

2D Image Projection in Teleoperation System Using Virtual Reality

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ABSTRACT:The use of embedded systems has a wide capabilities and features especially in smart home. Nowadays there is a demand for smart home automation access via virtual reality. This paper mainly focuses the owner to access the system via virtual reality and control the home appliances. In this paper, the design and implementation of virtual reality at a low cost yet a flexible, feasible and secure virtual reality based home automation system. These work also demonstrates the use of virtual reality in the context of the appliance control. Virtual reality can be used in a conventional manner to simulate the behavior of a system, but also in parallel with the real system to improve quality control. To validate our work, we conducted teleoperation experiments in various places. Experimental results show the effectiveness of the proposed architecture in a successful manner.

KEYWORDS:Image projection, Teleoperation, Virtual Reality, qualityof service.

I. INTRODUCTION

Virtual Reality (VR) is the use of computer technology to create a simulated environment. Unlike traditional user interfaces, VR places the user inside an experience. Instead of viewing a screen in front of them, users are immersed and able to interact with 2D worlds. By simulating as many senses as possible, such as vision, hearing, touch, even smell, the computer is transformed into a gatekeeper to this artificial world. The only limits to near-real VR experiences are the availability of content and cheap computing power. Virtual reality or virtual realities (VR), which can be referred to as immersive multimedia or computer-simulated reality,[1] replicates an environment that simulates a physical presence in places in the real world or an imagined world, allowing the user to interact with that world. Virtual realities artificially create Sensory experience, which can include sight, touch, hearing, and smell. Most up-to-date virtual realities are displayed either

On a computer screen or with an HD VR special stereoscopic displays, and some simulations include additional sensory information and focus on real sound through speakers or headphones targeted towards VR users. Some advanced haptic systems now include tactile information, generally known as force feedback in medical, gaming and military applications. Furthermore, virtual reality covers remote communication environments which provide virtual presence of users with the concepts of telepresence and telexistence or a virtual artifact (VA) either through the use of standard input devices such as a keyboard and mouse, or through multimodal devices such as a

Wired glove or omnidirectional treadmills. The immersive Environment can be similar to the real world in order to create a lifelike experience for example, in simulations for pilot or combat training or it can differ significantly from reality, such as in VR games.

A projector or image projector is an optical device that projects an image (or moving images) onto a surface, commonly a projection screen. Most projectors create an image by shining a light through a small transparent lens, but some newer types of projectors can project the image directly, by using lasers. A virtual retinal display, or retinal projector, is a projector that projects an image directly on the retina instead of using an external projection screen.

ZigBee is an IEEE 802.15.4-based specification for a suite of high-level communication protocols used to create personal area networks with small, low-power digital radios. The technology defined by the ZigBee specification is

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intended to be simpler and less expensive than other wireless personal area networks (WPANs), such as Bluetooth or Wi-Fi. Applications include wireless light switches, electrical meters with in-home-displays, traffic management systems, and other consumer and industrial equipment that requires short-range low-rate wireless data transfer. Its low power consumption limits transmission distances to 10–100 meters line-of-sight, depending on power output and environmental characteristics. [1] ZigBee devices can transmit data over long distances by passing data through a mesh network of intermediate devices to reach more distant ones. ZigBee is typically used in low data rate applications that require long battery life and secure networking (ZigBee networks are secured by 128 bit symmetric encryption keys.) ZigBee has a defined rate of 250 kbit/s, best suited for intermittent data transmissions from a sensor or input device and output device. It is one of the most simple and efficient device.

II. RELATED WORK

A. Stereo Viewing and Virtual Reality Technologies in Mobile Robot Teleguide

Works in the paper have demonstrated how stereovision contributes to the improvement of the perception of some depth cues, often for abstract tasks, while it is hard to find works addressing stereoscopic visualization in mobile robot teleguide applications. This paper intends to contribute to this aspect by investigating the stereoscopic robot teleguide under different conditions, including typical navigation scenarios and the use of synthetic and real images. This paper also investigates how user performance may vary when employing different display technologies. Results from a set of test trials run on seven virtual reality systems, from laptop to large panorama and from head-mounted display to Cave automatic virtual environment (CAVE), emphasized few aspects that represent a base for further investigations as well as a guide when designing specific systems for telepresence.

