A REMOTE MONITORING SYSTEM FOR RIVER BARRAGE GATES AND ALLIED STRUCTURES USING VIRTUAL INSTRUMENTATION TECHNOLOGY

Shri. Amit Chaudhuri Addl. Director
Sri. Jayanta Kumar Roy Technical Officer
Sm. Shampa Dey Project Assistant

Centre for Development of Advanced Computing, Kolkata
(Erstwhile Electronics Research & Development Centre of India, Calcutta)
Plot E-2/1, Block GP, Sector V, Bidhannagar, Kolkata - 700 091, INDIA
Phone: 91 33 2357-9846 / 5989 / 3581, Fax: 91 33 2357 5141
Email: amit.chaudhuri@erdcical.org

ABSTRACT

A Barrage Gate Monitoring System (BGMS) has been developed through application research .The developed system uses micro-controller and wire-less technologies backed by virtual instrumentation for graphical remote monitoring on PC. The field-electronics and electrical systems have been designed to ruggedised and fail-proof. Internet/Wire-less based remote visualization of dynamic field-conditions using virtual instrumentation are also possible for water management or safety monitoring. The system was developed taking into consideration the real-life situations of a large Barrage in operation and has been successfully field-tested integrating the prototype system model partially with the Barrage. The technology-package may be customized and deployed in any other Barrage. The system features specially suit the site-conditions in developing countries.

INTRODUCTION

India is a land of rivers. Rivers of India have been tamed for managing flood situation, for arranging agricultural/industrial/civic water supply and for ensuring navigation channel capacities. Barrages, dams, canals are constructed for river-water management wherein, manually or electrically operated gates control water discharges. Indian River / Barrage project authorities and Engineering / Construction firms had been searching appropriate modern electronic systems useful for remote gate operation. Remote intelligent gate operation is also important for controlling flood situations. The search has resulted in a Govt. sponsored application-research and development project through which, a Virtual Instrumentation Based Remote Monitoring System for Barrage-Gates has been developed to provide high-speed monitoring and control of three Field / Remote Stations at the gate structure, each of which controls raising and lowering of gates, generating alarm and status information (including gate height), which is continuously displayed in a PC in the Control Station.

DEVELOPED SYSTEM - BASIC FEATURES

The functional-modules and basic-features of the Remote monitoring System can be understood with the help of Figures 1 & 3. Here, each Remote or Field Station controls up to a maximum of 6 gates. Gates under control of Field Stations can be operated from the Control Station through a control panel as shown in Fig.5. The System is capable of handling 18 no. of gates, from a distance of 10 kms at present. However, this technology has got the provision for controlling 175 numbers of gates with additional accessories as required and minor modifications in the System Software. The Remote Monitoring Software has been developed on LabVIEW (NI-USA), and is built with Graphical codes, which makes it user-friendly not only from the visualization aspects but also from the customization or modification aspects with-out spending of much costly coding hours. Several innovative analysis-scopes with real-time logging of structural and water release/movement data have been kept for making Water-management from remote place easy, dependable and effective saving various hazards and use-less expenditure.

SYSTEM/FIELD STUDIES

In order to evolve, some standard application-linked system-specifications for development, a Barrage called Sir Arthur Cotton Barrage or Godavari Barrage was thoroughly inspected as arranged by M/s. Jessop & Co. Ltd., the renowned Indian Construction Firm which had built the Barrage and based on the System-studies, application R&D activities leading to Hardware / Software / System development were taken up. Godavari Barrage is the longest barrage of its kind in India, situated near Rajamundry in Andhra Pradesh. The Barrage has 175 gates distributed in 4 arms. The existing system of barrage operation, site conditions, etc. has been studied. Each gate is operated by a Hoist motor, which is controlled from the respective local-panel consisting of the electrical-interface circuitry as shown in Fig.4. Hoist Motor specification was found to be as follows:
3 phase induction motor, Type-ILA2 084-8,415V, 50Hz, 4.85 kW, 710 rpm, 0.77 p.f., Delta connected, 10.2 amps load, Make-Bharat Bijlee Ltd.
There was a provision for telemetry at gate no. 4, 10 and 16 for the first 18 numbers of gates in the Dowliswaram Arm. Each telemetry box can take care of 6 local panels of gates. Some relevant **features** of the target Barrage-System were noted as below,

No. of Arms: 4	total length of the barrage: 7000 meters maximum	
Dowliswaram	total length: 1450 mts.,	No. of gates: 70
Ralli	total length: 884.45 mts.,	No. of gates: 43
Maddur	total length: 471.79 mts.,	No. of gates: 23
Vizzeswaram	total length: 804.90 mts.,	No. of gates: 39

The linear distance between the Remote Control Room (RCR) and the first gate in Dowliswaram Arm is 260 mts. The linear distance between the Remote Control Room (RCR) and the 18th gate in Dowliswaram Arm is 396 mts.

