

CENTER OF BIOMEDICAL ENGINEERING – IIT DELHI & AIIMS:

BME being an interdisciplinary field, the rapid advances in physical, biological and computer sciences have been integrated to provide innovative solutions to global health problems. Technology development in this discipline is a continuous process and long term commitment and financial support is essential in order to achieve desirable results. BME is the fastest growing discipline internationally and interestingly, India also is at par and can play a lead role. Innovations in medical electronics and advancement in imaging modalities have brought in a revolutionary change in prevention, diagnosis, treatment and rehabilitation of the handicapped. Patients can now avail the advanced health care facilities on site by the sophisticated online noninvasive monitoring systems. Early diagnosis and treatment planning by ultramodern imaging modalities provide technological window into the body to assess the normal and the pathological state. However, major challenge before the scientists and engineers in BME lies in innovating devices and techniques for better understanding of the mechanisms and functions of organ systems to aid clinical diagnosis and management of various diseases.

While research focus in conventional medicine addresses the structure function at cellular and molecular level (biological hardware), but the doctrine (software) that governs these changes has not been addressed yet. It is therefore imperative to address this issue by taking advantage of our existing evidence based traditional medical systems evolved over ages. These systems have withstood the test of time and have the capability to deliver the goods with almost the same accuracy as modern medical systems. On comparison, it is apparent that transition has occurred from natural clinical skills to sophisticated technology. A research initiative has to be taken to judiciously apply technology for holistic healing. Holistic approach is a combination of science and skills and physical symptoms are just the tip of iceberg. The optimal combination of psycho-neuro-correlates to physical symptoms would unfold the mechanisms involved in objective assessment of disease diagnosis and treatment

Following is a glimpse of the several technologies developed by the CBME – IIT D and AIIMS group having mass impact on healthcare.

REHABILITATION

***Integration of handicapped people with normal –A technological challenge
Contributions have made a paradigm shift in quality of life in the country***

UNIVERSAL GRAPHICAL COMMUNICATION SYSTEM FOR THE BLIND



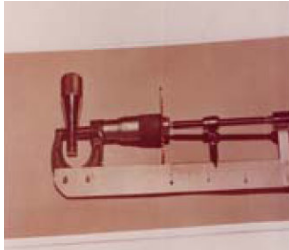
Innovation provides a new dimension to presentation of diagrams (freehand/digitized) and text to the blind students. Editorial comment “It is a privilege to publish your



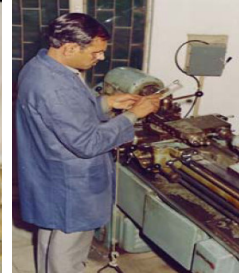
excellent article in the journal.”

Article translated and reprint in Colombia in Journal Venciendo Barreras

MICROMETER AND LATHE FOR THE BLIND –VOCATIONAL AVENUE



Conventional micrometer has been modified for use by the blind. It has been extensively used to work on industrial machines and quality control. Bureau of Indian Standards has now



formulated the specifications based on IITD standards. Using alternate senses viz touch, vibration, audition and smell, a completely blind person has been made to operate a Centre Lathe Machine. Attachments do not hamper the activity of the sighted. Cost of jigs and fixtures required is Rs 300/-. These inventions have been adapted well by the Blind organizations. Other industrial machines can also be adapted to enable the blind to operate them as their sighted counterparts. Safety and efficiency of the systems have been demonstrated by trials for more than two and half decade.

BRAILLE DUPLICATION MACHINE



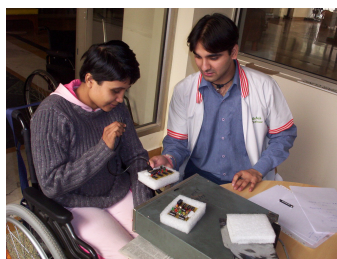
An indigenous Braille duplication machine has been designed with a number of unique features. Prototypes were tested at a number of Blind institutions in the country. Knowhow for production was taken by industry and the invention has received several awards. Bureau of Indian Standards has now formulated the specifications based on IITD standards. BIS No. is IS 13837: 1993.

