



Swami Keshvanand Institute of Technology, Management & Gramothan

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*Center of Excellence
in
“Internet of Things (IoT)”*

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TABLE OF CONTENTS

1. INTRODUCTION.....	3
2. CENTRE OF EXCELLENCE FOR INTERNET OF THINGS (COE-IOT).....	3
3. OBJECTIVES.....	4
4. BENEFITS OF CENTER OF EXCELLENCE ON IOT.....	4
5. STRENGTHS AND RESOURCES.....	5
6. RESEARCH FACILITY AVAILABLE IN INTERNET OF THINGS LAB.....	12
7. EQUIPMENT'S AND SENSORS AVAILABLE IN THE IOT LAB.....	14
8. FDPS/WORKSHOPS/CONFERENCES AND OTHER EVENTS ORGANIZED.....	16
9. IOT RELATED SELECTED PUBLICATIONS.....	17
10. PATENTS (PUBLISHED/GRANTED).....	19
11. STUDENT PROJECTS.....	22
12. GLIMPS of IOT LAB.....	24
13. GEOTAGGED PHOTOS OF IOT LAB.....	25
14. IOT FACULTY EXPERT GROUP.....	26
15. IOT SOFTWARE COMPONENTS.....	27
16. TENTITIVE EVENTS.....	28

1. Introduction

This Internet of Thing lab which was established in 2018-19 as the Centre of excellence (CoE) for Internet of things (IoT) at SKIT, Jaipur, Rajasthan as a part of Digital India Initiative to jump start the IoT ecosystem. The department of Computer Science & Engineering and Information Technology aims at educating and training students with sound knowledge and awareness in recent developments in Internet of Things technology. It is well equipped laboratories with latest hardware and software including Raspberry Pi (Mini Computers), Arduino Uno R3 Microcontroller Boards, Xilinx Vivado Design Software Suite for high-level Synthesis, Nexys 4 DDR FPGA Boards, ZYBO FPGA boards, NODEMCU ESP8266-12 CH340 Wireless Micro-Controller Boards, Proteus Simulator for Industrial IoT, Lab View Software for System Design and Analysis , NI MYRIO (Mechatronics kits, Embedded Kits, Starter kits), MY RIO 1900 Microcontroller Boards etc., which complement the high standards of the Institute. The Centre of Excellence also comprises distributed facility within the campus such as E-Yantra lab, Printed Circuit Board (PCB) Lab, Field Programmable Gate Arrays (FPGA) Lab etc for developing Industry 4.0 Standard IoT enabled products.

Experts from the industry are periodically invited to give lectures/demonstrations to the students/faculty members on the latest developments in the field. Students are given exposure to industries by industrial visits and industrial training sessions. The Centre will organize and propose specific FDP, Conference, Short Term training programs and workshops for benefits of students and research fellow's start-ups.

It is proposed to have a centralized dedicated administration office comprising of one coordinator from each department, a chief coordinator and other administrative staff under one roof. Coordinator of each department will be synchronizing the activities of the labs under their department for IoT activities.

2. Centre of Excellence for Internet of Things (CoE-IoT)

Vision:

The Centre of Excellence in near future will be able to enable it as innovation hub with proper standardization, realization of prototypes, and provide complete support to the

solutions for IoT applications. It will help entrepreneurs by providing ideas, research, and development facilities to build up the Atmnirbhar bharat.

Aims:

The aims of the CoE-IoT are to enable India as the innovation hub in the emerging technology of Internet of Things through democratization of Innovation, Standardization, Realization of prototype, products before deployment of the IoT devices in the public domain/ infrastructure and support Government Initiatives on IoT solutions for specific areas like water, energy, agriculture, health, security, and privacy of data.

3. Objectives:

The main objective of the centre is to create innovative applications and domain capability by harnessing the innovative nature of start-up community and leveraging the experience of corporate players. The other objectives are as follows:

1. To create innovative applications and domain capability across vertical for country's needs such as Smart City, Smart Health, Smart Manufacturing, Smart Agriculture, and others.
2. To build industry capable talent, start-up community, and entrepreneurial ecosystem for IoT.
3. To provide an ecosystem for innovation to thrive and embrace entrepreneurship.
4. To energise research mind-set and reduce cost in Research and Development by providing neutral and interoperable, multi technology stack laboratory facilities.
5. To reduce import dependency on IoT components and promote indigenization.
6. To promote indianisation by providing development facilities to researchers as well as to those who need to develop prototypes using reverse engineering, and required library of equivalent components.

4. Benefits of Center of Excellence on IoT

Stakeholder	Benefits
Start-up/Small Medium Enterprises	<ul style="list-style-type: none"> ✓ Use of Open Technology Stack, ✓ Access to Industry experts /Consultants ✓ Showcasing the prototype/project to companies. Access to students to work on projects.
Investors	<ul style="list-style-type: none"> ✓ Future products for cross functional business process

	enhancement in various industry verticals.
Engineering Service providers, Global MNCs	<ul style="list-style-type: none"> ✓ “Risk free" demand technology lab on demand proficiency centre for skill up-gradation. ✓ Access to industry ready talent, technical experts, and consultants
Academia / Researchers	<ul style="list-style-type: none"> ✓ Availability of technology lab for faculty/researchers. ✓ Industry standard proficiency courses for upgrading skills ✓ Platform for offering special course/consulting projects ✓ Innovative ideas from stack holders, start-up starters, self, etc. ✓ Access to current research papers related to their work. ✓ Team of experts helping them to find research solutions.
Industry	<ul style="list-style-type: none"> ✓ Trained Industry ready students ✓ Innovative Ideas ✓ Prototypes for new products.
Students/job seekers	<ul style="list-style-type: none"> ✓ Internships on IoT projects ✓ Access to Industry experts/ courses / showcase of talent

5. Strengths and Resources to support the CoE for Internet of Things

In the subsequent sections, we have highlighted the resources, summary of related FDP/Conferences/workshop/STTPs, research publications, patents, and student’s projects with glimpse of Internet of Things lab.