Gate Features : All the gates were in operating condition either manually or electrically driven by motor.
Gate dimension : 18.29 mts. (span) x 3.35 mts. (height) x 2ft. app. (width)
Gate weight : 27 tonne
Figure 6 shows details of a Vertical gate with hoisting arrangement.
Soil/Wind Features : Sandy Soil with bearing capacity up to 10-tons/sq. meter. The Wind Pressures and Velocities at different heights (as per IRC: 6-1966) as below:

H The average height in mts. of the exposed surface above the mean retarding surface (ground or bed level or water level)	**V** Horizontal velocity of wind in Km. Per hour	**P** Horizontal wind pressure in Kg. per sq. mt.
4	100	63
6	107	73
8	113	82
10	118	91
15	128	107
20	136	119
25	142	130

The barrage-studies pointed towards the requirements of wireless-communication for remote-operation. Field Data-acquisition required ruggedised local electronics development incorporating safety features both in electrical and embedded systems. Antenna and frequency selection were made keeping the ground-conditions e.g., Structural-designs, Noise-sources, Security-restrictions etc into consideration. User-requirements were analysed to be basically simplicity and safety in operation, zero-maintenance at the Barrage-installations, flexibility at the control-room PC in terms of Display-graphics, Analysis/Computational add-ons and Data-storage options. Thus, the development problems were derived as below. These situations and requirements are common in most old large Barrage-sites in all developing countries of the world.

DEVELOPMENT PROBLEMS

The technology development project required technological area wise application R&D activities as below:

Gate Electrical Systems with Encoder-electronics and other attachments, needed to be studied/developed/engineered on virtual instrumentation approach. **Value added** Micro-controller based Field DAS Cards and Control Station Cards needed to be developed.

Standard/Industrial **Wireless Electronics (VHF)** needed to be integrated and interfaced with newly developed value added DAS Hardware Modules and PC (VI). **Virtual Instrumentation** Software (VI) needed to be developed with proper visualization graphics and data flow programming simplifying digital electronics.

DEVELOPED TECHNOLOGY AND SOFTWARE-DESIGNS

The technology designs (See Fig. 3) are broadly divided into four subsystems:

1 Wireless Control Network with Transceiver/Antenna

2 Micro controller cards for Value-added DAS functions

3 Graphical monitoring Software on Virtual Instrumentation

4 Encoder Transducer & Gate Electrical Attachments

The Control Station consists of the following items:

1 Control card (micro controller based)
2 Power supply Unit and UPS.
3 Modem Card
4 GP Antenna & Wireless Transceiver
5 DAQ Card & PC with Lab VIEW Software
6 Control Panel

Each Remote / Field Station consists of the following items:

1 GP Antenna and Wireless Transceiver
2 Modem Card
3 Digital I/O Card (Command)
4 Digital I/O Card (Feedback)

5 Field Card (Micro controller based)
6 Relay Panel and Termination Block
7 Power Supply Unit
8 Encoder and Transducer Electronics for each gate
9 Gate Motor Interface for each gate

Ministry of Communication, Govt. of India, Licensed to establish, maintain and work an experimental wireless telephone station under Indian Telegraph Act, 1885.

Type : Radiating Frequency : 166.875 to 167.225 MHz
Period : 24 hours Max. Power : 25W Simplex NI_B/NP_B

VIRTUAL INSTRUMENTATION

Virtual Instrumentation (VI) is a new technology paradigm, which leverages all the continuing advancements in Processor/PC Technologies, Bus Standards, Internet based Communication / Software standards / protocols and all Application/Network Connectivity features. The power of this technology lies in Graphical Data-flow Programming techniques, Multi Vendor/Cross Platform interface technologies extended to the Internet domain and Networked Measurement/Automation Tools. The evolution of this programming paradigm was marked by the transition from machine language to assembly languages, and from these to functional, procedural, and eventually Object-Oriented High-Level languages. During the past ten years a totally new paradigm evolved along these lines, offering problem-solving approaches in a new dimension - Graphical Data Flow Programming in the form of so-called "**Virtual Instruments**". In the Instrumentation domain, Data Flow Programming Model has proved to be superior to all the other current paradigms, which are built on Cryptic, Text-Oriented Programming grammars. In this project, LabVIEW (Laboratory Virtual Instrument Engineering Workbench) platform has been used. VI software has been developed for **3 control panels** (See Fig. 3) through which interactive sessions for gate movements (with precise height measurement) hoist motor overload conditions, etc. can be monitored. This software can be used with PCI compatible DAQ cards as well as RS 232C serial communication for acquiring real time gate status from field. The VI is flexible enough to incorporate 175 gates. This VI can be linked to database like ORACLE, MS-Access, etc. through SQL toolkit embedded in the VI environment. Sample of VI screen is given in this paper (Fig. 2), which has been developed for use. Important Software-features are as below.

