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Wireless based Operation and control of Electron Gun for Medical LINAC (Linear Accelerator)

Miss. Rupali V Satpute **Dr. Ram Chand Sethi** **Prof. N S Killarikar**

***ABSTRACT*—This paper gives brief idea about wireless based operation and control of electron gun for medical LINAC. A medical LINAC that use to destroy tumors using high-energy beams. The electron gun is a source of electron beams. Todays leading technologies, such as ZigBee, Bluetooth, GPRS/GSM can help to make wireless operation and control which gives reliability and security as well reduce the wiring and cost.**

The aim of this project is to make operation and control of electron gun through a long distance i. e. without any physical connection. To achieve this aim, Zig-Bee wireless technology is used. For this, on one side, zigbee interfaced microcontroller hardware is required and on another side zigbee interfaced personal computer is required.

Personal computer consists of graphical user interface program by using this user can send the commands to the microcontroller and microcontroller is also programmed so accordingly it indicates the status of microcontroller and communicate with user.

***Keywords* — Electron gun, Medical LINAC, Wireless technologies**

I. INTRODUCTION

A. Medical LINAC

A linear particle accelerator (often shortened to linac) is a type of particle accelerator that greatly increases the velocity of charged subatomic particles or ions by subjecting the charged particles to a series of oscillating electric potentials along a linear beam line. Linacs have many applications: they generate X-rays and high energy electrons for medicinal purposes in radiation therapy, serve as particle injectors for higher-energy accelerators, and are used directly to achieve that highest kinetic energy for light particles (electrons and positrons) for particle physics.

The design of a linac depends on the type of particle that is being accelerated: electrons, protons or ions. Linac range in size from a cathode ray tube (which is a type of linac) to the 2-mile (3.2 km) long linac at the SLAC National Accelerator Laboratory in Menlo Park, California.

B. Electron Gun

The ELECTRON GUN consists of a HEATER and a CATHODE to generate electrons, a CONTROL GRID to control brightness by controlling electron flow, and two ANODES (FIRST and SECOND). The main purpose of the first (FOCUSING) anode is to focus the electrons into a narrow beam on the screen. The second (ACCELERATING) anode accelerates the electrons as they pass. The control grid is cylindrical and has a small opening in a baffle at one end. The anodes consist of two cylinders that contain baffles (or plates) with small holes in their centers.

Cathode and Control Grid As in most conventional electron tubes, the cathode is indirectly heated and emits a cloud of electrons. The control grid is a hollow metal tube placed over the cathode. A small opening is located in the center of a baffle at the end opposite the cathode. The control grid is maintained at a negative potential with respect to the cathode to keep the electrons bunched together.A high positive potential on the anodes pulls electrons through the hole in the grid. Because the grid is near the cathode, it can control the number of electrons that are emitted. As in an ordinary electron tube, the negative voltage of the grid can be varied either to control electron flow or stop it completely. The brightness (intensity) of the image on the fluorescent screen is determined by the number of electrons striking the screen. This is controlled by the voltage on the control grid.

Electrostatic Lenses and Focusing The electron beam is focused by two ELECTROSTATIC FIELDS that exist between the control grid and first anode and between the first and second anodes.

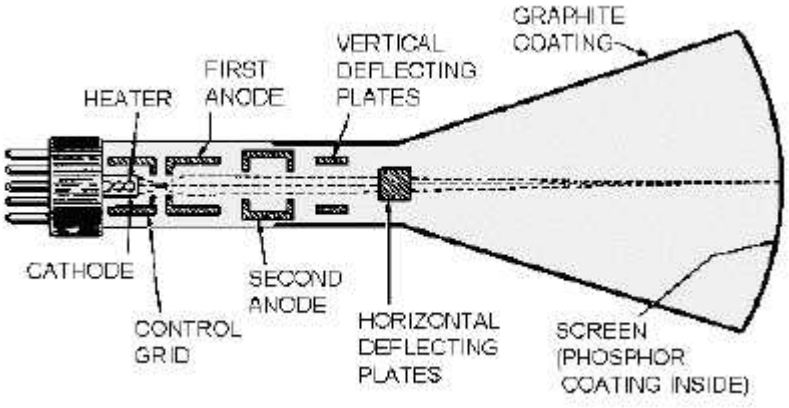

Fig.1: structure of Electron Gun

II. WHY WE NEED WIRELESS TECHNOLOGY

Goes where cable and fiber cannot:
the inherent nature of wireless is that it doesn't require wires or lines to accommodate the data/voice/video pipeline. As such, the system will carry information across geographical areas that are prohibitive in terms of distance, cost, access, or time

