

Executive Summary Report
for UGC SAP DRS-II of Department of Applied Physics
Sanction No. F. 530/15/DRS-II/2015(SAP-I) dated August 18, 2015
Sanctioned Amount: Rs 100L+ Rs 33.75L

1(a) Thrust Area(s): (2015-2020)

Approved Theme of DRS-II project is : Remote Communication System

i) Approved sub areas:

- (i) Smart Grid Development;
- (ii) Remote Health Care;

Three approved application areas of DRS-I (Order No. F.530/5/DRS/2009(SAP-I) Dated 6th April, 2009) was

- i) Smart meter-based AMI:
- ii) Condition Based Monitoring (CBM) of Electrical Machines
- iii) Power System Monitoring using Geographical Information System (GIS)

The Application areas of DRS-I is extended with the sub-area-I i.e. Smart Grid Development in the approved DRS-II proposal;

Approved sub-areas under Smart Grid Development part

- A. Formation of Micro-grid using Solar PV, Fuel Cell, Wind
- B. Adoption of various FACTS control Strategies
- C. Grid Synchronization using, inverter and NES DC bus
- D. Islanding Schemes of Micro-grids etc.
- E. Overall performance study under different abnormal conditions
- F. PMU based online Load flow, State Estimation etc. Analysis
- G. Exploration and adoption of Self healing features

Achievements:

Part-I: Smart Grid Development

- A. Hardware prototype development of the proposed Smart grid test bed has been started on the receipt of the NR grant just at the beginning of the fourth year of its progress.

The basic design of the hardware components are so arranged that conventional three layered substation housing concepts are introduced with the adoption of the (i) monitoring and control room in the SAP laboratory physically placed at the first floor of the department from where data analysis, server based storage and necessary control actions can be produced. While (ii) Bay controllers with several control panels, HMI based monitoring and indications, data acquisition systems, data communication channels etc. are housed in the mezzanine floor. Lastly (iii), the machines and physical sensors etc are placed at the ground floor with the view of filed positions of filed devices and field equipment.



B. Product & Prototype development:

i. For Smart grid development part:

Prototype development for Smartgrid Testbed, (b) Remote monitoring and control, (c) deployment of both star and mesh Zigbee networks, (d) 10kW hybrid BESS solar system and its online monitoring with data storage in local server, (e) smart meter, (f) Phasor measurement unit (PMU), (g) Power Hardware-in-Loop testing facility

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using four quadrant power amplifier and existing RTDS unit, (h) Man power training for power system related issues in real time aspects, (i) Prototype for synchronised running of grid tied alternator, (j) Wind emulator, (k) various loading condition simulation, (l) emulation of short, (m) medium and long transmission system, (n) Offgrid and ongrid running of the test bed with hybrid renewable, (o) power quality assessment etc.

C: Break through and innovations:

- a) Establishment of Zigbee based Star and mesh network using scale free based network topology.
- b) Adoption of Scale free topology for establishment of NAN structure for making SPV monitoring system.
- c) Python based and VB.net based storage of SPV data in a local server for monitoring and analysis in one second interval.
- d) Installation and Commissioning of 10 kWp solar power plant at the rooftop of the departmental building for renewable energy generation.
- e) Creation of SCADA based remote substation for field data acquisition, storage in a LAN based server for remote monitoring, analysis and control of the smart grid test bed.
- f) Creation of power hardware-in-loop testing facility using RTDS based power amplifiers in order to test the performance of power system equipment with real time based simulated environment.
- g) Development of Server and Multi Client based Remote Monitoring System for monitoring, analysis and control of the components of the smart grid test bed system.
- h) Development of state-of-the-art wind energy generation emulation scheme with provision for DFIG or PMSG interfacing facilities.
- i) This facility is utilized to study the synchronization aspects of an incoming alternator, the design aspects of the digital synchronization schemes and necessary controller, load sharing schemes under various generation conditions in grid tied mode by adopting prime mover and field control strategies.
- j) Provisions for penetrating renewable energy from sources like solar, wind, waste materials, biomass, batteries etc. to the grid are kept.
- k) The energy mix algorithm, with various loading conditions, demand side management etc. provisions are made.
- l) The load sharing schemes of the alternator under different loading condition can be developed.
- m) Development of various state-of-the-art algorithms to generate different analytical tools, mathematical models of power transmission and distribution system with and without renewable energy sources, power electronics based converters for renewable energy exchange with the grid and/or stand alone mode of operation etc.
- n) Two patents and one copyright are filed in this process.
- o) The thematic schemes of this DRS-II project are being extracted to implement some real world pilot project through DST's Mission Innovation project and/or Kolkata Corporation's waste energy project.

Four Ph.D. have been awarded which are in line with the focused areas of the DSR-II programme. Five more registered scholars are also working in these areas two of whom are very near to their thesis submission. Besides, some M.Tech students as well under graduate (B.Tech) students have worked on these topic and some are still working.

The following information are provided in support of this research-

Journal publication -23

Conference publication -22

M.Tech Thesis-22

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Ph.D. (Awarded +submitted)- 9, Registered – 8, Enrolled - 5

Area-II:

This approved Sub-Area-II was a new proposal in respect of DRS-I and the scheme was:. Remote Health Care

Theme: Application of Remote communication system in the field of Biomedical Health Monitoring

Objective: The objective is to develop a cardiovascular health monitoring system using wireless communication technique. The different sub-areas are proposed:

Achievement with the following developments:

A: Short range centralized health monitoring system using low-power ISM band communication:

This will consist of development of the following:

- (a) Acquisition of cardiovascular signals (ECG, PPG etc.) from the patient in an indigenous standalone embedded system consisting of bio amplifiers, filters, and microcontrollers.
- (b) Real-time collection and compression of the medical signals using the acquisition end controller and delivery to a low-power RF communicating device operating in the 2.4 GHz range.
- (c) Wireless reception of the encoded data at a centralized processor and checking of data reliability.
- (d) Computerized processing of the received signal for pre-processing (noise elimination) and feature extraction using advanced computational techniques.

B: Mobile phone based of cardiovascular health parameter leading to context aware sensing:

C: Product and prototype developments

Short range centralized health monitoring system using low-power ISM band communication with Biomedical Sensor Node, Master Sensor node, Data Collection unit as Local host including Intelligent Routing Scheme (b) Biomedical signal processing unit with models for Motion artifact reduction from Photoplethysmogram signal, Improved Heart Rate tracking from PPG with periodic motion artifact corruption and morphology reconstruction using mode decomposition techniques, PPG reliability assessment and prediction of missing segments using machine learning approach

Research Publications out of the work (2015-2020):

- ❖ SCI- Journals accepted/ published: 06 (IEEE Trans: 03; Elsevier: 02, IETE JR: 01
- ❖ International Conference published: 03
- ❖ Indian copyright grant: 01

4. Total Google scholar citations of the published articles (2015-2020): 32

5. Support to collaborative research with other institutions: 02.