(a) The PC screens display the gate movements in the form of multi-colour "Pictorial" diagrams where different alarm conditions can also be represented.
(b) The exact value of Vertical Displacement of gate i.e. the amount of gate

opening is available in C.G.S. units i.e. in meter/centimeter with maximum resolution possible.

(c) Help Menus, Calibration procedures and Password facility is provided in PC.

(d) Daily, Monthly, Yearly records of Gate Opening, etc. may be kept in the database of PC and analysis/judgment may be automatically performed on these data using special Software to be developed as per requirements.

(e) Add-on facility for Data Porting to remote places using Cables, Telephone Lines and Wireless has been provided. Internet based remote-connectivity may be added.

Each gate has separate Gate Motor Interface (GMI) which consists of contacts relays for gate operation and potential free contacts to provide gate status. The old GMI blocks had been studied and modified to match the new design. The modified implementation has been tested satisfactorily at site. The standard rotary transducers and encoder electronics have been re-designed and re-engineered successfully. Development of a low cost-transducer, which is potentiometric type having 4 - 20 mA output for remote data transfer with local display has been successfully completed. An imported-product, which has in-built encoder electronics with RS 485 serial communication facility with PC has been also tested. All these options are studied/explored and experimented interfacing the System.

CONCLUSION

This System Technology can also be applied to any other Barrage or moving engineering Structures, such as overhead crane, mines machinery, etc. with minor modifications as required. Control Station PC has got the standard connectivity features for extending the system to different offices with extra terminals. The System Software has tool-kits for Internet based data porting to any distance as required. The System has been successfully tested in the Godavari River Barrage in Andhra Pradesh, India and a technology-package is available for customization/technology-transfer.