AIDS FOR THE SPASTICS, PARAPLEGICS AND GERIATRICS



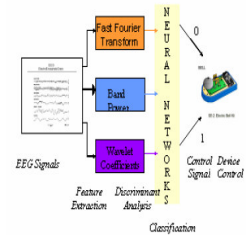
An electronic module has been interfaced with the computer, which enables the spastics to control the computer keyboard with number of keys depending upon the residual abilities. Evaluated by Spastic Society of India. Touch, blow, sip, eye /limb/ body part movement, gaze, muscle contraction or even thought process (EEG) have been interfaced with the module. Communications by symbols, stored messages, personal

vocabulary or dictionary are possible.



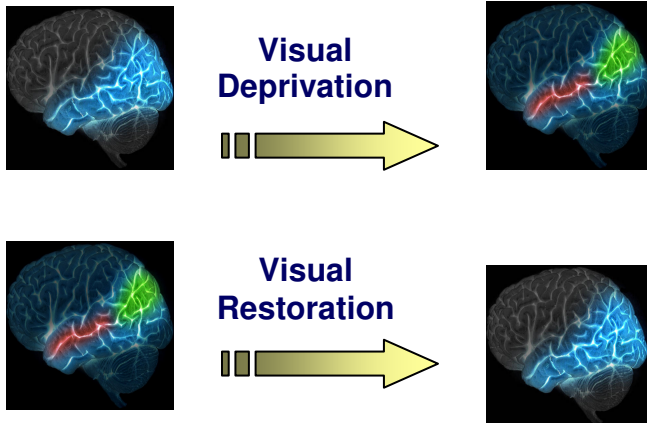
A microcontroller based device used by spinal injury patients or geriatric subjects at Apollo hospital and Spinal injury Centre. Assistive devices have enabled them to live independent.

Brain computer interface developed uses thought process EEG or change of blood flow prior to EEG changes. System has been tested on Amyotrophic lateral Sclerosis (ALS) patients and right handed normal subjects. A spin off of the study suggest association of impaired verbal fluency with cognitive deficits in ALS patients.



ADAPTIVE ABOVE KNEE PROSTHESIS AND COGNITION IN BLIND (in progress)

It is a wireless based intelligent prosthetic lower limb for unilateral amputee based on lower limb synergy. The input variables are taken from normal leg and send wirelessly to amputee limb. Electrorheological fluid will be the choice for actuator as they have very fast response.



DIAGNOSTICS

FONTANELLE TRANSDUCER FOR INFANTS



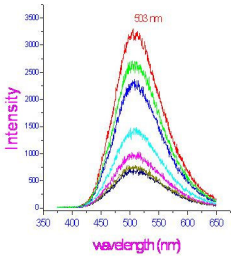
An innovative concept has been formulated to monitor brain pressure in infants and neonates non-invasively. Asphyxia, convulsions and meningitis in babies could be predicted well in advance



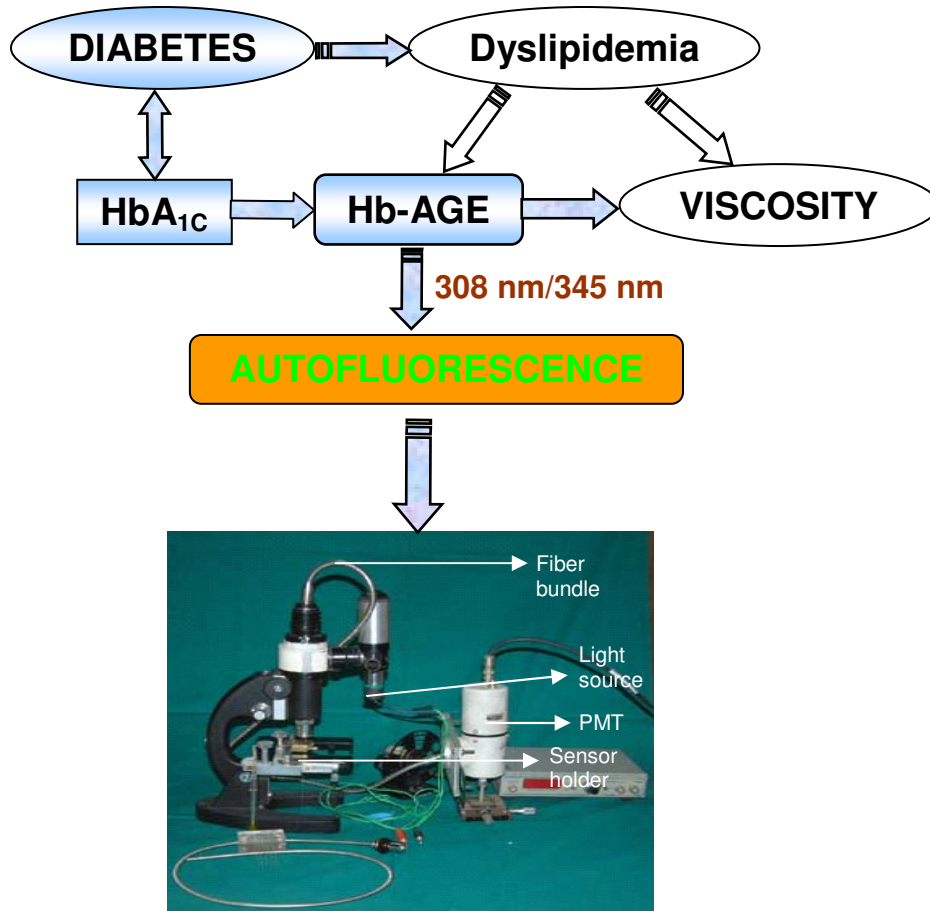
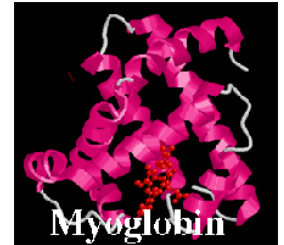
Corrective action could be taken before the brain cell damage occurs. Over 700 babies