Method Used: Stereo vision, teleoperation, telerobotics.

Disadvantage: No VR facility that performs best on all proposed parameters. The large display facilities are more suitable for mobile robot teleguide, but some have limitations in comfort.

B. Virtual Hand-Button Interaction in a Generic Virtual Reality Flight Simulator

Virtual buttons are used without a physical mock-up to make the virtual reality flight simulator independent of the aircraft type. The classic virtual hand metaphor is employed to interact with the virtual objects. This paper examines the virtual hand-button interaction in the generic virtual reality flight simulator where no haptic feedback is provided. The effect of the collision volume of a virtual button during the virtual hand-button interaction is determined. It is concluded that a change in the collision volume within aircraft design limits, does not have a significant impact on the interaction. We also investigate different virtual hand avatars. We find that the accuracy of hand-button interaction depends on the hand avatar rather than the collision volume. Representing a smaller part of the hand avatar results in less efficient interaction. This shows the size and shape of hand avatars plays a major role in the virtual reality simulator design. This finding contributes to the various virtual reality applications which exploit the virtual hand metaphor.

Method Used: flight simulator, Hand button interaction, Joystick control.

Disadvantages: concealment of virtual objects by virtual hands makes interaction difficult.

C. Design of Mobile Robot Teleoperation System Based on Virtual Reality

This paper presents the remote control of a mobile robot via internet. To solve the problem of delay time which is unpredictable, direct teleoperation architecture is proposed. This architecture allows us to minimize the trajectory error of the robot movement which is controlled via the internet. This work also demonstrates the use of virtual reality in the context of the remote control. Virtual reality can be used in a conventional manner to simulate the behavior of a system, but also in parallel with the real system to improve quality control. To validate our work, we conducted teleoperation experiments in various places. Experimental results show the effectiveness of the proposed architecture.

Method Used: Virtual Reality, mobile robot, teleoperation.

Disadvantage: Manual operation performed.

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III. SYSTEM DESIGN

Systems design is the process of defining the architecture, components, modules, interfaces, and data for a system to satisfy specified requirements. Systems design could be seen as the application of systems theory to product development. There is some overlap with the disciplines of system analysis, system architecture and system engineering.

The following fig.1 explains the overall architectural diagram of the Virtual reality concept. It explains modules where the system consisting of both transmitter and receiver.