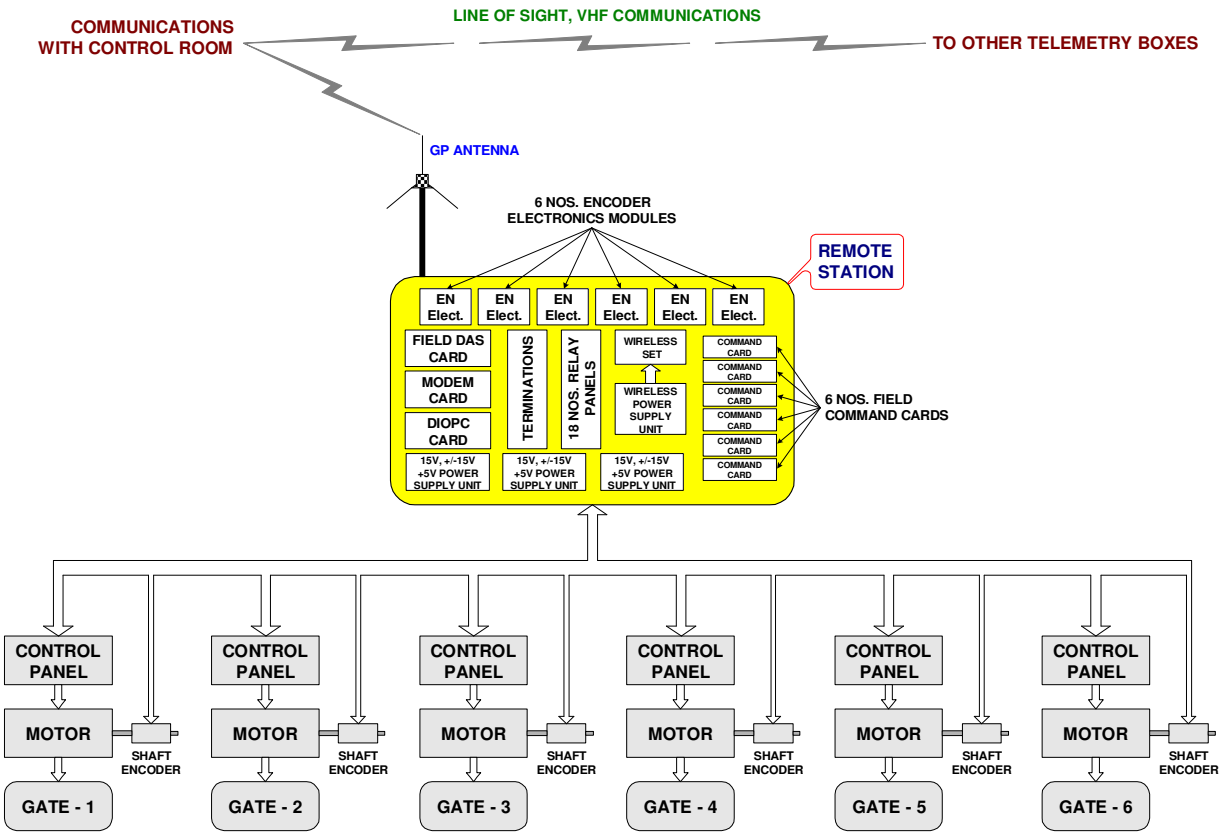


Fig. 1 WIRELESS COMMUNICATION SCHEME FOR REMOTE