Completes the access technology portfolio:
customers commonly use more than one access technology to service various parts of their network and during the migration phase of their networks, when upgrading occurs on a scheduled basis. Wireless enables a fully comprehensive access technology portfolio to work with existing dial, cable, and DSL technologies.

Involves reduced time to revenue:
companies can generate revenue in less time through the deployment of wireless solutions than with comparable access technologies because a wireless system can be assembled and brought online in as little as two to three hours.

Provides broadband access extension:
wireless commonly both competes with and complements existing broadband access. Wireless technologies play a key role in extending the reach of cable, fiber, and DSL markets, and it does so quickly and reliably. It also commonly provides a competitive alternative to broadband wire line or provides access in geographies that don't qualify for loop access.

One of the main advantages is the ability to provide anytime, anywhere connectivity. The widespread implementation of wireless in public locations, known as hotspots, allows people to easily connect to the Internet to download information and exchange emails and files.

Wireless technology is fairly easy and inexpensive to install. The cost of home and business wireless devices continues to decrease. Yet, despite the decrease in cost, the data rate and capabilities of these devices have increased, allowing faster, more reliable wireless connections .

Wireless technology enables networks to be easily expanded, without the limitations of cabled connections. New and visiting users can join the network quickly and easily.

III. COMPARISION OF WIRELESS TECHNOLOGIES

The wireless communication technologies has taken its birth from Radio technology and it has grown strength to strength connecting people across the globe.

Table 1: Comparision of Wireless technologies

Se. No.	Wireless technology	Data rate	Radio Coverage
1	2 G digital cellular	10 kbps	Nationwide through roaming
2	2.5 G digital cellular	Up to 384 kbps	Nationwide through roaming
3	3 G digital cellular	Up to 2 kbps	Nationwide through roaming
4	WLAN 802.11b	11 Mbps	Building / campus, 100-120 meters
5	WLAN 802.11g	11 Mbps	Building / campus, 100-120 meters
6	WMAN 802.16 WiMax	75 Mbps	Metro city area, 56 Kilometers
7	Bluetooth	1 Mbps	Room/house, within 10 meters
8	Ultra Wide band (UWB)	100 Mbps	Auditorium, 50 meters
9	RFID	Few Kbps	Small area within a store room, 2.5 cm to 100m
10	GPS and satellite	250 ms delay	Worldwide global

Following table gives comparision between latest technologies

Table 2: Comparision of Latest Wireless technologies

Parameters	ZigBee 802.15.4	Bluetooth 802.15.1	Wi-Fi 802.15.11b	GPRS/ GSM
Application Focus	Monitoring and Control	Cable replacement	Web, Video, email	WAN, Voice, data
System Resource	4KB-32KB	250KB+	1MB+	16MB+
Battery life (days)	100-1,000+	1-7	1-5	1-7
Nodes/Network	255/65K+	7	30	1,000
Bandwidth(Kbps)	20-250	720	11,000+	64-128
Range(meters)	1-75+	1-10+	1-100	1,000+
Key attributes	Reliable, Lower Power, Cost effective	Cost convinience	Speed, flexibility	Reach, Quality

IV. THE CONCEPT

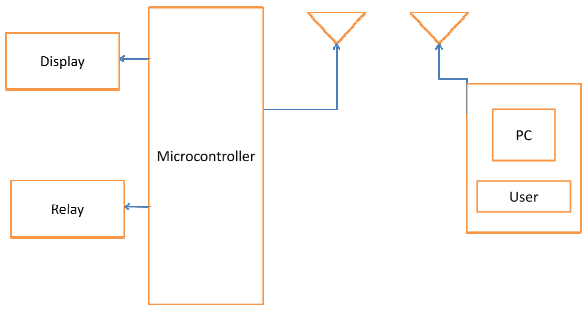

Fig.2: Block diagram of Wireless system

In this project, the commands are given from the Computer which is far away from the electron gun and not connected through wires. The various parameters like main power supply, vaccum pressure, power supply of electron gun, current and energy of electron beam are connected to the bidirectional port of Microcontroller through relays. Microcontroller operates and control the various parameters. Dispay shows present status of microcontroller. The transreceivers are connected through zigbee wireless technology.