were monitored and technique has been well accepted by the pediatricians. An intracranial Pressure transducer was also designed for epidural pressure monitoring in adults, which underwent limited trials on head injury patients. A MEMS based device is being proposed.

DIABETIC HbAGE AND AMI MYOGLOBIN MARKER



A marker having autofluorescence glycated Hb to monitor long term diabetic status identified evaluated and is undergoing multi-centric field. Research is on the threshold of introducing a single step measurement procedure. A Sol-Gel based sensitive and specific Mb sensor for unstable angina and Acute Myocardial Infarction uses fluorescent probes and target clinical levels detected.



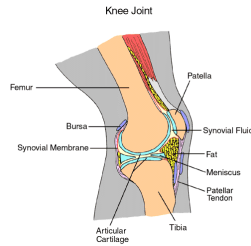
MONITORING DEPTH OF ANAESTHESIA



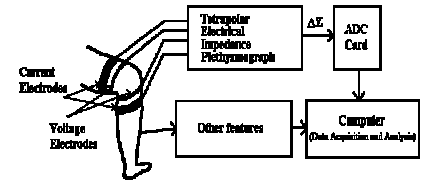
Open loop depth of Anesthesia index on human subject undergoing surgery using EEG parameters has been introduced using fuzzification and ANN. Closed loop control of the anaesthetic

dose will be tested on monkeys after ethical clearance before human trials.

NON-INVASIVE DIAGNOSIS OF KNEE OSTEOARTHRITIS



Non-invasive diagnosis of knee osteoarthritis using Electrical Impedance Plethysmography and EMG signals has been established to evaluate the extent of damage.



ANORECTAL AND OESOPHAGEAL MANOMETRY

Anorectal and Oesophageal manometry with ambulatory pH monitoring systems have been developed and tested over thousands of patients with faecal incontinence, neuronal dysplasia, lower visceral perception threshold, carcinoma and other pelvic disorders and patients having dysphagia or gastro esophageal reflux disorder at AIIMS. Upgraded version has a telelink with senior consultant.

THERAPEUTICS

ELECTRICALLY ENHANCED mDC TRANSDERMAL DRUG DELIVERY DEVICE



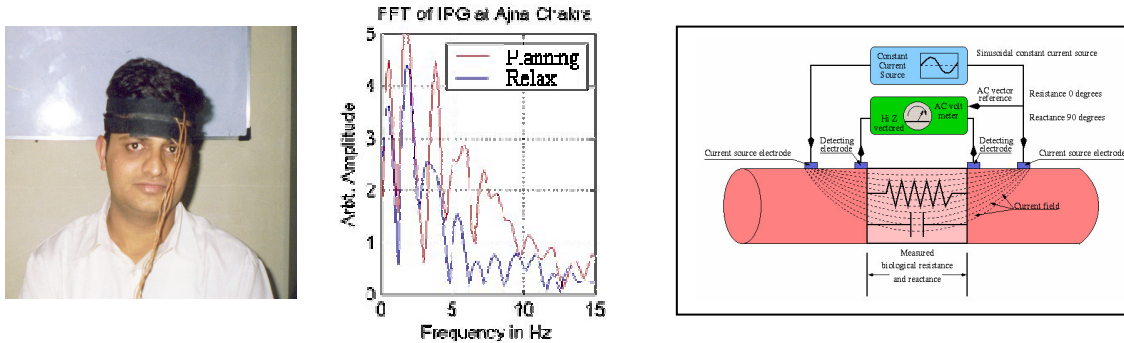
A miniature programmable device for modulated iontophoresis and chemical enhancers for transdermal delivery of some therapeutic agents for treatment of diabetes mellitus and psoriasis (methotrexate) Results are encouraging.