CONTROL OF BARRAGE GATES

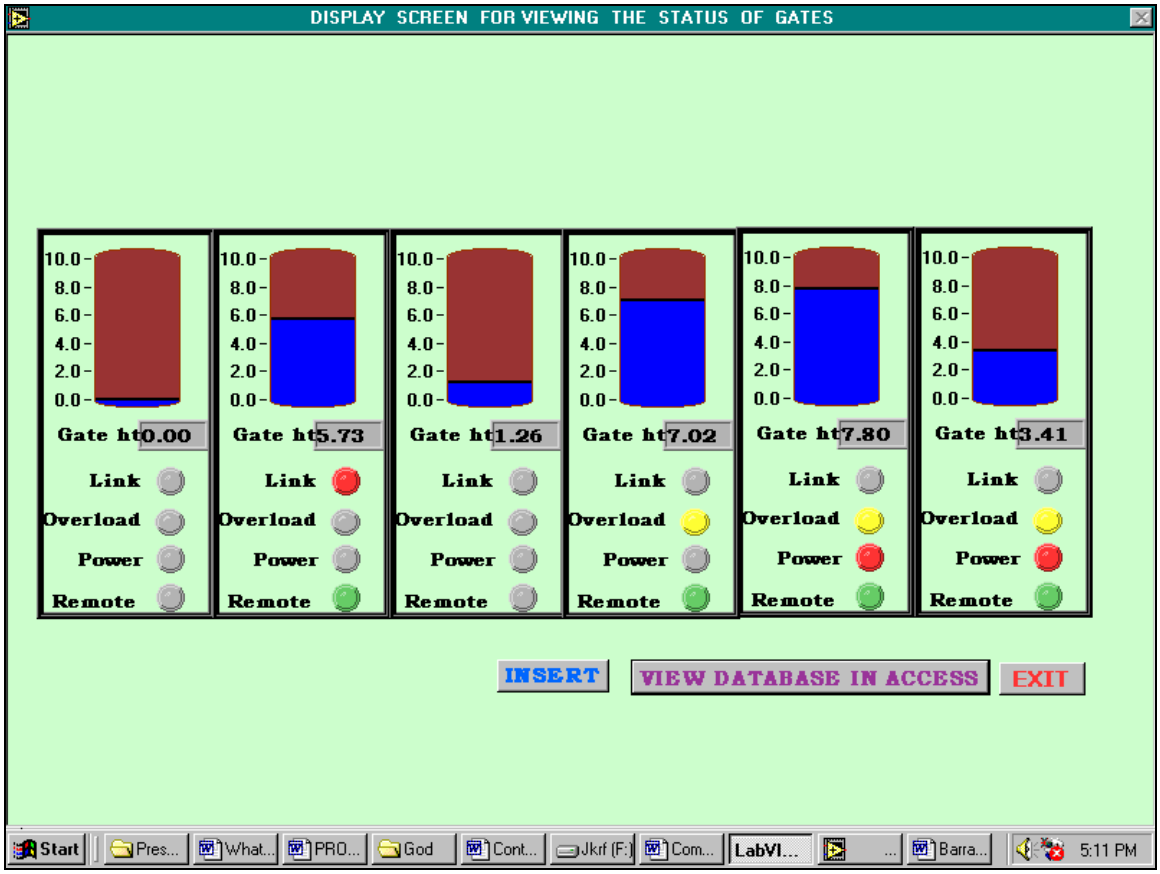


Fig. 2 Gate