5.1 Research Facility available in Internet of Things Lab

S. No.	Name of software/Hardware	Details	Quantity	Features	Area in which students are expected to enhance learning
1	Raspberry Pi	Raspberry Pi 4 model with 4 Gb Ram	12	The Raspberry Pi 4 includes 1.5GHz quad-core Broadcom processor, two micro-HDMI ports, 2 USB 3.0 ports, and support for 4K video output at 60 fps	IOT, Embedded Systems

2	Arduino Uno R3 - compatible	Arduino Uno is a microcontroller board	13	The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.	IOT, Embedded Systems
3	Xilinx Vivado Design suite	25 users licensed, Xilinx vivado 2017.4 version	25 user	Synthesis and analysis of HDL designs	IOT, VLSI, Embedded system, FPGA based design
4	Nexys 4 DDR	7 kits available, based on Artix-7 FPGA from Xilinx	7	Synthesis and hardware interfacing of HDL design	IOT, VLSI, Embedded system, FPGA based design
5	ZYBO board	2 kits available, Zynq series FPGA	2		

6	NODEMCU ESP8266-12 CH340 BASED		20	NodeMCU has ESP-12 based serial WiFi integrated on board to provide GPIO, PWM, ADC, I2C and 1-WIRE resources at your fingertips, built-in USB-TTL serial with super reliable industrial strength CH340 for superior stability on all supported platforms.	IOT, Embedded Systems
7	Proteus	VSM software	2	Simulation software for microcontroller and analog and digital circuit, PCB design package	Analog and digital circuits, embedded system design and PCB design
8	Lab View	NI/Academic FDS teaching	2		
10	NI MYRIO Mechatronics kit	3 axis digital compass, 3 axis digital accelerometer, 3 axis digital gyro	1		
11	NI MYRIO embedded kit	BT interface, temp sensor, LCD display, Serial EEPROM	1	Real time simulation and sensor interfacing for embedded system design	IOT, Embedded system design
12	NI MYRIO starter kit	Bread board, adapter, power cable	1		
13	MY RIO 1900	WIFI and MSP connector	1		

14	NI USB-6008 LabView interfacing module	NI/ 12 bit,10 ks/s	1	Multifunction Input output and NI DAQ mx software with NI USB	
15	Spectrum Analyzer	HM 5012-2 150 kHz to 1 GHz Caddo 8010 150 kHz to 1050 MHz	1+1	Circuit testing, measurement and troubleshooting	Electronic Devices and circuits
16	DSO	Model No. 401-DSO- Scientech 50 MHz, 500 ms/s, Channel-2	2	Circuit testing, measurement and troubleshooting	Electronic Devices and circuits
		Model No. HM1507-3, 150 MHz, 200 ms/s, Channel-2 (Analog and digital)	1		
		Keysight DSO 1012 A/ 100 MHz/ two channel	1		
17	Proto Cure PCB Curing Machine (Oven)	Maximum allowable PCB size: 250 X 300 mm (10" X 12"), finned heaters with thermostat controls	1	Table top unit for curing of liquid photoresist	PCB fabrication
18	Photoresist dip coating	Maximum allowable	1	Coating of laminates with photoresist	

	machine	PCB size: 250 X 300 mm (10" X 12"), Rectangular tank 2 L capacity			PCB fabrication
19	PCB art work film maker	Working area: 250 X 300 mm (10" X 12") with diffused light	1	Negative making contact printer as well as an Illuminated art work table	PCB fabrication
20	PCB etching machine	Usable etching area: 250 X 300 mm (10" X 12"), Tank capacity 20 L	1	For fast etching of single sided and double sided PCB	PCB fabrication
21	Tina Pro Simulation Software	1 User License	1	Simulation software for microcontroller and analog and digital circuit, PCB design package	Analog and digital circuits, embedded system design and PCB design
22	OrcadPspice Simulation and PCB Design Software	1 User License	1	Simulation and PCB design software	Analog and digital circuits, embedded system design and PCB design
23	Xilinx ISE tool	Open source	1	Xilinx software for synthesis and analysis of HDL designs	VLSI, Embedded system, FPGA based design
24	Digital microscope	USB digital microscope magnifier	1	Circuit testing, measurement, and troubleshooting	Electronic devices and circuits
25	CRO	Caddo 803/Scientec h ST251/ 30	4		

		MHz/ Two Channel					
26	Milli ohm meter	scientiFic SM 5081	3				
27	Frequency counter	scientiFic SM 5051/ 1 GHz	5				
28	Distortion meter	scientiFic SM 5027	1				
29	Digital LCR meter	Caddo 9302	4				
30	Pulse generator	scientiFic SM 5035/ 20 MHz	1	Circuit testing, measurement and troubleshooting	Electronic devices and circuits		
31	Digital Multimeter	scientiFic SM 7022/metravi 19 F/Agilent U-1252 A	14				
32	Function generator	scientiFic SM 5070/caddo 4061/ 3 MHz	3				
33	Universal IC tester	VPL -VICT	1			Circuit testing, measurement, and troubleshooting	Digital IC testing
34	Project interfacing board	TI	5				
35	Microcontroller development board	Dynalog/NVI S NV 5001, NV 5002,	6	Designing and developing electronics and embedded systems	Electronic circuits and embedded system design		
36	Programmable multiplier	scientiFic SM 5015	4				
37	Power scope	scientiFic	1				

		SM 901/ 30 MHz			
38	Power Supply	Scientech ST-4070, ST-4077	3		
39	Project Board	Scientech ST-2610	5		
40	ADC interfacing kit	TI/ AD58364M-EVM	1		
41	DAC interfacing kit	TI	1		
42	GSM modem interface kit	TI	1		
43	Finger print sensor	TI	1		
44	GLCD interfacing kit	TI	1		
45	Video interfacing kit	TI/ 6713 DSK	1		
46	CCD camera & TV Tuner	TI	1		
47	RF development kit	TI	1	Designing and developing electronics embedded systems	and of and Electronic circuits and embedded system design
48	USB EPROM Eraser	VPL EE-1	6		
49	USB based EPROM programmer	VPL UPROG-VX	6		
50	R-pi Camera module		2		
51	AVR programmer	Micronics	1	USB programmer for AVR development	Embedded system

				board	
52	Spartan 2 FPGA kit	ST102, ST103, ST104, ST105	4	Design and implement digital circuits of all kinds	VLSI, Embedded system, FPGA based design
53	Spartan 3 FPGA Protoboard	Spartan 3 IM Board MXS3FK-IM	1	Development platform for realizing various digital designs	VLSI, Embedded system, FPGA based design
54	Spartan 3 DSP Protoboard	MXS3FK- 004-DSP	1	Used to physically verify DSP algorithms	VLSI, Embedded system, FPGA based design
55	Spartan 6 DSP Protoboard		1	Used to physically verify DSP algorithms	VLSI, Embedded system, FPGA based design
56	CPLD Trainer kit	XC9572	1	Provides advanced in system programming and test capabilities	VLSI, Embedded system, FPGA based design
57	FPGA trainer kit XCS05	XCS05	1	Have generous routing resources to accommodate most complex interconnect patterns	VLSI, Embedded system, FPGA based design