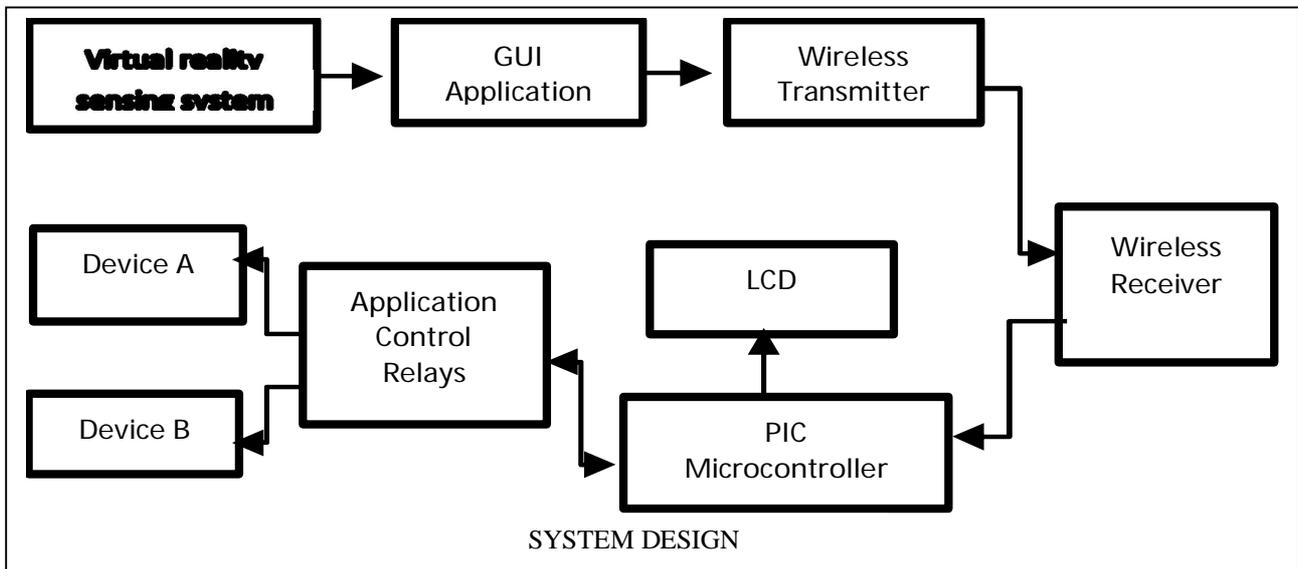


Fig.1: Architectural Diagram of Virtual Reality

Virtual reality projector acts as a primary system. It tends to visualize the 2D image on an object. It emphasizes the transparency of our predefined device with the operation to perform in the system. The camera located parallel to the projector senses the gesture of our user motion and transmits to the system. Embedded C language is used to define the functions that a user needs to operate in the image. The Virtual reality system is connected to the Graphical User Interface application on the Personal Computer along with a ZigBee controller which acts as a wireless transmitter. At the receiver end, ZigBee controller is located, which helps to receive the signal and sends to a step-down transformer which in turn is connected to a Peripheral Interface Controller(PIC) microcontroller and RELAY circuit composed of in-built components connected in a parallel manner. The integrated circuit IC (MAX 232) used in the embedded board integrates the microcontroller with the application relays. The Liquid Crystal Display notifies the current status of the appliances. The RELAY circuit generates voltage which is used for the devices to work. The relay circuit connected to output system.

IV. TRANSMITTER

The transmitter block diagram describes the virtual reality sensing unit, such as the image projector with a camera placed on top, connected to the GUI application to monitor and sense the projected image. It goes by the principle of motion capturing i.e. it senses the hand movement which on the other side triggers the desired loop in Embedded C programming. Then the signal is transmitted through the ZigBee controller to the receiver via a common medium.

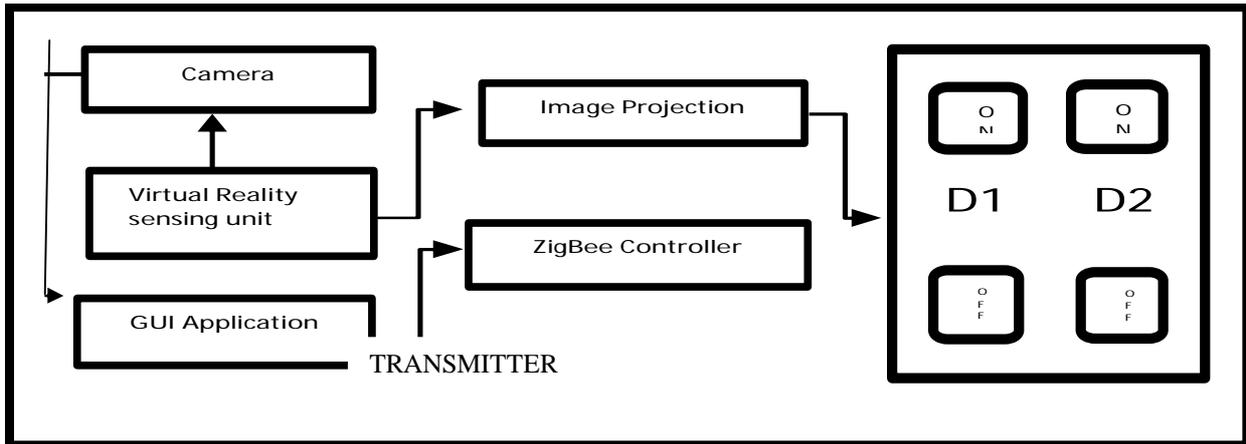


Fig.2: Transmitter of Virtual Reality

V. RECEIVER

The ZigBee receiver acquires the signal from the transmitter by the means of wireless network. The signal is then transmitted to the step-down transformer where the power is reduced to the specified ratio. This transformer is further connected to two circuits namely relay circuits and PIC Microcontroller parallel. There alone mentioned two circuits are interlinked to a MAX232 IC. The relay circuit is responsible for the operation of various devices connected to it.

