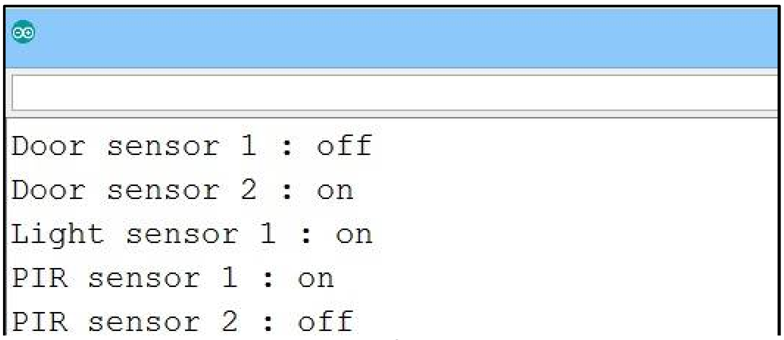

Figure 7. Testing of the sensor status

In the figure 11, it shows serial monitoring of arduino in which the real time sensor status with respect to LCD display. The delay between the testing node and LCD display is 1.3 seconds. The sensor response can be tested through serial monitor

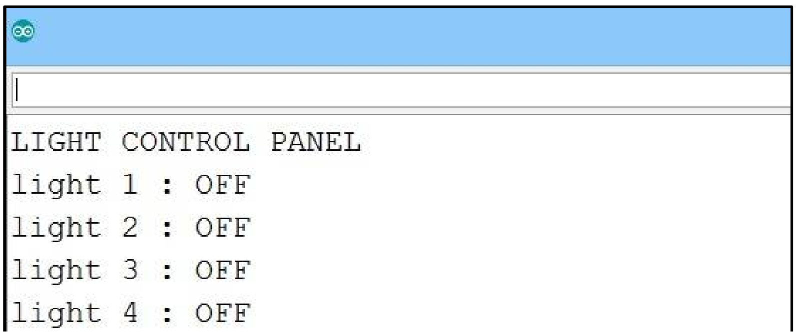

Figure 8. Testing of the light

In the figure 12, it shows the serial monitor of the arduino platform, the status of the light loads with respects to the LCD display can be view in thee serial monitor. The lights can also be controlled from the LCD touch display.

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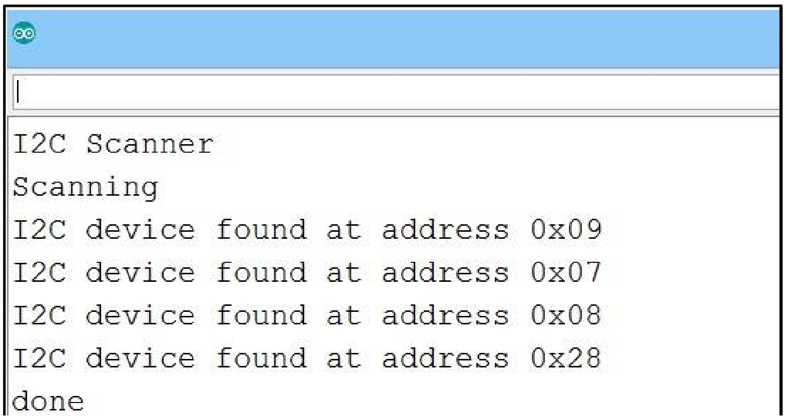

Figure 9. Testing of the I2C devices in the I2C communication bus.

In the figure 12, it shows the scanning of the I2C device present in the I2C bus. It also shows the address of the device connected to the I2C bus. This test can be used to check the address and number of device connected to the I2C bus. A device with unknown address can be identified by using this method.

VIII. CONCLUSION

By integrating one such system, we can easily network the remote low cost building automation system with the master building automation system / the building automation server such that deploying and remote monitoring of such systems via internet is possible.

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