Internet Controlled Robot (ICR)
# Table of Contents

1  Preface .................................................. 2
2  Acknowledgements ..................................... 3
3  Abstract .................................................. 4
4  Introduction ............................................ 5
5  Discussion ............................................... 6
   5.1  ICR: Electronics .................................... 7
   5.2  Software Implementation ............................ 9
   5.3  Mechanical Fabrication ............................. 11
   5.4  Applications of ICR ................................. 14
   5.5  Scope for further improvements ................... 14
6  References ............................................... 15
7  Appendix: A ............................................. 16
8  Index .................................................... 17
9  Glossary ................................................ 18
1 Preface

Robots have always fascinated mankind. Be it movie makers who make motion pictures set in the future where robots have taken over mankind, or be it cartoonists who introduce robots as characters into their cartoons. Even today, the thrill of seeing a machine perform an automated task doesn't cease to fire up the imagination of youngsters and elders alike.

We as students have been fascinated with robots since the time we were school children, and had always dreamt of making our very own robot. The availability of guidance and resources at the college level motivated us to convert our dream into a reality.

Also, a strong desire to do a project very different from the conventional ones done at our college was one of the factors that motivated us to design and fabricate the ‘Internet Controlled Robot’.

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2 Acknowledgements

We are highly indebted to Prof. D.V Gadre, Assistant Professor, Electronics Division, NSIT for his support and encouragement at all stages of the project.
3 Abstract

This report discusses design, constructional details, applications, and economics of the Internet Controlled Robot. The Electronics of the ICR has been primarily built around the AVR ATMega8 microcontroller which controls data transmission between the server and the robot, and controls the motion of the motors. Two Zigbee modules have been used to implement the wireless data link between the robot and server. JAVA servlets have been used to implement the control through internet. Ideas for future modifications have also discussed.

**Keywords:** Internet Controlled, JAVA Servlet, Wireless, Multimedia Interface, Robot.
4 Introduction

Robots are intelligent machines that can be controlled according to need. If a multimedia interface is provided, it further aids in navigation of the robot. Making the robot wireless increases the effective area of operation, thereby making it possible to control the robot from a remote location. Keeping all the above factors in mind the, a robot capable of being remotely controlled through the Internet and possessing a multimedia interface, was conceived and developed.

The ICR is a multi-functional mobile device which can be controlled in real time through the Internet. The movement of the ICR is controlled by pressing appropriate buttons on its website. A unidirectional video link and a bi-directional audio link aid the user in navigation. These also provide a stronger and more user-friendly means of communication with the environment of the robot.

An AVR ATmega8L microcontroller controls the movement of two D.C. Motors and one Stepper Motor. An F.M. receiver circuit, an XBee module and an audio video transmitter circuit comprise the RF link between the server and the robot. A 12V, 7 AH battery is used to power the robot and a distributed power supply is used to step down voltages to appropriate levels, as required by the various modules.

*Plug and Play* concept has been practiced throughout the design and construction phases of the robot. All sub-modules of the robot can be replaced / repaired in case they malfunction without having to alter other modules of the robot.

The following pages discuss in detail the three broad aspects involved in designing and construction of the robot; namely electronics hardware, software and mechanical hardware.
5 Discussion

5.1 ICR: Electronics

The electronics of ICR govern data transfer between the server and the robot, the control of two D.C motors, one Stepper motor, a bidirectional audio link and a unidirectional video link. All electronic modules are supplied power by a distributed power supply which steps down voltages to levels required by various electronic modules.

The operation of various electronic modules is illustrated below:

![ICR Electronics Operation Diagram](image)

Figure 5.1: ICR electronics operation
Following are the various modules that comprise the electronics of the ICR

Following modules are mounted on the robot:

1. AVR ATMega8 microcontroller based PCB
2. F.M. receiver circuit
3. Distributed power supply
4. ULN2003 and L293 based motor driver circuit
5. Audio-Video transmitter on wireless video camera

Following modules are connected to the server

6. F.M transmitter circuit
7. Audio-Video receiver circuit

1 **AVR ATMega8 microcontroller**

The ATMega8 microcontroller controls two D.C motors used for the driving the robot. In addition it controls a Stepper motor used for tilting the camera up/down. A summary of features of the microcontroller and how they are used in the present version of ICR is given below:

1) *Serial USART* – Used for communicating through an XBee module to the server.
2) *PORTB* – All the eight GPIO pins on PORTB of the microcontroller are used to control the D.C motors and a Stepper motor.

