

PROJECT COMPLETION REPORT

1. Title of the project:

Design and Development of Compressed Sensing Based Image Reconstruction Prototype Hardware Architecture for Medical Imaging Applications

2. Principal Investigator(s) and Co-Investigator(s):

Principal Investigator:

Dr. Bhabesh Deka, Associate Professor, Dept. of ECE, Tezpur University, Napaam, Tezpur 784028

3. Implementing Institution(s) and other collaborating Institution(s):

Tezpur University, Napaam, Tezpur 784028

4. Date of commencement: **15.07.2012**

5. Planned date of completion: **14.07.2015**

6. Actual date of completion: **31.12.2015**

7. Objectives as stated in the project proposal:

- a) To study the state-of-the-art compressed sensing based image reconstruction algorithms proposed in the literature.
- b) To implement the compressed sensing based image reconstruction algorithms in the MATLAB environment and assess their optimality.
- c) To develop new algorithms/ improving existing algorithms for sparse-image reconstruction.
- d) To design for optimal/proposed CS-based image reconstruction algorithms using the *hardware description language* (HDL) e.g. VHDL (Very High Speed Integrated Circuit-HDL) and implement the prototype hardware architecture using the Field-Programmable Gate Array (FPGA).

8. Deviation made from original objectives if any, while implementing the project and reasons thereof: Nil

9. Experimental work giving full details of experimental set up, methods adopted, data collected supported by necessary table, charts, diagrams & photographs:

Please see Annexure-I

10. Detailed analysis of results indicating contributions made towards increasing the state of knowledge in the subject:

Please see Annexure-I

11. Conclusions summarising the achievements and indication of scope for future work:

Please see Annexure-I

12. S&T benefits accrued:

i. List of Research publications:

(a) List of Research Papers Published and Communicated

Sl. No	Authors	Title of paper	Name of Journal	Volume	Pages	Year
1	B. Deka, and S. Datta	A Practical Under-Sampling Pattern for Compressed Sensing MRI	Advances in Communication and Computing, Lecture Notes in Electrical Engineering, Springer India	347	115-125	2015
2	B. Deka, and S. Datta	High Throughput MR Image Reconstruction Using Compressed Sensing	in Proceedings of the 2014 Indian Conference on Computer Vision Graphics and Image Processing	--	1-6	2014

(b) List of Research Papers already communicated/under preparation

Sl. No	Authors	Title of paper	Name of Journal	Volume	Pages	Year
1	S. Datta and B. Deka	An Efficient Interpolated Compressed Sensing Method for 2D Multi-slice MRI	IEEE Signal Processing Letters (Ref. No. SPL-19362-2016)	--	--	--
2	S. Datta and B. Deka	A Fast Interpolation Technique for Compressed Sensing Based Reconstruction of Multi-slice MRI	in SPCOM 2016, IISc Bangalore (EDAS No. #1570246740)	--	--	--
3	B. Deka and S. Datta	Recent Developments of Compressed Sensing based MR Image Reconstruction Algorithms- A Review	Magnetic Resonance Imaging, Elsevier	--	--	--

ii. Manpower trained on the project

a) Research Scientists or Research Associates: **Nil**

b) No. of Ph.D. produced: **02 (ongoing)**

c) Other Technical Personnel trained: M. Tech. : **04**
B. Tech.: **05**

iii. Patents taken, if any **Nil**

13. Financial Position:

No	Financial Position/ Budget Head	Funds Sanctioned	Expenditure	%Total cost
I	Salaries/ Manpower costs	Nil	Nil	Nil
II	Equipment	Rs. 10,62,000.00	Rs. 10,54,927.00	91.11
III	Supplies & Materials, Consumables	Rs. 50,000.00	Rs. 19,213.00	1.66
IV	Contingencies	Rs. 60,000.00	Rs. 20,457.00	1.76
V	Travel	Rs. 60,000.00	Rs. 6,496.00	0.56
VI	Overhead Expenses	Rs. 2,51,000.00	Rs. 56,648.00	4.90
VII	Others, if any	Nil	Nil	Nil
	Total	15,08,000.00	Rs. 11,57,741.00	100%

14. Procurement/ Usage of Equipment

a)

S No	Name of Equipment	Make/ Model	Cost (Rs)	Date of Installation	Utilisation Rate (%)	Remarks regarding maintenance/ breakdown
1	Altium nano board with Xilinx virtex-4 hardware boards	Altium NB2DSK01	8,15,065.00	26.08.2012	100	Nil
2	Xilinx ISE Design Suite	Xilinx/ System Edition 13.3 (25 users)	1,24,950.00	19.12.2012	100	Nil
3	Desktop PC	HP Compaq 8200 Elite SFF PC/HP	43,877.00	05.11.2012	100	Nil
4	Printer and Scanner	HP Laser Jet 500 color M551 Scanjet G2410/HP	55,585.00	25.09.2012	100	Nil
5	Camera	Nikon COOLPIX L810 71007364	15,450.00	03.09.2012	100	Nil

b) Plans for utilising the equipment facilities in future

- i) The equipment will be permanently shifted to a laboratory in the Dept. of ECE, Tezpur University.
- ii) The equipment will be fully utilized for research works in the area of image and signal processing by regular research scholars of the department.
- iii) It will be fully utilized by B. Tech./M. Tech. students for implementation of their final year projects