BIOENGINEERING RESEARCH IN REPRODUCTION

Research conducted has produced a synthesis of the engineering and reproduction. Mechanical engineering and fluid mechanics has been applied to understand movement of gametes in opposite directions in the fallopian tube. Role of peristalsis, anti-peristalsis, ciliary beat and segmental contractions critically analyzed to reveal mechanisms of transit delay of the ovum at the Ampullary Isthmic Junction (AIJ). Electrical impedance technique developed could be monitor fallopian tube and vas deferens activity over extended periods in near-physiological conditions. These techniques have been used by other investigators in India and abroad.

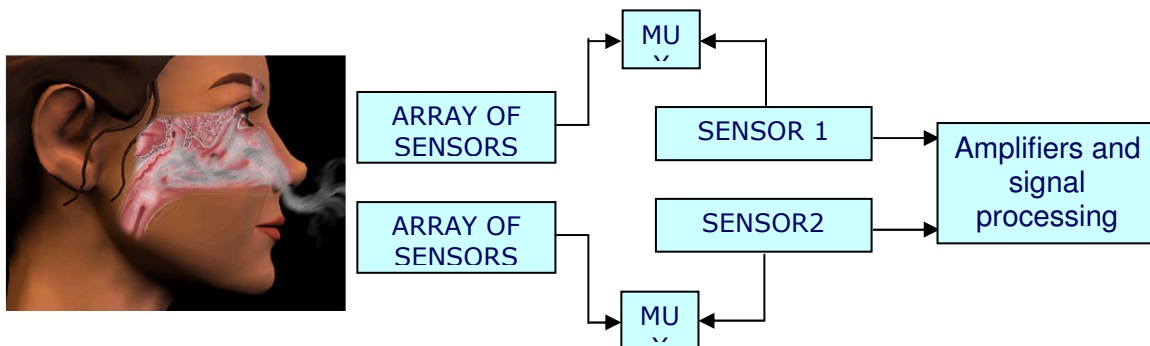
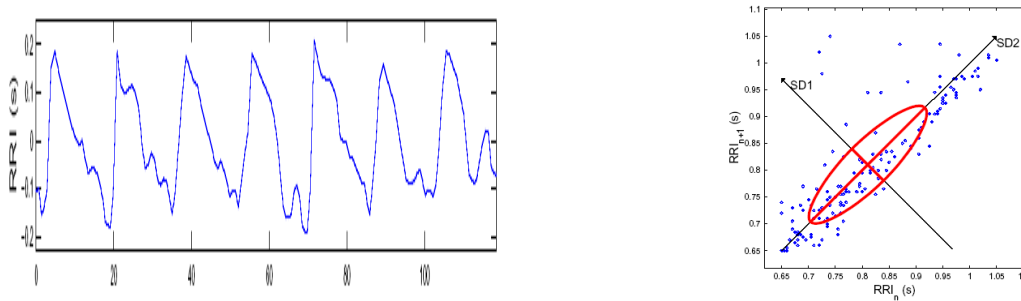
SCIENTIFIC VALIDATION OF ANCIENT MEDICAL SYSTEMS

OPTICAL IMAGING OF AJNA CHAKRA USING PHOTOPLETHYSMOGRAPHY



Chakras are the energy centers (Vortices), in the etheric body related to the spine and important endocrine glands responsible for the co-ordination and vitalization. Pineal gland is the master controller and *Ajna chakra* provides the window. An interesting rhythm ranging from 0.07-0.13 Hz was observed in (IPG) signals that correlate well with heart and respiratory rate. An attempt has been made to understand the neurological and physiological aspects of these rhythms.