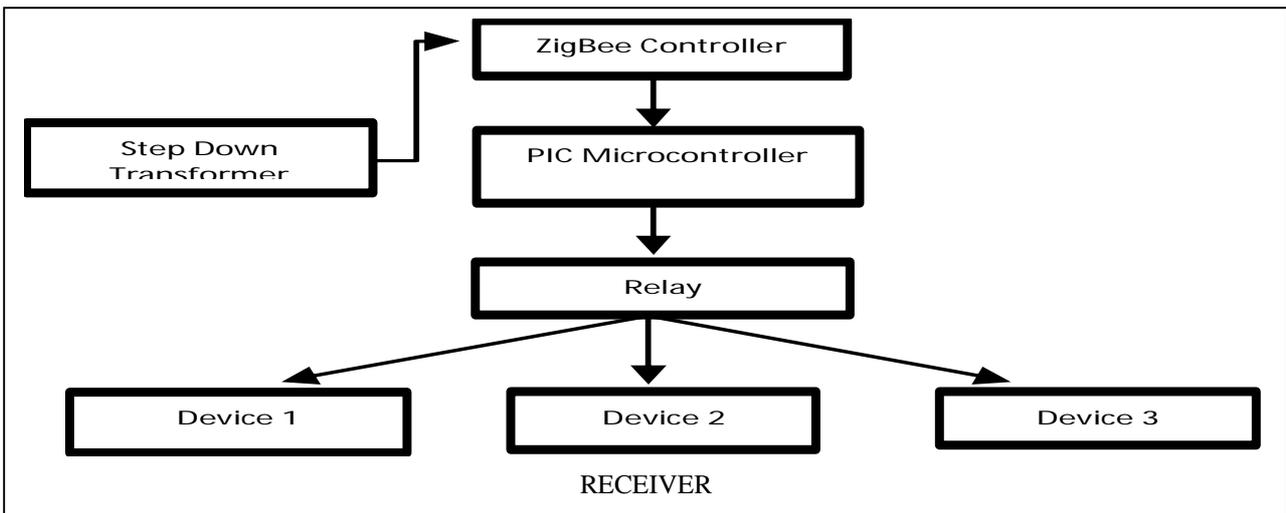


Fig.3: Receiver of Virtual Reality

VI. SPECIFICATION

A. PIC 16F877A MICROCONTROLLER

In this project work the basic and essential concepts of radio communication were utilized to create a wireless communication channel between two Computers. One computer is placed at the transmitter section. In this section we

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can see the display of the parameter values. The second computer is placed at the receiving end, where the maintenance persons are monitoring the system. Here we can monitor the parameters condition continuously. A PIC micro-controller (16f877A) and MAX232, RS232 are used as interfacing units between the system and RF transmitter and also at the receiver section. The program code is written in Assembly language and the serial communication concept is used to transfer the data. This project can be used as an alternate to wireless communication.