6. Equipment and Sensors available in the IoT Lab

S. No	Items	Quantity
1	Raspberry Pi Casing	12
2	ERD Mobile Charger TC55	12
3	Bread Board	12
4	HDMI To VGA Converter	10
5	1*40 Female To Female	13
6	1*40 Male 2 Female	13
7	1*40 Male 2 Male	100
8	LED 5 MM	100

9	Potention Meter	20
10	Resistance 1K	100
11	Resistance 10K	100
12	Sound Sensor Module	10
13	IR Sensor Module	10
14	PIR HC-SR 501	10
15	MQ-6 gas sensor Module	5
16	Display 20*4 (Green)	3
17	Display 16*2 (Green)	10
18	1CHANNEL RELAY BOARD without OPTO 5V	10
19	Bluetooth HC-05	4
20	Sensor DHT-11	8
21	HC-SR -04 Ultrasonic	3
22	Soil Moisture Sensor	3
23	LDR MODULE	3
24	Switch	10
25	Peltier	3
26	Heat Sink	2
27	Relay 2 channel	3
28	Relay 4 channel	2
29	Water Level Sensor	2
30	Dust Sensor	1
31	Flame	2
32	GSM 900	2
33	GPS	3
34	Camera Pi	1
35	Camera UNO	2
36	Water Temp	1
37	Solenoid valve	2
38	DC motor (water pump) 5-12 V	5
39	Wi Fi	4
40	Vibration Sensor	2
41	Pulse Sensor	2

42	Small passive buzzer module	1
43	2-color LED module	1
44	Hit sensor module	1
45	Vibration switch module	1
46	Photo resistor module	1
47	Key switch module	1
48	Tilt switch module	1
49	3-color full-color LED SMD modules	1
50	Infrared emission sensor module	1
51	3-color LED module	1
52	Mercury open optical module	1
53	Yin Yi 2-color LED module 3MM	1
54	Active buzzer module	1
55	Temperature sensor module	1
56	Node 32	1
57	Lilipad	1
58	Water Meter	1

7. IoT Related FDPs/Workshops/Conferences and Other Events Organized

S. No	Year	Name of the Workshop / Seminar	Date From-To	Link to the Activity Report on the Website	Number of Participation
1	2020-21	4th International Conference on “Emerging Technologies in Computer Engineering: Data Science & Blockchain Technology” (ICETCE-2021), Technically Sponsored By: IBM, Infosys Campus Connect, Natural Group	03rd-04th February, 2021 (Two Days)	http://www.icecte.skit.ac.in/2021	264

2	2019-20	AICTE Sponsored Faculty Development Programme on “Internet of Things: Education Canvas” (FDPIT-2019), Sponsored By: AICTE, IBM Academic Initiative (IBM Ltd.), Infosys Campus Connect (Infosys Ltd.), Tata Consultancy Services (TCS), Einfochp	09th-20th November, 2019 (Two Week)	http://www.skit.ac.in/fd pit2019	78
3	2019-20	3rd International Conference on “Emerging Technologies in Computer Engineering: Machine Learning and Internet of Things” (ICETCE-2020), Sponsored By: AICTE, IEEE, IBM Academic Initiative (IBM Ltd.), Infosys Campus Connect (Infosys Ltd.)	07th-08th February, 2020 (Two Days)	http://www.icecte.in/2020	276
4	2020-21	TEQIP-III RTU(ATU) Sponsored Student Workshop on “Data Science & Analytics”, Sponsored By: TEQIP-III RTU(ATU)	11th-25th August, 2020 (Two Week)	https://www.skit.ac.in	122
5	2019-20	AICTE Sponsored Short Term Training Programme (STTP) on “Internet of Things: Education Canvas” (STTP-2020), Sponsored By: AICTE, New Delhi	02nd-07th March, 2020 (One Week)	https://www.skit.ac.in/sttp/	45
6	2020-21	AICTE Training and Learning (ATAL) Academy sponsored online faculty development programme on "Blockchain Technologies and its Applications"	23rd - 27th November, 2020 (One Week)	https://www.aicte-india.org/atal	103

7	2020-21	AICTE Training and Learning (ATAL) Academy sponsored online faculty development programme on “Electrical & Computer Engineering (Applications of Machine Learning & Artificial Intelligence)”	04th - 08th January, 2021 (One Week)	https://www.aicte-india.org/atal	103
8	2018-19	International Workshop on “Micro Services and its Applications in Analytics and Cloud”, Sponsored By: Infosys Ltd.	02nd-03rd February, 2019 (Two Days)	http://www.icetce.in/INFOSYSworks	81+5=86
9	2018-19	DST Sponsored International Workshop on "Big Data Analytics Using Hadoop & Spark: A Practical Approach" (BDHS-2K19)	31st Jan.- 01st Feb. 2019 (Two Days)	http://www.skit.ac.in	116+5=121

8. IoT Related Selected Publications

1. An Optimal Framework for Spatial Query Optimization Using Hadoop in Big Data Analytics ,Pankaj Dadheech, Dinesh Goyal, Sumit Srivastava, Ankit Kumar ,Recent Advances in Computer Science and Communications, Formerly: Recent Patents on Computer Science (2021) 13:6, pp: 1188-1198, Published on: 28 January, 2021, <https://doi.org/10.2174/2213275912666190419215231>, ISSN: 2666-2558 (Print), ISSN: 2666-2566 (Online), Bentham Science Publisher.
2. A Multi-Stakeholder Involved Effective E-Waste Management in Manufacturing Recycled Electronic Products Using Game Theory Sengan, S., Palaniappan, K., Kathamuthu, N., Amin R., Mariappan R., Hashim N. Zain E., Dadheech P. Arabian Journal for Science and Engineering (2021), Special Issue- Frontiers in Parallel Programming Models for Fog and Edge Computing Infrastructures Published 12th April 2021, Impact factor: 1.711, Published by Springer, <https://doi.org/10.1007/s13369-021-05620-9>.
3. Implementation of Internet of Things-Based Sentiment Analysis for Farming System, Pankaj Dadheech, R. Sheeba, R. Vidya, Pothuraju Rajarajeswari, P. Srinivasan, C. Sathiy Kumar and Sudhakar Sengan Journal of Computational and Theoretical Nanoscience, Vol. 17,

Number 12, pp. 5339-5345 (7), December 2020, ISSN 1546-1955 (Print); ISSN 1546-1963 (Online), American Scientific Publishers, United States of America, <https://doi.org/10.1166/jctn.2020.9426>.