2 **F.M receiver circuit**

The F.M receiver accepts wireless audio from the F.M transmitter on the server, amplifies the received signal and feeds it to a speaker on the robot. Therefore a unidirectional audio link is established.

3 **Distributed power supply**

The distributed power supply provides secondary sources of power of different voltage levels required by the various electronic modules while using a single 12V 7AH sealed lead acid battery as the primary source of power.

4 **ULN2003 and L293 based motor driver circuit**

Two D.C motors are used for the horizontal motion of the robot. Additionally a stepper motor is required for tilting mechanism of the camera assembly. These two tasks were accomplished by using a single circuit employing a L293 to drive the two D.C motors and a ULN2003 was used to drive the stepper motor. L293 is a quadruple half-H bridge IC primarily meant for motor driving applications with a high current handling capacity of up to two amperes peak current as required. The ULN2003 has seven high power NPN Darlington arrays. Successive phases of the stepper motor are connected to each input pin of the IC. This composite motor driving circuit requires eight GPIO pins on the ATMega8 microcontroller.
6 F.M transmitter circuit

The F.M band transmitter circuit transmits audio from the server to be received by the F.M receiver on the robot. Operating on 9V the circuit consumes only 4mA current while providing a range of 75 meters in open. Thus combined with the F.M receiver on the robot and the camera transmitter-receiver combination a bidirectional audio and a unidirectional video link is established which effectively increases the precision with which the navigation of the robot in its environment can be performed. This also enables a means of communication between the robot’s environment and the client’s environment.
5.2 Software Implementation

The following components broadly describe the software implementation aspect of the ICR

1. Internet control using JAVA servlet and server side program
2. Code running on ATMega8 microcontroller
3. Multimedia module (Audio – Video Interface)

1 Internet Control

The following components make up the software implementation aspect of the ICR

A. Web Server program
B. JAVA Servlet
C. HTML (Hyper Text Markup Language) based web page

A. Web Server program

The web server used in this project is APACHE TOMCAT 5.5.9 or APACHE TOMCAT 5.0.28. Some modifications were needed to be made in the .xml files of the software so a preconfigured version of APACHE TOMCAT 5.5.9 was downloaded from http://www.Coreservlets.com. Also, a windows system environment variable JAVA_HOME with value /<JAVA ROOT>/jdk/bin was set.

B. JAVA Servlet

The algorithm for the servlet code is illustrated.

When a submit button is pressed on the web page, the information is sent to the servlet, which identifies which button has been pressed and what is the state of the radio buttons. It thus sends the corresponding character to the microcontroller by means of a serial RS-232 port. The microcontroller processes the received character and takes action accordingly.

Figure 5.2
Algorithm for Internet Control Servlet
C. HTML based Web page

The web page contains multiple submit buttons which when pressed initiate the servlet discussed before and do the corresponding functions. A multiplier is also provided in the form of radio buttons to make the maneuvering of the ICR even easier.

The web-page preview is shown below. The multiplier radio buttons have no effect on the ‘move camera up’ and ‘move camera down’ buttons.

![Web Page Preview](image)

Picture 5.1 Web Page Preview

2 Code running on the ATMega8 Microcontroller

The microcontroller is connected to the server computer by means of a USART (Universal Synchronous Asynchronous Receiver and Transmitter). The communication link between the two is set at 9600 bits per second. These settings are configured by the servlet on the server computer. The code on the microcontroller sets these settings for the microcontroller. The micro controller waits in an infinite loop for data, and upon receiving a character from the server, does the corresponding action.