Monitoring Software on Virtual Instrumentation Platform

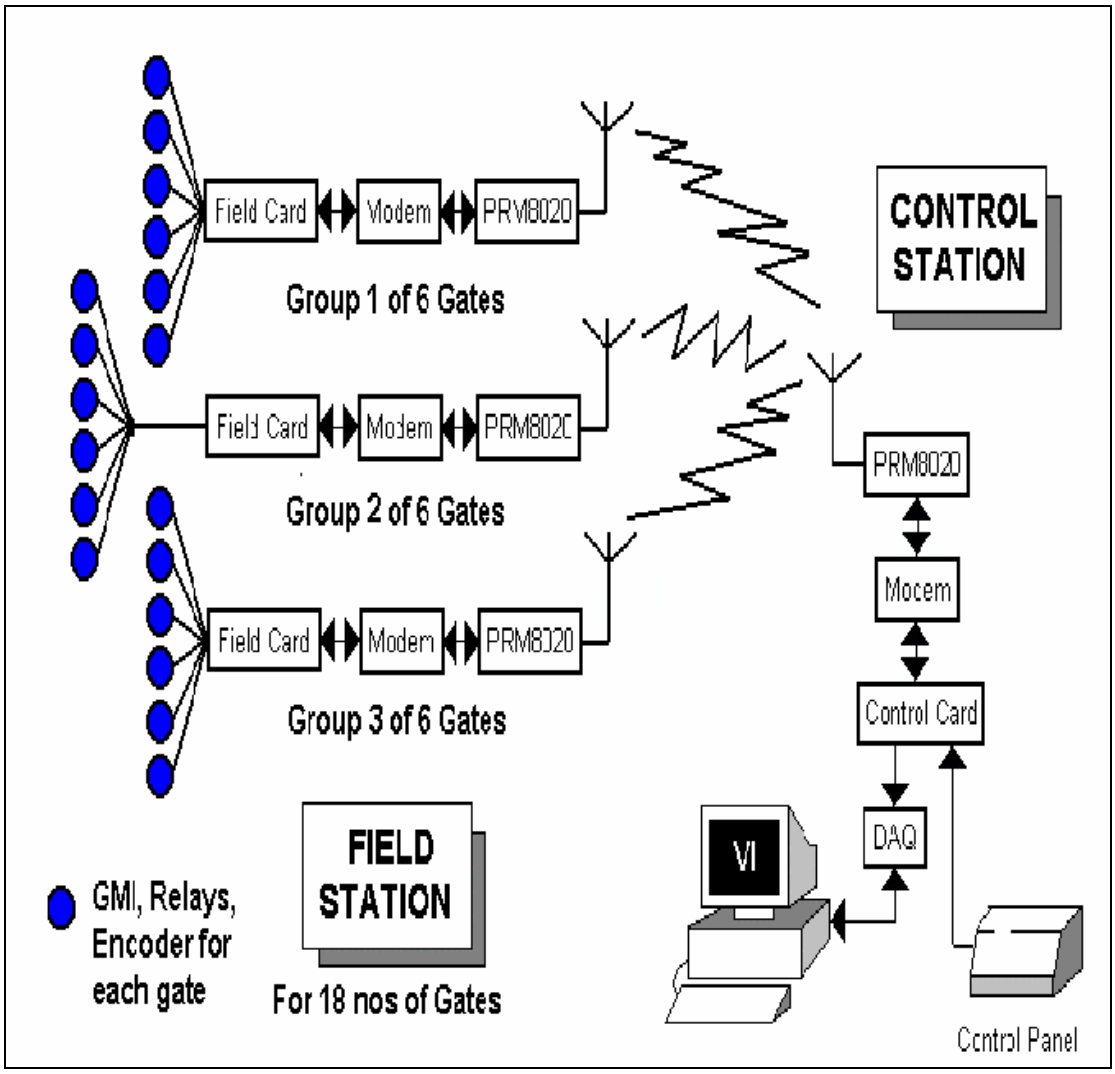