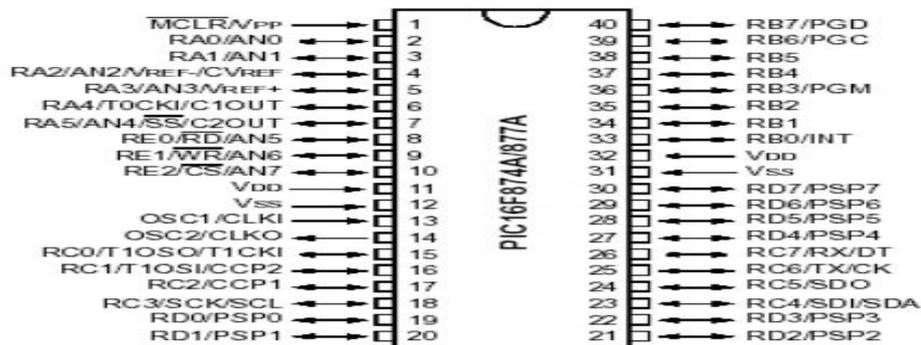


Fig.4: Pin Diagram PIC 16F877A

The project report describes on the design development and fabrication of one demo unit of the project work “Implementation of wireless communication between computers”. Now a day, with the advancement technology, particularly in the field of Micro-controllers, all the activities in our daily living have become a part of Information Technology and we find micro-controllers in each and every application. Thus, trend is directing towards Microcontrollers Based Project works. However, in this project work, the transferring of data serially is monitored. Subsequently, after serial processing, these signals are encoded. This information is transmitted through RF transmitter. The received information (using suitable RF receiver) is again decoded into digital signal at the receiver end. Then the decisions are taken with the help of micro-controllers and associated software. The micro-controller block is playing a major role in this project work. The Micro-controller chip is used in this project work is PIC 16f877A, and this is like heart of the project work. The PIC micro-controller is 40 pin IC. Microcontrollers are “embedded” inside some other device so that they can control the features or actions of the product. Another name for a micro-controller, therefore, is “Embedded Controller”. Micro controllers are dedicated to one task and run one specific program. The program is stored in ROM (read only memory) and generally does not change. Micro controllers are often low-price devices. A battery operated micro-controller might consume 50 mille watts. A micro-controller has a dedicated input device and often (but not always) has a small LED or LCD display for output.

Features

- High performance RISC CPU.
- ONLY 35 simple word instructions.
- All single cycle instructions except for program branches which are two cycles.
- Operating speed: clock input (200MHz), instruction cycle (200nS).
- Up to 368×8bit of RAM (data memory), 256×8 of EEPROM (data memory), 8k×14 of flash memory.

B. POWER SUPPLY

Power supply is a reference to a source of electrical power. A device or system that supplies electrical or other types of energy to an output load or group of loads is called a power supply unit or PSU. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others.

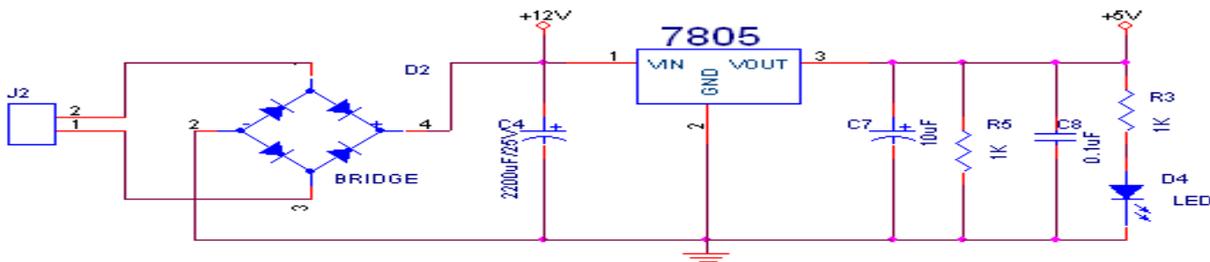


Fig.5: Power Supply

A 230v, 50Hz Single phase AC power supply is given to a step down transformer to get 12v supply. This voltage is converted to DC voltage using a Bridge Rectifier. The converted pulsating DC voltage is filtered by a 2200uf capacitor and then given to 7805 voltage regulator to obtain constant 5v supply. This 5v supply is given to all the components in the circuit. A RC time constant circuit is added to discharge all the capacitors quickly. To ensure the power supply a LED is connected for indication purpose.

Input Specifications:

Power Supply: DC +12v 1Amp.

USB : CAMERA driver installation

Output Specifications:

Output : UART RS232

Baud rate: 9600

C. UNIVERSAL ASYNCHRONOUS RECEIVER/TRANSMITTER

A **universal asynchronous receiver/transmitter** is a type of "asynchronous receiver/transmitter", a piece of computer hardware that translates data between parallel and serial forms. UARTs are commonly used in conjunction with other communication standards such as EIA RS-232.

A UART is usually an individual (or part of an) integrated circuit used for serial communications over a computer or peripheral device serial port. UARTs are now commonly included in microcontrollers. A dual UART or **DUART** combines two UARTs into a single chip. Many modern ICs now come with a UART that can also communicate synchronously; these devices are called **USARTs**.

The Universal Asynchronous Receiver/Transmitter (UART) controller is the key component of the serial communications subsystem of a computer.

The UART takes bytes of data and transmits the individual bits in a sequential fashion. At the destination, a second UART re-assembles the bits into complete bytes. Serial transmission of digital information (bits) through a single wire or other medium is much more cost effective than parallel transmission through multiple wires. A UART is used to convert the transmitted information between its sequential and parallel form at each end of the link. Each UART contains a shift register which is the fundamental method of conversion between serial and parallel forms.