4. An Automated Optimize Utilization of Water and Crop Monitoring in Agriculture Using IoT
Sanwta Ram Dogiwal, Pankaj Dadheech, Ankit Kumar, Linesh Raja, Abhishek Kumar, Mahender Kumar Beniwal 4th International Conference on “Emerging Technologies in Computer Engineering: Data Science & Blockchain Technology” (ICETCE-2021) Organized by the Swami Keshvanand Institute of Technology, Management & Gramothan (SKIT), Jaipur, Rajasthan, India held online on 03-04, February 2021, Publication Partner: IOP Science, IOP Conference Series: Material Science and Engineering, 1131 (2021) 012019, pp 1-10, <https://doi.org/10.1088/1757-899X/1131/1/012019>, ISSN 1757-899X (Online)
5. A Scalable Data Processing Using Hadoop & MapReduce for Big Data ,Dr. Sumit Srivastava Ankit Kumar Pankaj Dadheech, Dr. Dinesh Goyal 2018, Journal of Advanced Research in Dynamical & Control Systems Volume 10 Issue 02-Special Issue, 2018 Pages 2099-2109 Publisher Institute of Advanced Scientific Research
6. Dadheech, Pankaj, Dinesh Goyal, Sumit Srivastava, Ankit Kumar, and Manish Bhardwaj. "Performance Improvement of Heterogeneous Cluster of Big Data Using Query Optimization and MapReduce." In *International Conference on Information Management & Machine Intelligence*, pp. 85-100. Springer, Singapore, 2019.

9. Patents (Published): -

7.5.1 IOT related International Patent

Following Australian Patents have been registered and published at Commissioner of Patents, Intellectual Property Australia, Australian Government:

1. Kshirsagar, Pravin R.; Gulati, Kamal; Dadheech, Pankaj; Manjunath, TC; Muthusundari, S.; Sreenivasu, S.V.N.; Chandnani, Neeraj; Chandrasekaran, Saravanan; Kumar, Kailash; Chandra, Akkaraju Sailesh; Reddy, G. Divakara; Manju, J. R.; R., Harsha; Yaseen, Syed Mufassir and Yaqoob, Syed Irfan, “An Artificial Intelligence and IoT based System for Monitoring and Detection of Electricity Theft”, Inventor and Applicant of the Patent, Australian Patent Publication Number-2020101562, Patent Application Number-2020101562, Date of Filing-29/07/2020, Publication Date-19/08/2020, Term of Patent: Eight years from 29 July, 2020, <http://pericles.ipaustralia.gov.au/ols/auspat/applicationDetails.do?applicationNo=2020101562>.

2. Dadheech, Pankaj; Kshirsagar, Pravin R.; Devaru, Susheela Devi B.; Patil, Shamshekhar S.; Chaturvedi, Rekha; Kumar, Loveleen; Mohan, Anand; Ray, Abhra Pratip; Aljabr, Ahmad Abdullah; Kumar, Kailash; Tewari, Ranjana; Islam, Saiful; Gulati, Kamal; Neeli, Jyoti and H., Girish, “An Artificial Intelligence and Internet of Things based Automated System for Animal Health Care”, Inventor and Applicant of the Patent, Australian Patent Publication Number-2020101719, Patent Application Number-2020101719, Date of Filing-07/08/2020, Publication Date-02/09/2020, Term of Patent: Eight years from 7 August, 2020, <http://pericles.ipaustralia.gov.au/ols/auspat/applicationDetails.do?applicationNo=2020101719>.
3. Chaturvedi, Anoop Kumar; Kumar, R. Lakshmana; Islam, Saiful; Khan, Nadeem Ahmad; Khan, Afzal Husain; Manjunath, TC; G., Pavithra; Kumar, Kailash; Veerakumar, K.; Gulati, Kamal; Bhasin, Narinder Kumar; Dadheech, Pankaj; Sankeerthana, R.; Chakravarthy, Srinivasa L.; Ghadiyaram, Anil Kumar and Panduri, Bharathi, “An Artificial Intelligence Based Automatic Cleanliness System For Physically Handicapped Persons”, Inventor and Applicant of the Patent, Australian Patent Publication Number- 2020103157, Patent Application Number- 2020103157, Date of Filing-31/10/2020, Publication Date-16/12/2020, Term of Patent: Eight years from 31 October, 2020. <http://pericles.ipaustralia.gov.au/ols/auspat/applicationDetails.do?applicationNo=2020103157>.
4. Devaneyan, S.Pradeep ; Sahoo, Santosh Kumar ; Dadheech, Pankaj ; Vijayalakshmi, A. ; B., Ebenezer Abishek. ; M., Lakshmanan. ; V., Noor Mohammed. ; M., Palanivelan. ; W., Razia Sultana ; Kumar, Chinnapalli Likith ; Pravallika, Sirigireddy ; Sasikala, K. ; Sekar, V. ; Monisha, M. ; P., Vijayalakshmi. ; Joshi, Hitesh ; Manoharan, Hariprasath ; Kshirsagar, Pravin R. ; Peroumal, Vijayakumar, “An IoT based Tyre Pressure and Temperature Monitoring System”, Inventor and Applicant of the Patent, Australian Patent Publication Number-2021100287, Patent Application Number-2021100287, Date of Filing-17/01/2021, Publication Date-31/03/2021, Term of Patent: Eight years from 18 January, 2021. <http://pericles.ipaustralia.gov.au/ols/auspat/applicationDetails.do?applicationNo=2021100287>.
5. Kumar, V. D. Ambeth; Bharath, Mallela; Malathi, S.; Elangovan, D.; Kumar, Abhishek; R, Vijay; B, Chitra; Kumar, V. D. Ashok; Pushpa, S.; Kumar, Ankit; Kushwaha, Alok Kumar Singh and Manish, R., “Holonomic Drive Conveyor System and its Method Using IoT”, Inventor and Applicant of the Patent, Australian Patent Publication Number-2020104116, Patent Application Number-2020104116, Date of Filing-16/12/2020, Publication Date-17/02/2021, Term of Patent: Eight years from 16 December, 2020, <http://pericles.ipaustralia.gov.au/ols/auspat/applicationDetails.do?applicationNo=2020104116>.