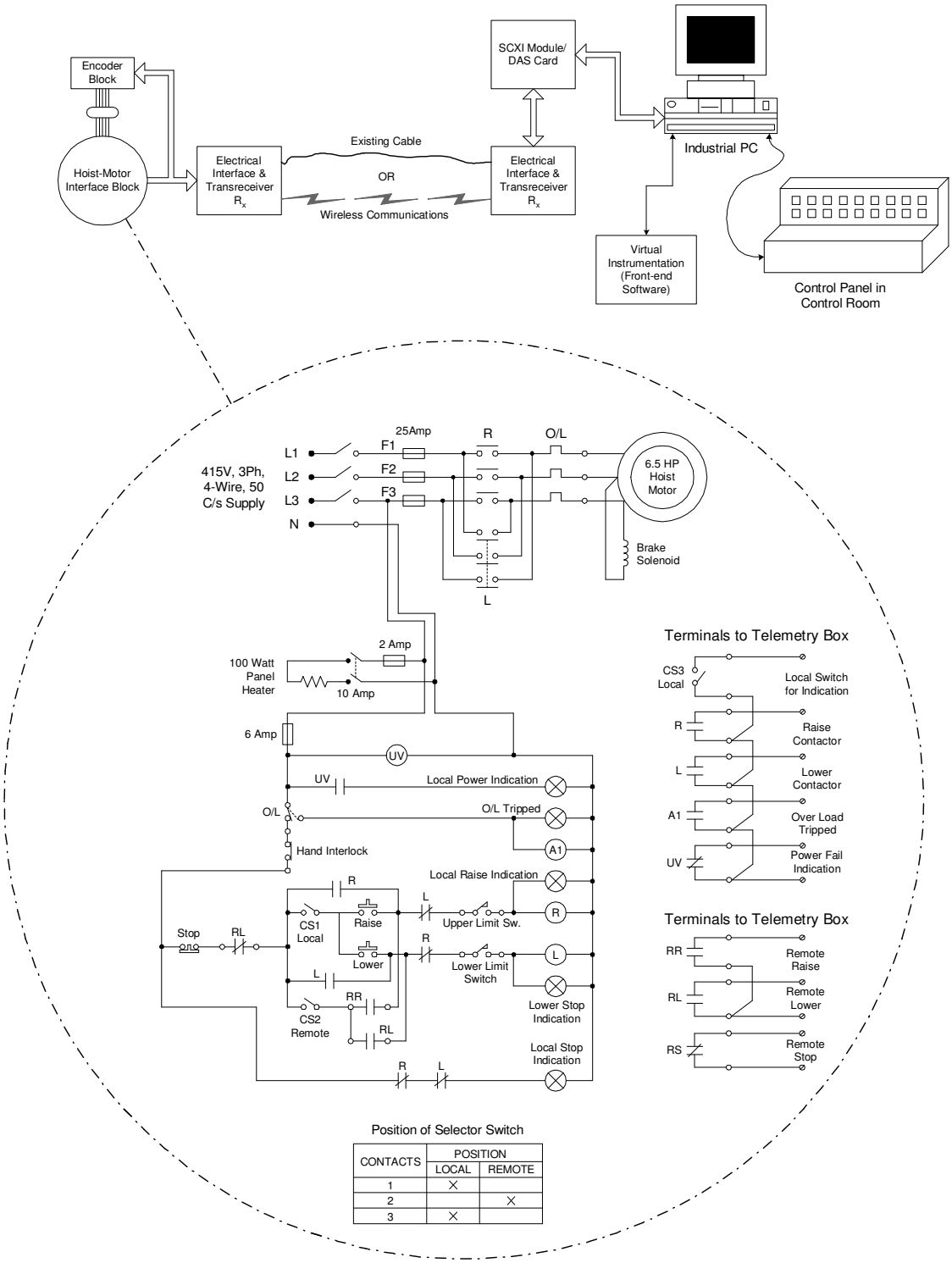
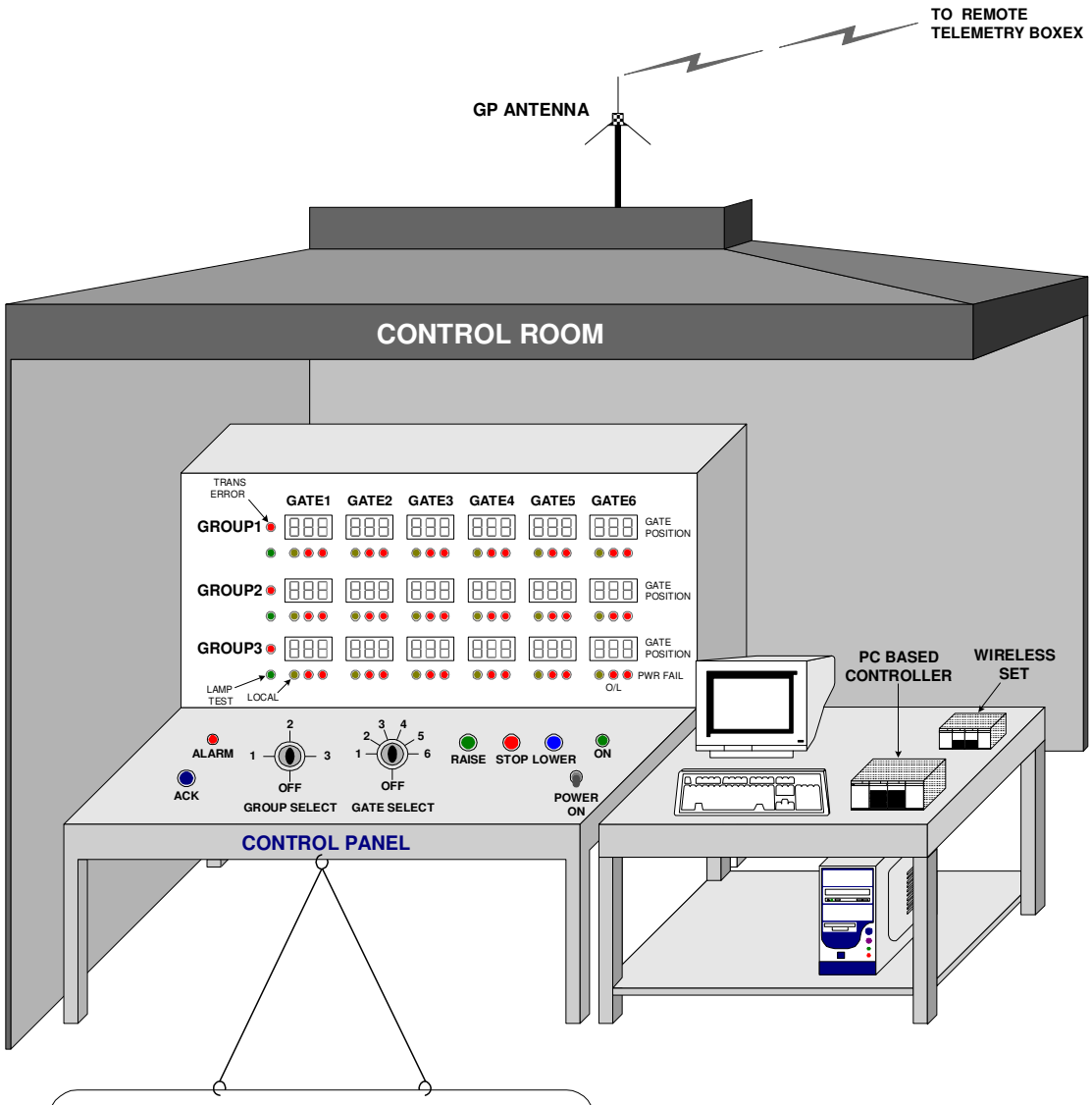