Operation:

Initially, User gives the command through computer to turn ON main power supply. As main power supply ON it display on computer , then set values for all parameters are enter through keyboard of

computer. Microcontroller process parameters as per given instruction and sequence. Consequently, we get wireless operation and control of electron gun for Medical LINAC.

V. CONCLUSION

As we are using basic module of ZigBee for wireless data transmission there is further scope, by using higher versions of ZigBee module of the range of data transmission can be increased.

The range of ZigBee communication can be further increased by using GSM network along with ZigBee. This further more increase more by using satellite communication

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Rupali V Satpute

M.E. persuing (EXTC) from Mumbai University, B. Tech. (EXTC) from Dr. Babasaheb Ambedkar Technological University, Lonere, Raigad, Diploma (ET) from Amaravati University.

Presently, serving as Assist. Prof. in K J Somaiya Institute of Engineering and information Technology.

Paper published on "Wireless sensor network" in International Conference on Emerging Trends in Technology 2012, Thakur College of Engineering and technology (tcet), Kandiwali, Mumbai.

Life time member of ISTE.

Dr. Ram Chand Sethi

Ph.D. (Physics) from Mumbai University in the year 1986.

MS Orientation Course (Physics) from Bhabha Atomic Research Centre (BARC), Mumbai in the year 1969.

B.Sc. Physics Honours Schoo, from Punjab University, Chandigarh in the year 1968.

B.Sc. Physics, with Honours in Mathematics, from Punjab University, Chandigarh in the year 1967.

Retired from BARC as a head of accelerator and pulse power division, , Project manager of electron beam centre, Kharghar, Navi Mumbai and chairman of BARC- ECIL security system project, in the month of oct 2005.

Presently serving as HOD in EXTC dept. of Terna Engineering college, Nerul, Navi Mumbai.

Published about 140 research papers in various Journals, International Conferences, National Conferences, Symposia & Seminars, during this tenure.

Aug'69 - Oct'2005 I worked at Bhabha Atomic Research Centre (BARC) in the Department of Atomic Energy (DAE), Mumbai, India, for 36 years.

While working at BARC, acquired expertise in the areas of:

Generation & Production of Electromagnetic Fields

Science & Technology of RF & Microwave Fields

Science & Technology of RF & Microwave Cavities / Structures

High Voltage based CW, DC, Pulsed & Induction Pulse Power Systems.

Science & Technology of Electron & Ion Beam Generation, Acceleration & their Optics

Science & Technology of DC & AC magnets

Science & Technology of High & Ultra High Vacuum

A recognised guide of Bombay University for guiding students for doing Ph. D. in Science

Guided students under Indian Institute of Science, Bangalore for M.Sc. (Engineering) degree by thesis.

Following degrees by research were Awarded under his guidance.

Mr. N.M.Thakur received Ph.D from Bombay University.

Mrs. K.P.Dixit received M.Sc. (Engg.) from Indian Institute of Science Bangalore.

Achievments:

Ranked first in the University in B.Sc. Hons. School

Ranked third in the University in B.Sc. with Hons. in Maths.

Received:

National Scholarship in B.Sc. Physics Honours School.

National Scholarship in B.Sc with Honours in Mathematics.

State Govt. Scholarship, in 12th Standard.

State Govt. Scholarship in 10th Standard.

Awarded the, "Roll of Honour" for an overall excellence in academics.

Prof. N S Killarikar

M. E. [Power Electronics] from Gulbarga University in 1996, B. E. (ET) from Marathwada University in 1992. Asso. Professor in Terna Engineering college, Nerul, Navi Mumbai.