10. IOT related National Patents

Following Patents have been registered and published in Intellectual Property India, Office of the Controller General of Patents, Design and Trade Marks, Department of Industrial Policy and Promotion, Ministry of Commerce and Industry, Government of India:

1. Dr. S. Sudhakar, Dr.S.Raju, Dr. Pankaj Dadheech, Dr. V. Priya, Mr. V. Vinoth Kumar, Dr. T. Avudaiappan, Dr. A. Syed Musthafa, Dr. C. Nallusamy, Dr. K.Prasanth, Dr. E. Punarselvam, “Automated Non Invasive Blood Group Determination and Cholesterol Level Using IoT”, Inventor and Applicant of the Patent, Patent Publication Number (Journal No.)-08/2020, Indian Patent Application Number-202041005771 A, 2020, Date of Filing-10/02/2020, Publication Date-21/02/2020,

Doi: http://www.ipindia.nic.in/writereaddata/Portal/IPOJournal/1_4844_1/Part-1.pdf, Page-10231.

2. Dr. S. Sudhakar, Dr. Pankaj Dadheech, Dr. V. Priya, Dr. A. Sagai Francis Britto, Mr. S. Ramesh, Mrs. M. Divyapushapalakshmi, Mr. V. Ramachandran, Mr. Ankit Kumar, Mr. R. Parthiban, Dr. Hemant Dhabhai, “IoT based Real-Time Fuel Efficiency and Monitoring System for a Smart Vehicle Using Mobile Device”, Inventor and Applicant of the Patent, Patent Publication Number (Journal No.)-09/2020, Indian Patent Application Number-202041007612 A, 2020, Date of Filing-23/02/2020, Publication Date- 28/02/2020,

Doi: http://www.ipindia.nic.in/writereaddata/Portal/IPOJournal/1_4846_1/Part-1.pdf, Page-11249.

3. Dr. K. Suresh Kumar, Dr. A. Vijayaraj, Dr. S. Sudhakar, Mrs. N. Suganthi, Dr. P. T. Vasanth Raj, Mr. V. Prasathkumar, Dr. Pankaj Dadheech, Mr. Ankit Kumar, Dr. Hemant Dhabhai, Ms. S. K. Aruna, “Image Captcha Cropping Using Symbols (ICS)”, Inventor and Applicant of the Patent, Patent Publication Number (Journal No.)-12/2020, Indian Patent Application Number-202041010986 A, 2020, Date of Filing-14/03/2020, Publication Date-20/03/2020,

Doi: http://ipindia.nic.in/writereaddata/Portal/IPOJournal/1_4855_1/Part-1.pdf, Page-14822.

4. Dr. V. Priya, Dr. S. Sudhakar, Dr. Jayanti Goyal, Dr. Pankaj Dadheech, Dr. Jitendra Singh Chouhan, Mr. Wilson Prakash, Mrs. A. Uma Maheswari, Mr. S. Ramesh, Mr. Sudhir Kumar, Mr. Nitin Purohit, Mr. S. Sudhagar, “Smart Traffic System for Emergency Vehicles Using IoT”, Inventor and Applicant of the Patent, Patent Publication Number (Journal No.)-12/2020, Indian Patent Application Number-202041011771 A, 2020, Date of Filing-18/03/2020, Publication Date-20/03/2020,

Doi: http://ipindia.nic.in/writereaddata/Portal/IPOJournal/1_4855_1/Part-1.pdf, Page-14834.

5. Dr. V. Priya, Dr. S. Sudhakar, Dr. S. Sharavanan, Dr. A. Vishnu Priya, Mrs. C. Karpagavalli, Dr. M. B. Suresh, Ms. K. Vidhya, Dr. Pankaj Dadheech, Mr. Gourav Purohit, Mr. Sachin Sharma, Ms. K. Kiruthiga, Ms. S. Abinaya, Ms. S. Athithi, “IoT based Water

Quality Monitoring for Textile Industry”, Inventor and Applicant of the Patent, Patent Publication Number (Journal No.)-19/2020, Indian Patent Application Number-202041012885 A, 2020, Date of Filing-24/03/2020, Publication Date-08/05/2020, Doi: http://ipindia.nic.in/writereaddata/Portal/IPOJournal/1_4864_1/Part-1.pdf, Page-18349.

6. Biswa Ranjan Acharya, Dr. Pankaj Dadheech, Puja Das, Dr. Deepti Bala Mishra, Satya Ranjan Dash, Dr. Mohammad Israr, Suresh Chandra Moharana, Anupama Baral, Asik Rahaman Jamader, “System and Method for Real Time Monitoring and Predicting Heart Health Performance”, Inventor and Applicant of the Patent, Patent Publication Number (Journal No.)-20/2020, Indian Patent Application Number-202031013658 A, 2020, Date of Filing-28/03/2020, Publication Date- 15/05/2020,

Doi: http://www.ipindia.nic.in/writereaddata/Portal/IPOJournal/1_4866_1/Part-1.pdf, Page-18852.

7. Dr. Achyut Shankar, Dr. K. Thenmalar, Dr. R. Rohini, Dr. R. Nirmala, Dr. Suchi Mala, Dr. Thompson Stephan, M.K. Mariam Bee, Dr. Pankaj Dadheech, Dr. S. Balamurugan, “Sensor Based System and Method for Automatic Mirror Adjustment in Vehicles”, Inventor and Applicant of the Patent, Patent Publication Number (Journal No.)-20/2020, Indian Patent Application Number-202011015819 A, 2020, Date of Filing-11/04/2020, Publication Date-15/05/2020,

Doi: http://ipindia.nic.in/writereaddata/Portal/IPOJournal/1_4866_1/Part-1.pdf, Page-18785.