PSYCHONEURO AXIS and PRANAYAM

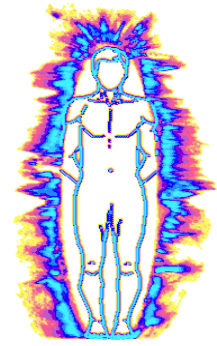


BODY ELECTROMAGNETICS



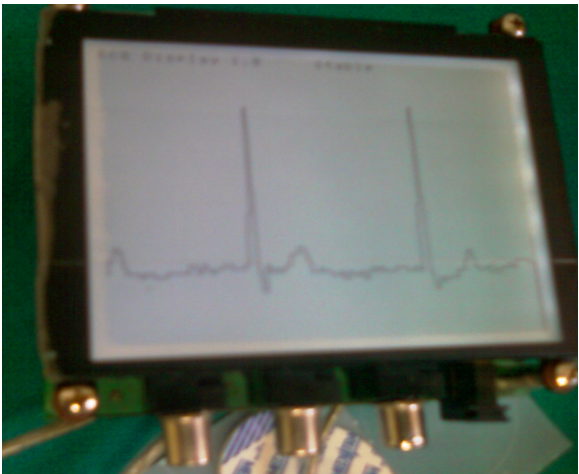
A Ph D student before submission of thesis

Role of bio-electromagnetics has been emphasized and technology is at its threshold to bring out its correlates with the psycho-neuro axis. Scientific validation of the doctrine is being investigated and results are very encouraging. Stress induced changes are presented here.



A Ph D student after getting job

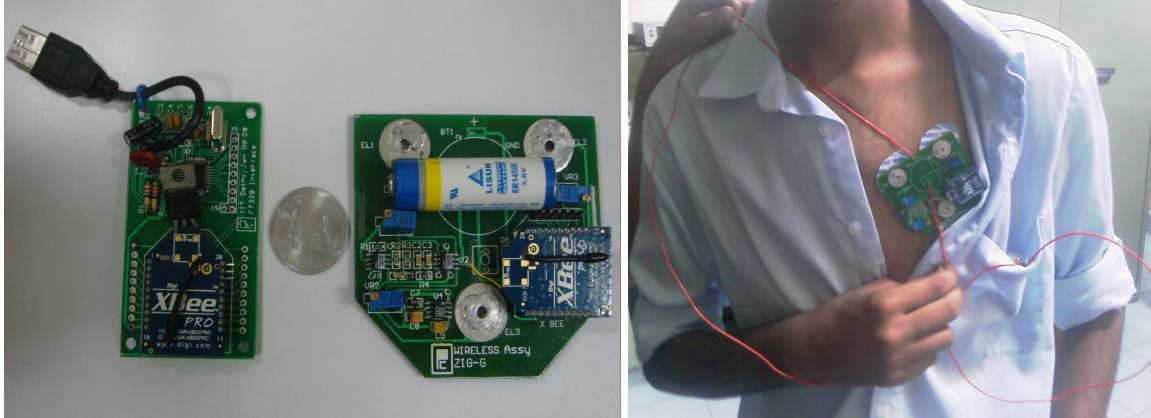
INSTANT ECG – a low cost ECG device to monitor ECG signals instantly on the display device attached on it. (*Patent applied*)



Description:

- *A battery operated on-the-go device to monitor rhythm of the heart.*
- *Three lead system.*
- *Back light facility on LCD.*

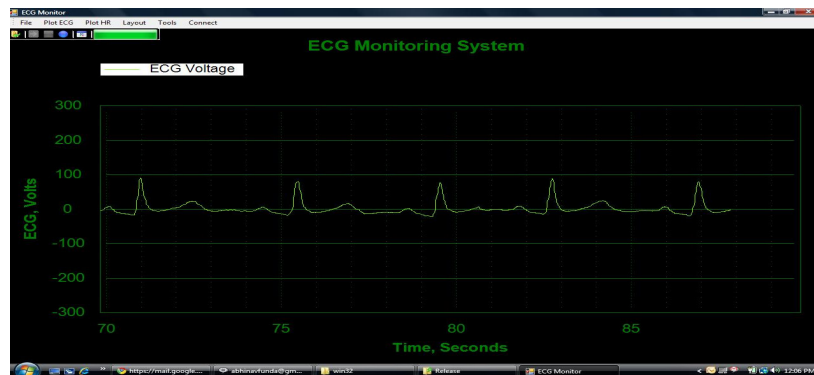
ZIG – G: Heart rate monitoring through ECG is an inseparable part in any major or minor operation. ECG wires (and other monitoring cables) connected to the monitor make the OT look clumsy and cluttered. Zig G is a low cost wireless ECG device to eliminate clumsy wires in the operation theatre. (*Patent applied*)