3 Multimedia Link

The task of implementing an audio-video link over the Internet is done by using the software - MSN Messenger. The server side version of MSN Messenger is kept logged in to the MSN network, while continuously streaming audio and video data over the Internet. This video and audio is available to the client upon signing in into MSN Messenger.

Thus a bi-directional audio link and a unidirectional video link is established. So the client can send audio messages to the robot and simultaneously receive an audio and video stream of the robot’s environment.

From the surveillance point of view an A.V. feedback is extremely vital, since the robot does not have any onboard sensors to guide it. The Audio-Video link is intended to be implemented using a JAVA™ Applet in the future which would fully integrate it with the existing web server (APACHE TOMCAT 5.5.9).
5.3 Mechanical Fabrication

The stages involved in the construction of the mechanical structure of the ICR are as follows:-

5.3.1 Design

1 Dimensional requirements

Although the dimensions of the area on floor covered by the robot are not such a major factor the factors considered while finalizing the size were:

   A. The area required by the different parts to be placed viz. PCB’s, Battery, Camera assembly.
   B. The required height was 100 cm from the floor as from this height the robot could ‘see’ over standard desks in home and office.

2 Weight Considerations

The total weight of the robot was required to be around 7-10 Kg. therefore the D.C. motors chosen for driving the robot were to be powerful enough to carry the weight and not lock while turning.

3 Reliability of design

When the idea of this robot was conceived it was decided that this robot and all its parts be made very reliable .Therefore the entire structure is put in place by tightening multiple screws and bolts making it extremely reliable and available for fine adjustments with great precision.

4 Strength required

The strength of the robot in terms of the strength of design was optimized while taking into account the conditions the robot has to operate in.

5 Plug and play

The ease of any plug and play design has been well accomplished in case of the computers used around the world. At the time while the idea of this robot was being conceived one of the major plus points was to use a design conforming to the plug and play idea used in today’s computers. The advantages of this terminology of design are:

   A. Ease of servicing / reparable of parts
   B. Ease of maintenance
   C. Improved reliability
5.3.2 Materials Identification

1 Cost

The material to be chosen was to be cost effective while conforming with the discussion in the above points.

A. The ideally suited material for this robot’s base was acrylic.
B. Shafts were made out of silver-steel rods (brite-rods).
C. All the gears bought from the market were made of plastic.
D. Right angle joints for fixing the rods to base were made out of Poly-Propylene (PP).

2 Strength required

All the materials chosen for their respective purposes were chosen after taking into account the strength factor.

3 Ease of use

A. Acrylic base
   1 Very easy from marking point of view
   2 Easily serviceable with general tools eg. Hacksaw, files, drilling machine
   3 Low cost

B. Silver-steel shafts
   1 Easily serviceable with general tools eg. Hacksaw, files, drilling machining, etc.
   2 High degree of strength, machine ability
   3 Easily available in various diameters

C. Poly-propylene
   1 Low cost
   2 High degree of machine ability
   3 Presentable

5.3.3 Mechanical Modules

1 Base

The various other mechanical modules are connected to the base with the help of nuts and bolts.
2 Wheel assembly

A. Wheels
The wheels have a diameter of two inches. Polypropylene has been used as it possesses high degree of machine ability.

B. Gears
Gears are employed to effectively increase the torque available at the wheels while simultaneously reducing the speed available at the wheels. Timer belts are employed to interconnect the gears as they allow for small lateral displacement of the relative position of the gears.

C. Acrylic pieces
The acrylic pieces form the structure of the wheel assembly. It houses the ball bearings to which the shafts are connected. Three separate sub pieces are connected to a central piece by the aid of nuts and bolts, therefore allowing room for fine adjustment of the assembly.

3 Camera assembly
The camera assembly allows for the pan-tilt mechanism of the camera. The required height is achieved by using a 60 cm long silver-steel rod.

