Detailed Call For Proposals (CFP) under ICPS programme.

Last date for receipt of proposals through online is 31/03/2017

The Scheme: R&D proposals are invited under ICPS programme. Broad research thematic areas under ICPS Division are

Theme-1: Interdisciplinary Cyber Physical Systems Research (ICPSR)
Theme-2: Data Science Research (DSR)
Theme-3: Internet of Things Research (IoTR)
Theme-4: Cyber Security Research (CSR)
Theme-5: Indian Heritage in Digital Space (IHDS)
Theme-6: Epidemiology data & Analytics (EDA)

Scheme: R&D projects are invited in above areas for both PI driven Individual projects and Multi Institutional and mult-disciplinary consortium based/cluster mode networked projects.

Theme -1 ICPS Research: Present call is for a focused research on some of the national issues. Thus, proposals will have thematic initiatives for developing systems for practical applications in the areas of 1. Water, 2. Energy, 3. Healthcare, 4. Agriculture, 5. Infrastructure, 6. Transport, 7. Security of Physical Systems. Some or all research aspects highlighted below

1. **CPS Design Fundamentals:** Project proposals must address basic scientific and engineering issues involved in design of CPS systems like (i) formal modelling of CPS systems;(ii) Autonomous control design issues; (iii) Stability analysis; (iv) Simulation & emulating systems; (v) Sensing & Actuation Systems: Algorithms and Electronics, Signal Processing, Fusion, Calibration, deployment, etc. (vi) Wireless for CPS: Phy & Mac layers for CPS, with latency, QOS, Reliability, Security, etc. (vii) Platform technologies and tools for CPS: Progamming frameworks, run time systems, hardware platforms, IoT Systems, etc.

2. **Future Generating IoT Platforms:** A number of IoT platforms are today available from a number of commercial organsiations for realisation of CPS. However, there are a number of open research issues like (i) design of IP's for application SOC's for IoT; (ii) Physical layer protocols; (iii) Resource efficient machine learning for IoT etc. Proposals may address these or other practical issues involved in developing

powerful IoT platforms. (iv) Control for CPS: Distributed Control Algorithms, Model based Control, Policy based control, Mechanism Design, Human-in-the-loop etc.

3. **Security of Cyber Physical Systems:** Security issues of Cyber Physical System are distinct from those of cyber security because in CPS security questions involve protection of physical device as well as cyber interface to the physical systems. Research endeavour can focus on security architecture, discovery and remediation of threats, detection of physical breaches at cyber level and other relevant issues.

4. **Predictive Technologies in CPS Context:** IoT data over time generates interesting patterns which needs to be analysed for actionable insights. The insights can be used for continuous refinement of CPS system. Some of the machine learning issues are research topics and required for CPS data are Streaming Analytics, Machine learning and intelligent processing etc

Theme -2 Data Science Research for CPS
(a) Machine learning at local level
(b) Dimensionality reduction, data visualization
(c) Learning from streaming data/ Learning in non-stationary environment
(d) Scalable learning
(e) Uncertainty handling
(f) Deep learning
(g) Distributed/parallel algorithms for learning
(h) Causality analysis
(i) Interpretation of data
(j) Security and privacy of data

Theme 3 Internet of Things Research (IoTR) for CPS

1. **Network Design, Architecture and Communication Protocols:** Embedded system architecture, Adaptive and cognitive networks, Wireless networks, Transmission protocols and algorithms, Energy-efficient networks, P2P and overlay networks

2. **Software Architectures and Middleware:** Inter-cloud interfaces, Programming models, Services provisioning and management, Hybrid cloud infrastructure, Requirements analysis and modelling, Middleware

3. **Mobile Cloud Services:** Mobiles as sensors, networks and applications, Spatial Mobility, geo-location and management, Pervasive and ubiquitous services, Mobile service architectures and frameworks.

4. **Hardware platforms:** Open source IP core based IoT-platform design, development and fabrication through academic licensing, Open source

processor, bus, peripherals and other related IP-cores, ISA, software and development tool chain from GNU based licenses, Antennas for IoT

5. **Data and Knowledge Management:** Data models, Tiny/small databases, Knowledge management, Rules, Semantics and Ontology.