8. Dr. Surya Deo Choudhary, Manish Kumar, Dr. Pankaj Dadheech, Dr. Pankaj Kumar, M.K. Mariam Bee, P. Jagadeesh, Dr. R. Lakshmana Kumar, Prof. M. Amala Jayanthi, Dr. Gunasekaran Manogaran, Dr. Bala Anand Muthu, Dr. S. Balamurugan, “Sensor Based Secured Bank Locker System Thereof”, Inventor and Applicant of the Patent, Patent Publication Number (Journal No.)-23/2020, Indian Patent Application Number-202041015333 A, 2020, Date of Filing-07/04/2020, Publication Date-05/06/2020,

Doi: http://ipindia.nic.in/writereaddata/Portal/IPOJournal/1_4874_1/Part-1.pdf, Page-21074.

9. Mr. Sri Hari Nallamala, Dr. Pankaj Dadheech, Mr. Aabhas Mathur, Dr. K. V. D. Kiran, Mrs. Sushma Chowdary Polavarapu, Dr. S. Geetha, Dr. J. Martin Leo Manickam, Dr. S. Jayasundar, Mrs. Kranthi Madala, Dr. J. Madhusudanan, Mr. Veenanand Kakarla, “IoT and Blockchain-Enabled Smart E-Vehicle Charging System”, Inventor and Applicant of the Patent, Patent Publication Number (Journal No.)-23/2020, Indian Patent Application Number-202041020699 A, 2020, Date of Filing-16/05/2020, Publication Date-05/06/2020,

Doi: http://ipindia.nic.in/writereaddata/Portal/IPOJournal/1_4874_1/Part-1.pdf, Page-21170.

10. Dr. G. Rajeshkumar, Dr. S. Sadesh, Dr. S. Gokulraj, Dr. R.Venkatesan, Mrs. T. Priyadarsini, Dr. Pankaj Dadheech, Dr. Hitesh Joshi, Mr. Rajesh Rajaana, Dr. Sanwta Ram Dogiwal, Mr. Sudhir Kumar, Dr. S. Sudhakar, “A Low-Cost 4G Smart Phone Detector and Jammer System GSM-900 MHz and 1800 MHz for Using Matlab Simulink”, Inventor and Applicant of the Patent, Patent Publication Number (Journal No.)-28/2020, Indian Patent

Application Number- 202041026105 A, 2020, Date of Filing-21/06/2020, Publication Date-10/07/2020,

Doi: http://ipindia.nic.in/writereaddata/Portal/IPOJournal/1_4885_1/Part-1.pdf, Page-25959.

11. Mr. S. Magesh, Mr. K. Mahendran, Mrs. V. R. Niveditha, Dr. S. Radha Rammohan, Mrs. N. Jayashri, Mrs. K. Sudha, Dr. R. Vidya, Mr. S. Ramesh, Dr. P. Rajaram, Dr. Pankaj Dadheech, Dr. S. R. Dogiwal, “Accuracy of Open-Air Temperature Prediction by Smart Weather Monitoring System for Effective Analytics Using IoT Devices”, Inventor and Applicant of the Patent, Publication Number (Journal No.)-39/2020, Indian Patent Application Number- 202041039505 A, 2020, Date of Filing- 12/09/2020, Publication Date-25/09/2020,

Doi: https://ipindia.gov.in/writereaddata/Portal/IPOJournal/1_4910_1/Part-1.pdf, Page-42983.

12. Dr. D. Hemavathi, Dr. Hitesh Joshi, Dr. K. Sharmilee, Ms. P. Vijaya Vani, Mr. M. Z. M. Nomani, Mr. S. Thangam, Dr. Ramya Govindaraj, Mr. Ashwini Saini, Mr. Rajesh Rajaan, Dr. Pankaj Dadheech, Mr. Alekya Kowta, Mr. Manya Smriti, “A Smart Walking System for the Elderly and Blind”, Inventor and Applicant of the Patent, Publication Number (Journal No.)-48/2020, Indian Patent Application Number- 202041050337 A, 2020, Date of Filing- 19/11/2020, Publication Date-27/11/2020,

Doi: https://ipindia.gov.in/writereaddata/Portal/IPOJournal/1_4929_1/Part-1.pdf,Page-59709.

13. Dr. Pankaj Dadheech, Dr. V. B. V. N. Prasad, Dr. C. G. Ravichandran, Mr. Rajesh Rajaan, Dr. S. Jayasundar, Dr. G. Saravanan, Dr. Ramya Govindaraj, Dr. T. Kavitha, Mr. Subrata Chowdhury, Mr. R. Regin, Ms. Manya Smriti, “VR based Psychological and Physical Training to Girls for Self-Defense”, Inventor and Applicant of the Patent, Publication Number (Journal No.)-49/2020, Indian Patent Application Number- 202011050375 A, 2020, Date of Filing- 19/11/2020, Publication Date-04/12/2020, Doi: https://ipindia.gov.in/writereaddata/Portal/IPOJournal/1_4931_1/Part-1.pdf,Page-60336.

14. Dr. P.Vijaya Vani, Ms.D.Tabhita, Dr.D.Krupa Daniel, Dr.R.Muthukumar, Dr. J.Vellingiri, Dr. Jagadeesh Gopal, Dr. K.Arivuselvan, Dr. J.Kamalakaran, Dr.J.Gitanjali, Mr. Vishwa Pratap Singh, Dr. S.R.Dogiwal, Dr. Pankaj Dadheech, “Open Source Internet of Tangible Things Based Smart Device for Children with Hearing Loss using Wi-Fi Communication”, Inventor and Applicant of the Patent, Publication Number (Journal No.)-50/2020, Indian Patent Application Number- 202041053003 A, 2020, Date of Filing- 05/12/2020, Publication Date-11/12/2020,

Doi: https://ipindia.gov.in/writereaddata/Portal/IPOJournal/1_4933_1/Part-1.pdf,Page-61805.