A. G.I sheet pieces
They are used to fasten the camera on the shaft.

B. Plastic flag-post shaped pieces
They are used to tighten the whole assembly to the silver-steel rod.
5.4 Applications of the ICR

The uses of ICR extend to an array of environments and an array of situations. Some of the critical uses include-

1. ICR can be used for *surveillance purposes* in military, domestic or industrial environments. The ability of the ICR to be controlled via the Internet makes it possible to make the control point of the robot as far as required from the area under surveillance.

2. ICR can be used in the *corporate environment*, wherein the CEO can use ICR to be up to date with the office activities, by actually moving around in the office, talking to employees and colleagues. The ICR, in this sense bridges a communication gap considerably thereby helping to eventually improve profits, increase productivity and efficiency of an organization.

3. ICR can be used in *homes* wherein the parents, even while sitting thousands of miles away, can baby sit their children, old people at home.

4. ICR can be used in *hospitals* wherein it can be used to transport medicines from one part of the hospital to another; the user having to just sit on a seat and control the movement.

5.5 Scope for further improvement

Following are some of the modifications which are planned to be implemented in the near future to further enhance the usefulness of ICR-

1. Implementation of wireless serial link between the server and the robot.
2. Building a wireless video transmitter to further improve upon the range provided by the present video transmitter employed.
3. Improving the mechanical design of the robot by adding shock absorbers etc. This would enable it to endure rough and uneven terrains, inclined surfaces etc.

The present version of the ICR essentially provides a template which can be modified to serve a variety of purposes by making minor modifications.
6. References


7. Appendix: A

**Economics of ICR**

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<tr>
<th>Material Class</th>
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<th>Cost (INR) Per item/meter</th>
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Approximate figures:

- **Mechanical cost**: INR 1800.00 (US$ 39)
- **Electrical cost**: INR 550.00 (US$ 11)
- **Electronic cost**: INR 1200.00 (US$ 25)

- **Grand total**: INR 3550.00 (US$ 75)
## 8 Index

<table>
<thead>
<tr>
<th>A</th>
<th>4</th>
<th>U</th>
<th>10, 18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td></td>
<td>USART</td>
<td></td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A.I</td>
<td>4</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Assembly</td>
<td>5, 7, 13, 16</td>
<td>XBee</td>
<td>5, 7</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base</td>
<td>5, 12, 16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camera</td>
<td>5, 7, 10, 11, 13, 16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Darlington</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distributed power supply</td>
<td>6, 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronics</td>
<td>3, 4, 6, 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F.M</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receiver</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmitter</td>
<td>7, 8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G.I</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glossary</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPIO</td>
<td>7, 8, 18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internet</td>
<td>4, 5, 9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multimedia</td>
<td>4, 9, 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCB</td>
<td>7, 11, 18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plug and Play</td>
<td>4, 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RS 232</td>
<td>6, 18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Servlet</td>
<td>5, 11, 18</td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
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</table>
9 Glossary

**A.I:** Artificial Intelligence; Programs capable of taking decisions without any control signals.

**Darlington:** A special configuration of two transistors that allow for high currents to flow when the transistor is used as a switch.

**F.M:** Frequency Modulation; the signal is superimposed on the carrier signal modulating its frequency. Signal is acquired by demodulating the above modulated signal. Commercial F.M band is 88-108 MHz. Digital version of F.M is known as FSK (Frequency Shift Keying).

**GPIO:** Data pins on a microcontroller that can be configured for input or output according to need are known as General Purpose Input Output (GPIO) pins.

**H-Bridge:** A standard high speed circuit used for driving D.C (Direct Current) Motors in clockwise and anti-clockwise directions.

**JAVA Servlet:** A servlet is a program running on the server side which responds to actions on the hosted web page, processes the gathered information and responds accordingly.

**PCB:** Printed Circuit Board; the circuit is printed on a glass-epoxy board in form of copper tracks where components are soldered thereby greatly increasing reliability over conventional circuit boards.

**RS-232:** A standard of serial communication where high is -3V to -15 V and low is +3V to +15V.

**USART:** Universal Synchronous Asynchronous Receiver and Transmitter, is a means of serial communication between a microcontroller and other devices that have a USART such as a computer.