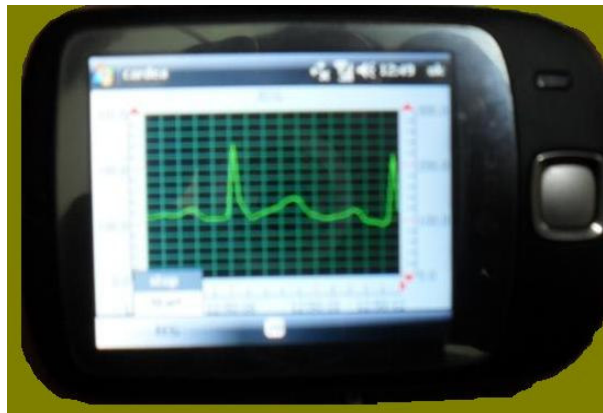
Description:

- *Wireless technology used : Xbee*
- *Range = 650 feet, Weight = 40 gms, Size = 7 cm ~equilateral triangle*
- *Placement = Against the chest of a person*

Software Screenshot



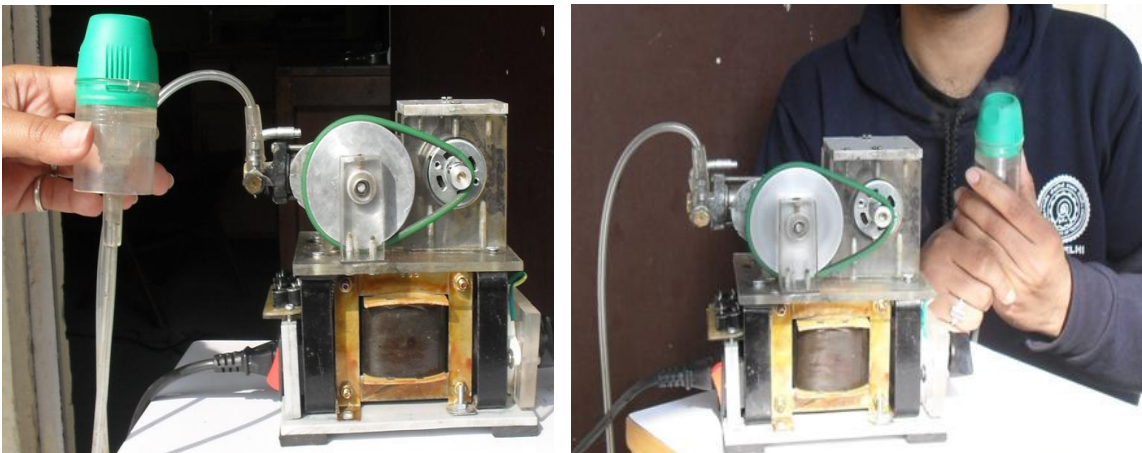
MOBILE ECG 1 out of every 3 person in India is suffering from Cardiac Anomaly. Regular monitoring of ECG is as important as sugar monitoring for diabetic people. Moreover in case of any emergency such as attack or a coma, heart condition visualization helps in taking necessary steps. Mobile phone is used to visualize ECG signals on a mobile phone and transmit it wirelessly to any other phone or to a central server. (patent applied)



Description:

- *Wireless technology used: Bluetooth.*
- *Range of 10 mts from the transmitter.*
- *Placemen of Transmitter = Against the chest of a person*
- *Platform Required: Windows OS.*
- *Software: .NET Platform.*
- *Scalable plot.*

HIGH EFFICIENCY NEBULIZER: Inhaled medications are the frontline treatment for respiratory conditions such as asthma and COPD. Taking medications by inhaling them directly into the lungs has several advantages over taking them as a pill such as faster action, lower dose and fewer side effects. Market survey establishes the need of a robust, low cost, high efficiency nebulizer for quicker delivery. Piston driven compressor based high efficiency nebulizer made from off the shelf components to reduce the cost. (Patent applied)



Description:

- *Compressor Type Piston Arrangement.*
- *Pressure ~ 11 psi.*
- *Mechanical Timer included.*
- *Only compressor nebulizer that can work with a battery.*