15. Prof. Ramesh Chandra Panda, Dr. Ashok Kumar Nanda, Dr. Pooja, Dr. Ipseeta Nanda, Dr. Nibedita Nanda, Mr. Meghraj Vivekanand Suryawanshi, Archana Kumari Prasad, Neeraj Kumar, Mr. Deepak Shivaji Dandwate, Dr. Pankaj Dadheech, Radha Priya, Miss Junter Loya, Dr. P Karthigeyan, “A Novel IoT based Disinfectant Sanitizer Tunnel”, Inventor and Applicant of the Patent, Publication Number (Journal No.)-50/2020, Indian Patent

Application Number- 202041051975 A, 2020, Date of Filing- 29/11/2020, Publication Date- 11/12/2020,

Doi: https://ipindia.gov.in/writereaddata/Portal/IPOJournal/1_4933_1/Part-1.pdf,Page-61730.

11. Student Projects

1. Smart Networks for Renewable Integrated Sources for stand-alone Micro grids

Conditioning Monitoring (CM) of electrical system is the process of systematic data collection and evaluation to identify changes in performance or conditioning of the system, or its components, such that remedial action may be planned in a cost effective manner to maintain reliability. It is the process of continuous monitoring of their electrical parameters in order to identify a significant change which is indicative of a developing fault. Different micro-grids groups have been developing their own remote maintenance and diagnostic units on engineering system of their choice. The appropriate generic tools having low cost providing safe solution are required to address the challenge for robust and reliable micro grid.

2. Digital Technologies /MIS for monitoring Water Quality Management in water supply network at district level

In the absence of any stringent norms on water, the existing methodology for Water Quality Management (WQM) is inadequate to identify the various sources of pollution. Integration of data on water quality with data on water supplies, which is very important from the point of view of assessing water availability for meeting various social, economic and environmental objectives, is hardly done. Finally, in the absence of any stringent norms on water quality testing, results can change across agencies depending on sampling procedure, time of testing, and testing instruments and procedure. Thus, water quality testing is tangent to a large group of beneficiaries. That is why development of simple and fast water quality detection kits is essential to test, validate and implement state-of-the-art, innovative, accurate, robust, reliable and cost effective rapid water quality monitoring tools in Indian context.

3. Digitized Platform /Automatic Response platform for handling Parliament Questions

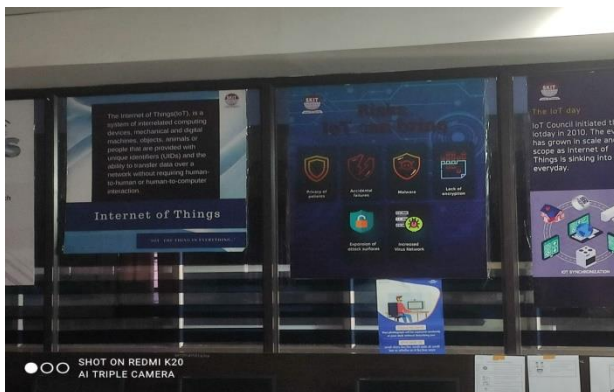
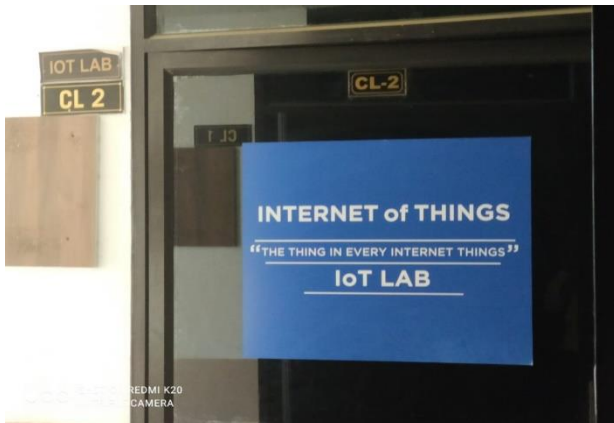
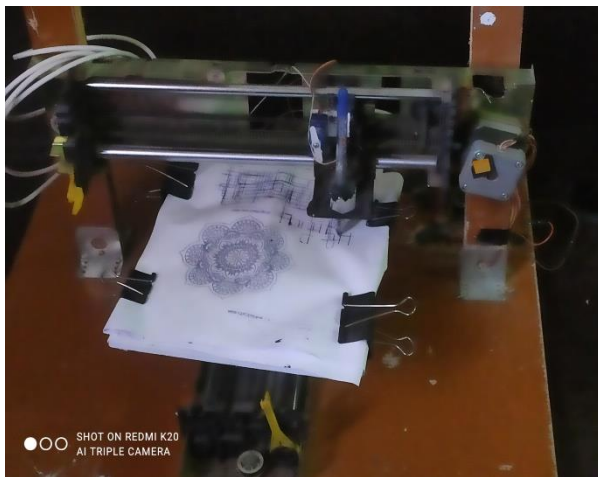
During parliament session, each Department receives number of Parliament Questions on varied topics raised by MPs and handled in a very time bound manner on top priority. Each reply is generally prepared by seeking inputs from all the other relevant departments which

requires lot of efforts and is also time consuming at the same time. It is proposed to digitize the entire process of receiving parliament question from the Lok Sabha and Rajya Sabha directed to each Department as per defined set of key words along with a provision to be sent to all concerned ministries by selecting through a drop down menu with an attached deadline . The platform should also have the feature of uploading the inputs by all selected departments and then subsequent uploading of approved reply by the handling department to the parliament unit and the Lok Sabha or Rajya Sabha Parliament unit.