6. **Software-defined Networking (SDN):** IoT Network virtualization, Software defined data and storage, SDN models and architectures, QoS evaluation, SDN scalability and optimization

7. **Performance Evaluation and Modeling:** Evaluation techniques, Performance monitoring, Scheduling and application workflows, Fault-tolerance and recovery, Capacity planning and elasticity

8. **Clouds at the Edges:** IoT applications for network edges, Processing of IoT data at network edges, Optimization of data traffic and latencies, Cloud, Fog and Mist computing

Theme 4 Basic research in Cyber Security for CPS

1. **Analysis techniques:** Formal Methods, Developing Game Theoretic Models for Cyber Security

2. **Simulation/Co-Simulation and Laboratory Emulation:** Analysis of CPS Threat Models and Discovery of Counter Measures, Discovery and Remediation of Cyber threats, Defense in Depth Strategies, Security Architecture

3. **Cryptography theory and Engineering:** Cryptographic, protocols, Cryptanalysis, Side Channel Attacks, and Counter Measures, Number Theory, Algorithms, and Analysis

4. **Software and System Security:** Automated Protocol Reverse Engineering for Various Protocols and Counter Measures, Cloud Security, Hypervisor Security, Separation Kernel Methods, Perimeter Defense and Penetration Testing, Malware analytics and malware entrapment - Honey Pots/nets, Detection of physical breaches at cyber level

5. **Program Analysis:** Static Analysis Based Techniques to Discover Software Vulnerabilities for Software Components, Analysis of Vulnerabilities in Hardware Components such as in PLCs, and IEDs

6. **Machine Learning:** Application of Machine Learning techniques for Discrimination of Physical Dynamics under Cyber Attacks, Anomaly detection for Intrusion Detection, Machine learning based System Model Inference as attack Strategy

7. **Network Security:** Intrusion Detection in Control Network using Automated Event Correlation

8. **Risk Modeling and Resilience:** Reliability vs. Robustness, Risk driven Resilience Security for Resilience

Theme-5: Indian Heritage in Digital Space (IHDS) Research themes and challenges: IHDS is a deliverable based directed research programme and will have the following sub-themes of research i.e., A. Socio-cultural Heritage, B. Intangible Heritage, C . Tangible Heritage, D. Predictive Technologies for heritage content, E. Sensing and actuation technologies for Heritage. Further details on each sub-themes is as given below

A. Socio-cultural Heritage:
1. Socio-cultural Landscapes of Cities – this will deal with research to digitally represent the evolving socio-cultural and historical landscapes of Indian cities.

Research challenges
- Information integration and fusion for generating socio-cultural evolution schema.
- Framework to design authoring and presentation modalities for immersive experience of evolving chronological landscape of a historical sites.

Expected Deliverable: Technology to create immersive experiential content for socio-cultural evolution of a historical sites.

2. Digitizing Ecological Heritage – Ecological heritage refers to the sum total of the elements of biodiversity, including flora and fauna and ecosystem types, together with associated geological structures and formations (geo-diversity), and how people effect the environment and are affected by it. Research could attempt to model and represent these diverse elements and processes in the digital domain.

Research Challenges
- Framework to preserve ecological heritage, community culture and local knowledge in digital space.
- Modeling of socio-physical interaction.

Expected Deliverable:
- Technology for digital archiving of ecological and community Heritage

- Models of complex interaction between society and ecological systems

3. Heritage of Living Spaces – It aims to preserve vernacular architectures and building traditions that have been a part of Indian heritage. This also involves attempts to understand, document and simulate utility and use of particular construction practices.

Research Challenges
- To create a virtual reality models of traditional living spaces and social practices linked to the living space.
- Modeling and simulation to understand and analyze functional utility and construction of living spaces

Expected Deliverable: Technology for experiencing traditional living spaces through digital simulation

B. Intangible Heritage
Preservation of intangible heritage deals with intangible resources like language, music and dance etc. It is crucial to preserve these aspects of these Indian heritage as they are interwoven into the Indian social fabric and are integral parts of celebrations and way of life.

1. Conceptual Archival of Art, Music, Dance, Games and Culinary Heritage

Research Challenges
- Knowledge based digital archiving.
- Multi-media Analytics for cross-domain and cross-form similarity.

Expected Deliverable: Techniques for knowledge rich multimedia archiving of intangible heritage elements.