MECHANICAL NEBULIZER *Nebulizers available today are either powered by AC or a battery. In the Indian scenario, esp. for the rural sector, power has always been an issue. A novel mechanical nebulizer is proposed which will not need power supply. In India alone the market size is going to cross \$ 70 million by 2030. Having a mechanical arrangement to nebulize the medicine will add value as it would be a cost effective, noiseless and portable product. Foot pump based nebulizer which can compress the air in a cylinder and provide controlled output. (Patent applied)*



Description:

- *Foot pump time : Nebulized airflow time (full efficiency) ::1:2*
- *Noiseless system.*
- *Safety Valve Provided.*

HYBRID NEBULIZERS Foot pump cum compressor (power operated) nebulizer which can compress the air in a cylinder and provide controlled output. (*Patent applied*)



Description:

- *Foot pump time : Nebulized airflow time (full efficiency) ::1:2*
- *Works both on electricity as well as mechanically.*
- *Safety Valve Included*

NADI YANTRA Radial pulse diagnosis is a popular research topic across globe and shows tremendous potential as an all-in-one medical diagnostic device. (Patent applied). NADI YANTRA is a robust system design to acquire pulse signals from the radial artery.

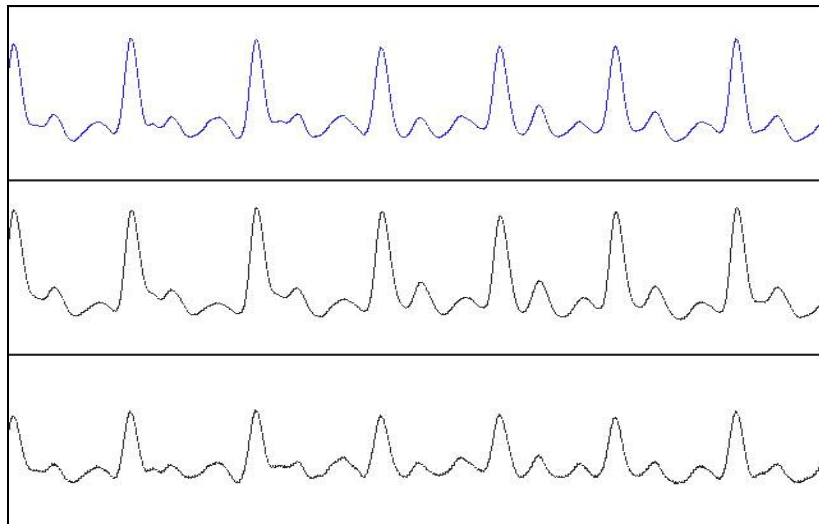
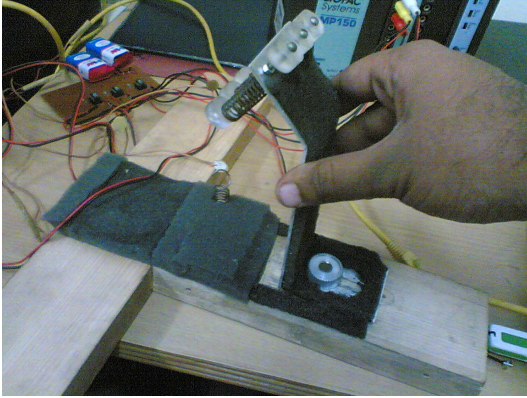