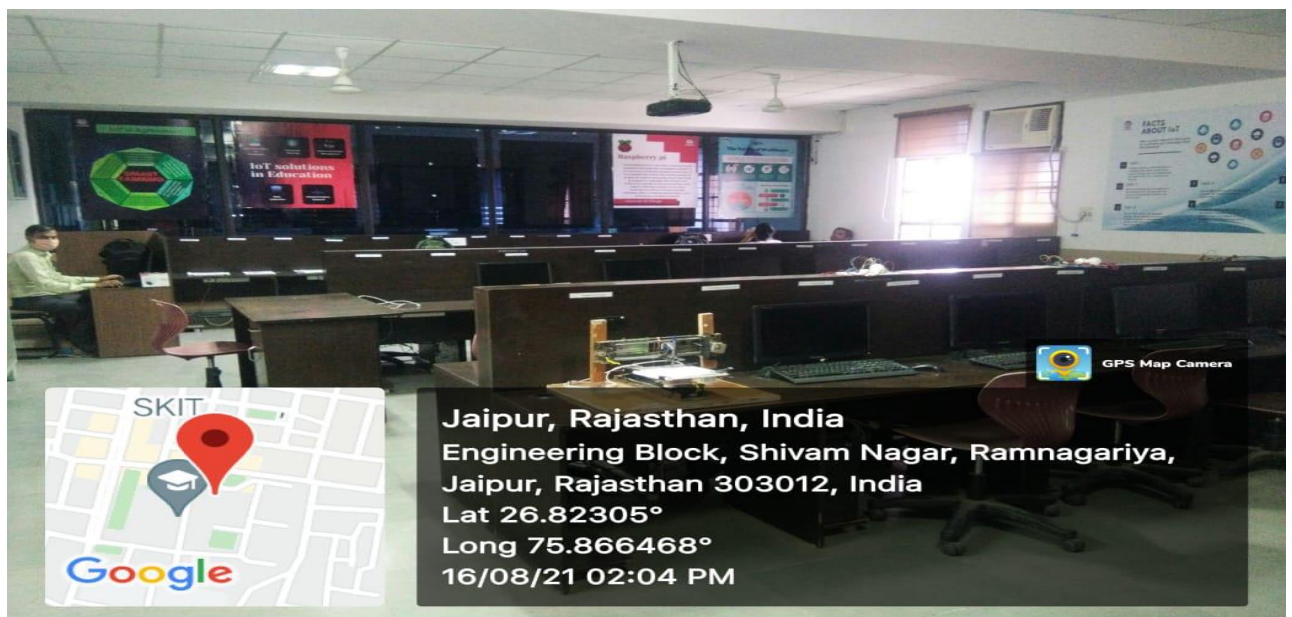
4. Implementation of a simple device mediation application of a Network Management System

In a typical NMS scenario a network service provider will have thousands of network elements of different kinds like switches, routers, bridges, gateways and also of various makes eg, Cisco, Juniper, Nortel, etc. All these network elements would like to collect data spewed out by these elements. This data will be analyzed for Faults, Configuration, Accounting, Performance and Security Data. This will give an overview of a typical network management Application and standardizing the interfacing thereof.

12. Glimpse of IoT Lab



13. GEOTAGGED PHOTOS OF IOT LAB



14. IoT Faculty Expert Group

Department of Computer Science Engineering & Information Technology			
Research Group: IoT & Big Data Analytics			
S. No.	Faculty Name	Designation	Area of Expertise
1.	Prof. (Dr.) Anil Chaudhary	Head of Department (IT)	Programming, Hadoop, IoT, High-Performance Computing
2.	Prof. (Dr.) Mukesh Kumar Gupta	Head of Department (CSE)	Big Data Analytics in Machine Learning, IoT Devices, IoT Security
3.	Dr. Pankaj Dadheech	Associate Professor (CSE)	High-Performance Computing, IoT, Hadoop, Big Data Analytics in Machine Learning, Information Security
4.	Mr. Mehul Mahrishi	Associate Professor (IT)	Machine Learning in Image Processing, Intelligent IoT
5.	Mr. Ankit Kumar	Assistant Professor (CSE)	IoT Devices, Smart Sensors, Machine Learning in IoT, Wireless Sensor Network
6.	Dr. Yogendra Gupta	Assistant Professor (CSE)	Embedded Systems, IoT Devices, Smart Sensors, VLSI
7.	Mr. Sushant Kumar	Assistant Professor (CSE)	Machine Learning, IoT Devices, Smart Sensors, Artificial Intelligence

15. IoT Software Components (Open Source & Other Platforms)

S. No.	Name of Component	Description
1.	IBM Watson IoT Platform	SKIT is IBM CoE under which the faculty members and students can access IBM software tools like WID, RAD, DB2, WAS etc. and has access to IBM Cloud. Certifications like Robotics and TJBOT are also provided under this initiative.
2.	Microsoft Azure IoT Central	Under Microsoft Ed-vantage Initiative, SKIT is recognized Microsoft Cloud Competency Center under which the faculty members and students can access various features and services of Azure Cloud. Certifications like IOT-BOT, Microsoft Innovative Educator are also provided to students and faculty members under this initiative.
3.	Shakti Processors (IIT Madras)	Open-source processor development initiative by the RISE group at IIT-Madras.
4.	Shakti Software (IIT Madras)	Software Development Kits and IDE's readily available to build applications on SHAKTI
5.	RISC-V ISA	Free and open-source ISA
6.	Arduino	Integrated development environment (IDE)
7.	Devicehub.net	Universal interface for IoT and M2M
8.	IoT Toolkit	Intelligent object API gateway service
9.	OpenWSN	Repository for IoT hardware and software projects
10.	Particle	Suite of hardware and software for building IoT devices, applications, and services
11.	SiteWhere	Deployment tool
12.	ThingSpeak	IoT application and API
13.	Webinos	web-based application platform for the IoT
14.	Zetta	API based IoT platform based on Node.js
15.	Node-RED	visual tool for lining the Internet of Things
16.	Flutter	Programmable processor core
17.	M2MLabs Mainspring	Application framework for developing M2M applications

18.	ThingsBoard	Data collection, Processing, Visualization, and Device Management toolkit
19.	Kinoma	Marvell Semiconductor hardware prototyping platform
20	Kaa IoT Platform	Multi-purpose middleware platform
21.	DSA	Open-Source Platform & “Toolkit” for Internet of Things Devices, Services and Applications.
22.	Thinger	Scalable cloud base for connecting devices. It supports Raspberry Pi, Intel Edison, ESP8266.
23.	OpenRemote	Open-Source IoT platform
24.	gem5	Simulator for computer-system architecture

16. FUTURE SCOPE of IOT LAB

The future of IoT has the potential to be limitless. In general, AI and machine learning programs are paired with IoT devices to provide proper automation. As a result, the Internet of Things (IoT) has broadened its field of application across various industries. IoT has found many applications in the fields of medicine, transportation, farming, manufacturing and automation. In the present scenario, the appliances of a laboratory like lights and fans are left on, even when not in use, which leads to a rise in power consumption of the laboratory. IoT can be used to automate the laboratory which will help in effective power consumption, minimal human assistance required and easy monitoring of the laboratory.