Fig. 3 Full System showing all components including Remote/Field Stations and Control Room



CONTACTS	POSITION	
	LOCAL	REMOTE
1	X	
2		X
3	X	

Fig. 4 HOIST MOTOR - ELECTRICAL SYSTEM



- Selection of Groups and Gates through two Selector Switches
- Operation (Upward, Downward and Stop) of Gates through Push Button Switches in Control Panel
- Online information of Gate Position on PC Screen through Virtual Barrage View System
- Indication of Gate Movement, Motor Condition, Power Condition, Link Failure, Remote/Local Mode of Operation, etc.
- Simplex/Semi-duplex Mode of Communication
- Battery back-up facility for Transmitter and Receiver
- Virtual Instrumentation based DAS and User Mimic Panels
- RF Communication : 160 MHz to 174 MHz
- Distance : 10 Kilometer; GP Antenna
- Display Updating of Gate Height: At every 9 sec.
- System Resolution : 2.5 cm. of Gate Movement

Fig. 5 Central Control Room

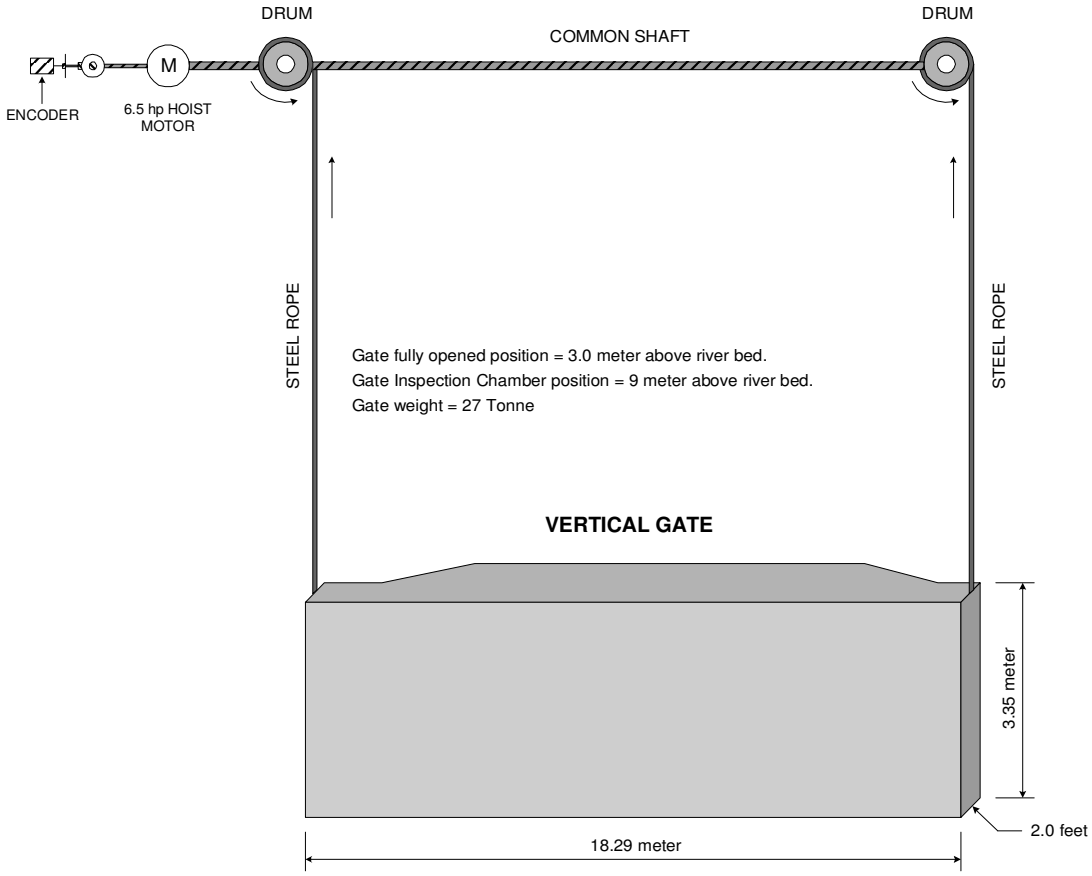


Fig. 6 Vertical gate with Hoisting Arrangement

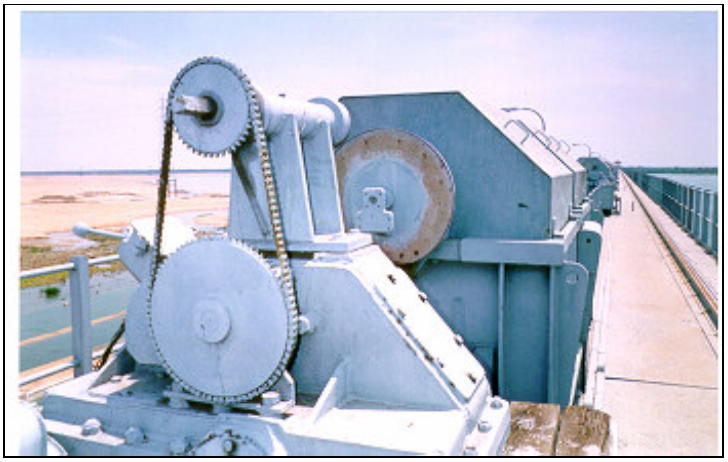


Fig. 7 Barrage Hoist Motor Mechanical Arrangement

Fig. 8 Barrage Gates in Operation

Fig. 9 Gate movement Dial with Encoder mounting device

ACKNOWLEDGEMENT

The authors are thankful to Sri A. B. Saha, Exe. Dir., CDAC-Kolkata for his kind permission to publish the paper. The authors are also thankful to Sri Amit Roy, Sri H. Bose and other officers / staff of CDAC-Kolkata and external agencies who had contributed in the project works. The development works were carried out under joint sponsorship of DIT, Govt. of India and Jessop Engineering Co., Kolkata.

REFERENCES

1. Rahman J & Herbat P, LabVIEW Application and Solutions, Prentice Hall PTR, Upper Saddle River, NJ 07458
2. Chaudhuri A, Roy J K, Dey S, Innovations in Virtual Instrumentation Systems with WAP / WEB Links for Integrated Power Plant Management, Proceedings of the Technical Symposium on Measurement and Automation, Aug. 2001, New Delhi, organised by NI-USA
3. Chaudhuri A, Bhattacharya C, Akuli A, Internet based Instrumentation with Multimedia features – Some Developments for Technical Education, Proceedings of the 2003 International Conference on Multimedia Technology and its Applications, Jan 13-16,2003 Agra, India, organised by Korea Multimedia Society