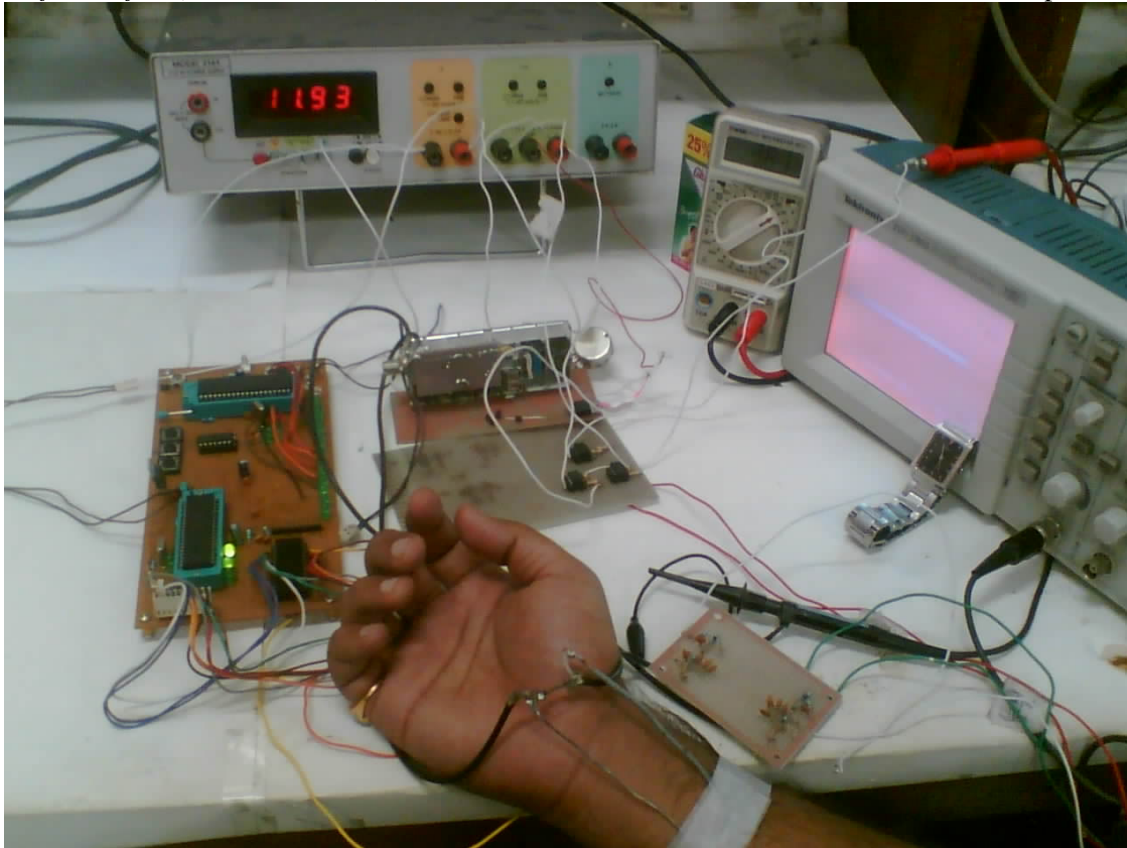
Fig. showing a screenshot of the signal captured

Sugar MONITOR WHO reports Diabetes to be one of the top five leading causes of death in most developed countries and substantial evidence is accumulating to

suggest that it will reach epidemic proportions in developing and newly industrialized countries. Talking in the Indian context, it is reported that our country has the maximum number of cases suffering from Diabetes. At worst, two out of three people in urban areas and three out of four in rural areas are suffering from it but they don't even know about it. It is a system to monitor changes in glucose level non-invasively.

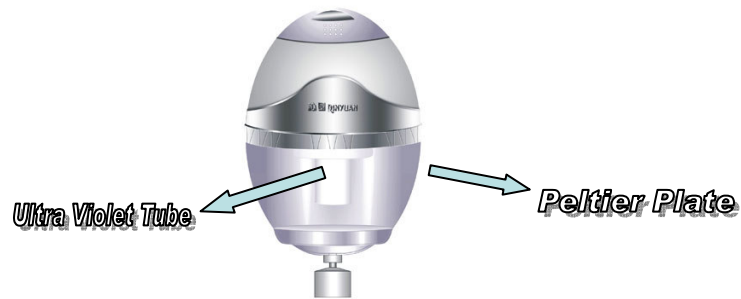
Major Project (Research intern)

Nov 2006- Apr 2007



On Going RESEARCH PROJECTS/ PRODUCTS:

a) Low Cost Water Purifier with Cooling Facility. (Patented)



b) Low Cost Digital Stethoscope. (Patent Applied)



c) Physio-Mouse (Computer Mouse which can capture physiological parameters and can send it via internet)



d) Ophthalmo-Capture (A better way to capture wide angle images of the retina) – Stanford India Biodesign (Patent Applied)



Spectacle with Camera connected to Computer.

EPILOGUE

President of India Dr. A.P.J. Abdul Kalam's words: "*Technology, unlike science, is a group activity. It is not based on individual intelligence, but on the interaction of many people.*" (Wings of Fire). This really sums up the pioneering work done at Centre for Biomedical Engineering at Indian Institute of Technology and All India Institute of Medical Sciences Delhi in the area of Biomedical Engineering