According to image touched a single character will be sent to the UART. It will be easy to connect to the controller or can directly connect any UART wireless transmitter.

D. MAX232

The **MAX232** is an integrated circuit that converts signals from an RS-232 serial port to signals suitable for use in TTL compatible digital logic circuits. The MAX232 is a dual driver/receiver and typically converts the RX, TX, CTS and RTS signals.

The drivers provide RS-232 voltage level outputs (approx. ± 7.5 V) from a single + 5 V supply via on-chip charge pumps and external capacitors. This makes it useful for implementing RS-232 in devices that otherwise do not need any voltages outside the 0 V to + 5 V range, as power supply design does not need to be made more complicated just for driving the RS-232 in this case.

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The receivers reduce RS-232 inputs (which may be as high as ± 25 V), to standard 5 V TTL levels. These receivers have a typical threshold of 1.3 V, and a typical hysteresis of 0.5 V.

The later MAX232A is backwards compatible with the original MAX232 but may operate at higher baud rates and can use smaller external capacitors – 0.1 μ F in place of the 1.0 μ F capacitors used with the original device.

E. ZIGBEE

ZigBee is a specification for a suite of high level communication protocols using small, low-power digital radios based on the IEEE 802.15.4-2003 standard for wireless personal area networks (WPANs), such as wireless headphones connecting with cell phones via short-range radio. The technology defined by the ZigBee specification is intended to be simpler and less expensive than other WPANs, such as Bluetooth. ZigBee is targeted at radio-frequency (RF) applications that require a low data rate, long battery life, and secure networking.

Features of ZigBee MRF24J40MA:

- IEEE Std. 802.15.4™ Compliant RF Transceiver
- Supports ZigBee®, MiWi™, MiWi™ P2P and
- Proprietary Wireless Networking Protocols
- Small Size: 0.7” x 1.1” (17.8 mm x 27.9 mm),
- Surface Mountable
- Integrated Crystal, Internal Voltage Regulator,
- Matching Circuitry and PCB Antenna
- Easy Integration into Final Product – Minimize
- Product Development, Quicker Time to Market
- Radio Regulation Certification for United States
- (FCC), Canada (IC) and Europe (ETSI)
- Compatible with Microchip Microcontroller
- Families (PIC16F, PIC18F, PIC24F/H, dsPIC33
- and PIC32)
- Up to 400 ft. Range

Pin Diagram:

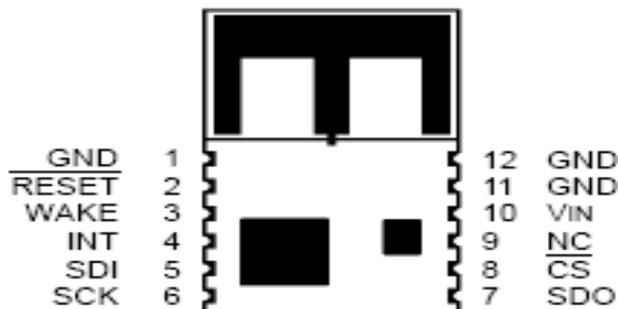


Fig.6: Pin Diagram for ZigBee

F. KEIL Compiler

The C programming language is a general-purpose, programming language that provides code efficiency, elements of structured programming, and a rich set of operators. C is not a *big* language and is not designed for any one particular area of application. Its generality combined with its absence of restrictions, makes C a convenient and effective programming solution for a wide variety of software tasks. Many applications can be solved more easily and efficiently with C than with other more specialized languages.

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The Cx51 Optimizing C Compiler is a complete implementation of the American National Standards Institute (ANSI) standard for the C language. Cx51 is not a universal C compiler adapted for the 8051 target. It is a ground-up implementation dedicated to generating extremely fast and compact code for the 8051 microprocessor. Cx51 provides you the flexibility of programming in C and the code efficiency and speed of assembly language.

Since Cx51 is a cross compiler, some aspects of the C programming language and standard libraries are altered or enhanced to address the peculiarities of an embedded target processor.

G. SOFTWARE ANALYSIS

The main purpose of using the microcontroller in our project is because high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications.

The programs of the microcontroller have been written in Embedded C language and were compiled using KEIL, a compiler used for microcontroller programming. The communication between PC and the microcontroller was established MAX 232 standard and those programs were also done in C language.