2. Soundscapes and Spoken Languages
Research Challenges
- To capture and correlate geo-tagged audio texture in speech and music.
- Modeling and identification of soundscapes.

Deliverable
- Technology for characterizing region-specific soundscape.
- Audio input based search.

C . Tangible Heritage
Tangible heritage consists of the monuments and structures that bear

witnesses to the historical development of India. It is essential to preserve the beauty and grandeur of such structures in the digital realm and also to understand their utility and historical significance via digital reconstructions.

1. Reconstruction of Underwater structures

Research Challenges
Development of novel 3D digital reconstruction technologies and algorithms for geometric reconstruction and visualization.

Deliverable: 3D digital models, reconstruction and visualization technology for underwater sites.

2. Reconstruction of heritage public utility structures (like Baoli) and their functional simulation

Research Challenges
3D digital reconstruction and structure based simulation.

Expected Deliverable: Structure based simulation scheme for mining traditional engineering knowledge.

3. Preservation of Manuscripts and Inscriptions

Research Challenges
1. Visualization of content through computational imaging and signal processing.
2. Interpretation of content.
3. Context and knowledge based archiving.

Expected Deliverable: Technology for digital acquisition, restoration, archiving and quality assessment of manuscript/inscription images.

4. Preservation of Paintings, murals and sculpture

Research Challenges: Capture and preservation of content through advanced imaging modalities. Restoration of form, structure, color and texture of degraded content.

Expected Deliverable: Technology for digital capture, restoration and archiving of content.

5. Augmented Reality based Rendering over real space

Research Challenges
1. 3D content generation and spatial localization of existing and lost structures.
2. Frameworks to present heritage via augmented reality.
3. Frameworks to develop narratives for story telling through augmented reality

Expected Deliverable
1. Technology to recreate heritage structures and situate them or augment them to reality to achieve a sense of presence and immersion.
2. Technology to author narratives through virtual reality/ augmented reality

D. Predictive Technologies for heritage content
This research theme deals with the issues in collection and processing of multi-modal and unstructured data and its analysis for identifying new knowledge and perspectives from it.

Research Challenges
1. Framework for data cleaning and validation.
2. Data-driven discovery of quantitative Parameters for novel insights into various aspects of digital heritage.
3. Mining traditional Indian knowledge.

Expected Deliverable: New perspectives for past events and Identification of traditional knowledge

E. Sensing and actuation technologies for Heritage
Many of the earlier presented research themes need to capture data in difficult conditions or data that has not been digitized before. This requires research into development of new sensors/ IOT devises to facilitate it.

Research Challenges involve formulation of data acquisition schemes for heritage artifacts using
- Computational photography.
- Catadiatropic Sensors, Spherical Camera.
- Imaging Spectroscopy.
- Use of Sonar, Lidar, Radar for heritage data acquisition.
- Development of actuators to deliver haptic feedback to users.
- Drone-based sensors and capture methodologies.

Deliverable: New sensors and actuators. New and novel data capture protocols and methodologies.

Theme-6: Epidemiology data & Analytics (EDA)

There are data sets related to epidemiology are available at various organisations in the country. The objective of the programme is to carryout analytics over the data, examine and evaluate data about epidemiology, diseases burden, clinical trials being generated all over the country. For the purpose DST will partner with Digital India, DeITY, DBT and ICMR and facilitate seamless access of the data. Proposals are solicited to carryout analytics over the data than generation of data.

Who can Apply: Academicians, Scientists, Technologists and other practicing researchers from recognised academic, research institutions and registered scientific societies etc.

Approval mechanism: As per standard DST Rules and Regulations.

How to apply: Prescribed format is down loadable from www.dst.gov.in. Only one hard copy proposals needs to be sent by post and the corresponding electronic copy be sent by email to krmm@nic.in. It is a call based programme. For more information, details and info on ICPS prgramme, visit www.dst.gov.in and for any queries, contact Dr Rajeev Sharma, Scientist-D, ICPS Division, DST, New Delhi Ph:26590310 and email:rajeevsharma@nic.in

Last date for submission: The last date for receipt of electronic and physical copy (only one copy) is 31/03/2017. No proposals shall be entertained after the last date. **Hard copy proposal be addressed to**

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