The following programs are used at various stages for the mentioned functions. Serial communication in this program, the various special function registers of the microcontroller are set such that they can send and receive data from the PC. This program uses the serial library to communicate with the ports.

H. Support for all 8051 Variants

The 8051 Family is one of the fastest growing Microcontroller Architectures. More than 400 device variants from various silicon vendors are today available. New extended 8051 Devices, like the Philips 80C51MX architecture are dedicated for large application with several Mbytes code and data space. For optimum support of these different 8051 variants, Keil provides the several development tools that are listed in the table below. A new output file format (OMF2) allows direct support of up to 16MB code and data space. The CX51 compiler is a variant of the C51 compiler that is design for the new Philips 80C51MX architecture.

VII. EXPERIMENTAL RESULTS

In the present day scenario, the world has become fast moving hence forth, a new invention, every second, becomes mandatory. Another such major problem is time management. Now a days, people find it difficult to even operate devices manually. In such a case 2d image projection in teleoperation system using virtual reality comes into play. Initially, a GUI application runs on the system, which stimulator the functioning of the virtual reality projector and the camera. One needs to pre-define the necessary operational functions in order to make use of it while performing an action on the desired device.

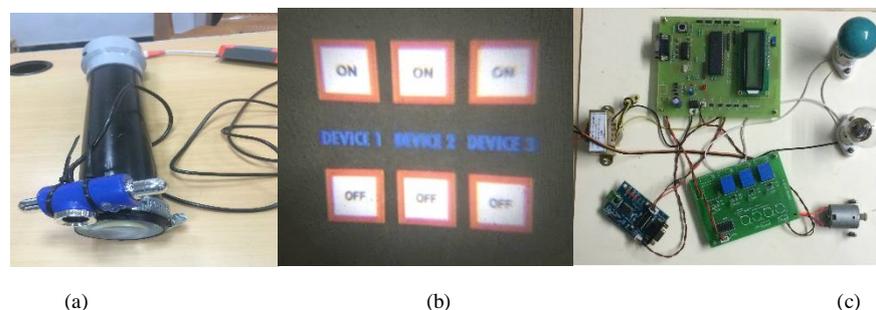


Fig. 7 Text Detection and In painting (a) Projector of Virtual Reality (b) Image projection of Virtual Reality (c) Receiver mechanism of Virtual Reality

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When the virtual reality projector is ready to use, it projects the 2d image on any surface. The projected image can be viewed by the user from a greater distance. The image would be crystal clear. The user by default, interrupts the ray falling on the surface by hand movement in order to perform any kind of operation. The camera then captures the action made by the user. The GUI application recognizes the sudden interruption and there by insisting the ZigBee controller to transmit the signal on a network. The ZigBee receiver placed on a far-away end, receives the transmitted signal. The signal is then transmitted to a circuit board consisting of a step-down transformer, bridge rectifier, capacitor, voltage regulator, MAX 232 IC, relay circuit, reset switch and PIC microcontroller. In the circuit, the signal first passes through a step-down transformer. The step-down transformer is basically used to cut down power from 230v to the required 12v dc. After passing through the step-down transformer, the signal passes through a bridge rectifier which rectifies the voltage from 12v to 15 dc. The signal further passes through the capacitor, a charge storage device, which filters the 5v dc. The voltage regulator then regulates the filtered voltage to a 3-volt dc. The reset switch is used to reset the board. The signal then passes through the MAX 232 IC which integrates the relay component to the microcontroller. The PIC microcontroller integrated with the relay component consists of an embedded c program to control the board. The signal then passes through the RELAY circuit which connects the 3v dc to 230v and ends to the other devices. The PN diode in RELAY circuit is used to avoid reverse bias in the circuit. Many devices can be accessed by connecting them to the RELAY circuit

IX. CONCLUSION

An operating a system manually would definitely consume the user's energy and their time. In the previous system, we found that the systems were operated using remote control which does not exhibit transparency there by not providing an interactive experience. In our work, we have developed a system based on virtual reality. This is a novel concept of image accessing and functioning which gives us an interactive experiences. Introduction of 3D image processing to this system would like up the operating experience to a supreme level. Our system is a basic level implementation. Henceforth, implementing through 2D image is the only possibility

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