Name and Signature with Date

Dr. Bhabesh Deka

a. Bhabesh Deka 30.03.2016

(Principal Investigator)

b. Not applicable

(Co-Investigator)

Annexure-III

UTILISATION CERTIFICATE (2 COPIES)

[FOR THE FINANCIAL YEAR - 2012-2013] (ENDING 31ST MARCH)

1. Title of the Project/ Scheme : Design and Development of Compressed Sensing Based Image Reconstruction Prototype Hardware Architecture For Medical Imaging Applications
2. Name of the Institution : Tezpur University
3. Name of the Principal Investigator: Dr. Bhabesh Deka
4. Science & Engineering Research Board (SERB) SR/ FTP/ ETA-0112/ 2011 and
Sanction order No & date sanctioning the project: 24. 05. 2012
(First financial sanction order)
5. Head of account as given in the original sanction order:
Non-recurring (Capital items) : Pmt Equipment Rs. 10, 62, 000.00

Recurring (General items): Consumables Rs. 50, 000.00
Contingency Rs. 60, 000.00
Travel Rs. 60,000.00
Over Heads Rs. 2, 51,000.00 Rs. 4, 46,000.00
6. Amount brought forward from the previous Financial year quoting SERB letter no and date in which the authority to carry forward the said amount was given
i. Amount Nil
ii. Letter No
iii. Date
7. Amount received during the financial year (Please give SERB Sanction order no and date)
i. Amount : Rs. 12, 12,000.00
ii. Order No :SR/ FTP/ ETA-0112/ 2011
iii. Date :24.05.2012
8. Total amount that was available for expenditure (excluding commitments) during the financial year (Sr. No. 6+7) Rs. 12, 12,000.00
9. Actual Expenditure (excluding commitments) Incurred during the financial year (upto 31st March) Rs. 11, 36, 311.00
10. Balance amount available at the end of the financial year: Rs. 75, 689.00
11. Unspent balance refunded, if any (please give details of cheque no etc.): NA
12. Amount to be carried forward to the next financial year (if applicable): Rs. 75, 689.00

UTILISATION CERTIFICATE

Certified that out of Rs. 12.12 Lakh of grants-in-aid sanctioned during the year 2012 - 2013 in favour of Dr. Bhabesh Deka vide SERB order No. SR/FTP/ETA-0112/2011 dated 24.05.2012, a sum of Rs 11,36,311.00 (Rupees Eleven Lakh Thirty Six Thousand Three Hundred Eleven only) has been utilised for the purpose of implementation of the project for which it was sanctioned and that the balance of Rs 75,689.00 (Rupees Seventy Five Thousand Six Hundred Eighty Nine only) remaining unutilised at the end of the year 2012-2013 will be adjusted towards the grants-in-aid payable during the next year i.e. 2013-2014



Signature of PI

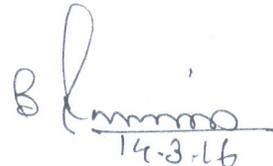
Date: 25-02-2016



Signature of Registrar/
Head of the Institute

Date:

Registrar
Tezpur University


14.3.16

Accounts Officer of the
Institute
Date: Finance Officer
Tezpur University

(Countersigned in SERB)

Signature: _____
Designation: _____
Date: _____

Annexure-III

UTILISATION CERTIFICATE (2 COPIES)

[FOR THE FINANCIAL YEAR - 2013-2014](ENDING 31ST MARCH)

1. Title of the Project/ Scheme Design and Development of Compressed Sensing Based Image Reconstruction Prototype Hardware Architecture For Medical Imaging Applications
2. Name of the Institution : Tezpur University
3. Name of the Principal Investigator: Dr. Bhabesh Deka
4. Science & Engineering Research Board (SERB) SR/ FTP/ ETA-0112/ 2011 and Sanction order No & date sanctioning the project: 24. 05. 2012
(First financial sanction order)
5. Head of account as given in the original sanction order:

Non-recurring (Capital items) : Pmt Equipment		Rs. 10, 62, 000.00
Recurring (General items):		
Consumables	Rs. 50, 000.00	
Contingency	Rs. 60, 000.00	
Travel	Rs. 60,000.00	
Over Heads	Rs. 2, 51,000.00	
		Rs. 4, 46,000.00
6. Amount brought forward from the previous Financial year quoting SERB letter no and date in which the authority to carry forward the said amount was given

	i. Amount : Nil
	ii. Letter No
	iii. Date
7. Amount received during the financial year (Please give SERB Sanction order no and date)

	i. Amount :
	ii. Order No :
	iii. Date :
8. Total amount that was available for expenditure (excluding commitments) during the financial year (Sr. No. 6+7) Rs. 75, 689.00
9. Actual Expenditure (excluding commitments) Incurred during the financial year (upto 31st March) Rs. 21, 430.00
10. Balance amount available at the end of the financial year: Rs. 54, 259.00
11. Unspent balance refunded, if any (please give details of cheque no etc.): Nil
12. Amount to be carried forward to the next financial year (if applicable):Rs. 54, 259.00

UTILISATION CERTIFICATE

Certified that out of Rs. 12.12 Lakh of grants-in-aid sanctioned during the year 2012 - 2013 in favour of Dr. Bhabesh Deka vide SERB order No. SR/FTP/ETA-0112/2011 dated 24.05.2012, a sum of Rs 11, 57, 741.00 (Rupees Eleven Lakh Fifty Seven Thousand Seven Hundred Forty One only) has been utilised for the purpose of implementation of the project for which it was sanctioned and that the balance of Rs 54, 259.00 (Rupees Fifty Four Thousand Two Hundred Fifty Nine only) remaining unutilised at the end of the year 2013-2014 will be adjusted towards the grants-in-aid payable during the next year i.e. 2014-2015



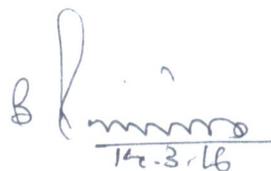
Signature of PI

Date: 25-02-2016



Signature of Registrar/
Head of the Institute

Date: Registrar
Tezpur University


14-3-16

Accounts Officer of the
Institute
Date: Finance Officer
Tezpur University

(Countersigned in SERB)

Signature: _____
Designation: _____
Date: _____

Annexure-III

UTILISATION CERTIFICATE (2 COPIES)

[FOR THE FINANCIAL YEAR -2014-2015] (ENDING 31ST MARCH)

1. Title of the Project/ Scheme: Design Development of Compressed Sensing Based Image Reconstruction Prototype Hardware Architecture for Medical Imaging Applications
2. Name of the Institution: Tezpur University
3. Name of the Principal Investigator: Dr. Bhabesh Deka
4. Science & Engineering Research Board (SERB)
Sanction order No & date sanctioning the project: SR/ FTP/ ETA-0112/ 2011
(First financial sanction order) and 24.05.2012
5. Head of account as given in the original sanction order:

Non-recurring (Capital items) : Pmt Equipment		Rs. 10, 62, 000.00
Recurring (General items): Consumables	Rs. 50, 000.00	
Contingency	Rs. 60, 000.00	
Travel	Rs. 60,000.00	
Over Heads	Rs. 2, 51,000.00	
		Rs. 4, 46,000.00
6. Amount brought forward from the previous Financial year quoting SERB letter no and date in which the authority to carry forward the said amount was given

	i. Amount : Nil	
	ii. Letter No	
	iii. Date	
7. Amount received during the financial year (Please give SERB Sanction order no and date)

	i. Amount : Nil	
	ii. Order No :	
	iii. Date :	
8. Total amount that was available for expenditure (excluding commitments) during the financial year (Sr. No. 6+7) Rs. 54, 259.00
9. Actual Expenditure (excluding commitments) Incurred during the financial year (up to 31st March) Rs. Nil
10. Balance amount available at the end of the financial year: Rs. 54, 259.00
11. Unspent balance refunded, if any (please give details of cheque no etc.): Nil
12. Amount to be carried forward to the next financial year (if applicable):Rs. 54, 259.00

UTILISATION CERTIFICATE

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Bhabesh Deka

Signature of PI

Date: 25.02.2016

B

Signature of Registrar/
Head of the Institute

Date: Registrar

Tezpur University

B. L...
14.3.16

Accounts Officer of the
Institute

Date: Finance Officer
Tezpur University

(Countersigned in SERB)

Signature: _____
Designation: _____
Date: _____

Annexure-III

UTILISATION CERTIFICATE (2 COPIES)

[FOR THE FINANCIAL YEAR -2015-2016] (ENDING 31ST MARCH)

1. Title of the Project/ Scheme: Design Development of Compressed Sensing Based Image Reconstruction Prototype Hardware Architecture for Medical Imaging Applications
2. Name of the Institution: Tezpur University
3. Name of the Principal Investigator: Dr. Bhabesh Deka
4. Science & Engineering Research Board (SERB)
Sanction order No & date sanctioning the project: SR/ FTP/ ETA-0112/ 2011
(First financial sanction order) and 24. 05. 2012
5. Head of account as given in the original sanction order:

Non-recurring (Capital items) : Pmt Equipment		Rs. 10, 62, 000.00
Recurring (General items): Consumables	Rs. 50, 000.00	
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		Rs. 4, 46,000.00
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	i. Amount : Nil	
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	iii. Date	
7. Amount received during the financial year (Please give SERB Sanction order no and date)

	i. Amount : Nil	
	ii. Order No :	
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8. Total amount that was available for expenditure (excluding commitments) during the financial year (Sr. No. 6+7) Rs. 54, 259.00
9. Actual Expenditure (excluding commitments) Incurred during the financial year (up to 31st March) Rs. Nil
10. Balance amount available at the end of the financial year: Rs. 54, 259.00
11. Unspent balance refunded, if any (please give details of cheque no etc.): Rs.54, 259.00
12. Amount to be carried forward to the next financial year (if applicable): Nil

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Bhabesh Deka

Signature of PI

Date: 25.02.2016

B

Signature of Registrar/
Head of the Institute

Date: Registrar

Tezpur University

B. K. ...
14.3.16

Accounts Officer of the
Institute

Date: Finance Officer

Tezpur University

(Countersigned in SERB)

Signature: _____

Designation: _____

Date: _____

FINAL STATEMENT OF EXPENDITURE (Two copies)

1. **SERB sanction Order No and date:** SR/FTR/ETA-0112/2011 and 24.05.2012
(First Sanction Order)
2. **Project Title** : Design and Development of Compressed Sensing Based Image Reconstruction Prototype Hardware Architecture for Medical Imaging Applications
3. **PI Name & Address** : Dr. Bhabesh Deka, Associate Professor, Dept. of ECE, Tezpur University,
Napaam, Tezpur784028
4. **Total Sanctioned Project Cost** : 15,08,000/-
5. **Revised Project Cost** : NA
(if applicable)
6. **Date of Commencement/start of the project:** 15.06.2012
7. **Date of Completion** : 31.12.2015
8. **Grant received in each year:**
 - a. **1st Financial Year** : 12,12,000/-
 - b. **2nd Financial Year** : Nil
 - c. **3rd Financial Year** : Nil
 - d. **4th Financial Year** : Nil
 - e. **Interest accrued, if any** : Nil
 - f. **Total (a+b+c+d+e)** : 12,12,000/-

Final Statement of Expenditure

(to be submitted financial yearwise ie. DOS* to 31st March of that financial year say 20XX, 01-04-20XX till 31.03.20XX+1 year and so on)
15.06.2012-31.03.2013 + 01.04.2013-31.03.2014+ 01.04.2014-31.03.2015+01.04.2015-31.12.2015

Sr No (I)	Sanctioned Heads (II)	Funds Allocated (indicate sanctioned or revised) (III-A)	Funds Received (III-B)	Expenditure Incurred				Total (VIII=IV+V+VI+VII)	Balance, if any (III-B)-(VIII)	Remarks
				1 st Year (15 th Jun 2012 to 31 st March 2013) (IV)	2 nd Year (1 st April 2013 to 31 st March 2014) (V)	3 rd Year (1 st April 2014 to 31 st March 2015) (VI)	4 th Year (1 st April 2015 to 31 st December 2015) (VII)			
1.	Manpower	Nil	Nil	Nil	Nil	Nil	Nil	Nil	NA	
2.	Equipment	₹ 10,62,000.00	₹ 10,62,000.00	₹ 10,54,927.00	Nil	Nil	Nil	₹ 10,54,927.00	₹ 7,073.00	
3.	Travel	₹ 60,000.00	₹ 1,50,000.00	₹ 6,496.00	Nil	Nil	Nil	₹ 6,496.00	₹ 47,186.00	
4.	Contingencies	₹ 60,000.00		₹ 13,357.00	₹ 7,100.00	Nil	Nil	₹ 20,457.00		
5.	Consumables	₹ 50,000.00		₹ 4,883.00	₹ 14,330.00	Nil	Nil	₹ 19,213.00		
6.	Overhead expenses	₹ 2,51,000.00		₹ 56,648.00	Nil	Nil	Nil	₹ 56,648.00		
7.	Others, if any	Nil	Nil	Nil	Nil	Nil	Nil	Nil	NA	
8.	Total	₹ 15,08,000.00	₹ 12,12,000.00	₹ 11,36,311.00	₹ 21,430.00	Nil	Nil	₹ 11,57,741.00	₹ 54,259.00	

Amount to be refunded (whichever is appropriate): ₹ 54,259.00 (Rupees Fifty Four Thousand Two Hundred Fifty Nine) only.

Dr. Bhabesh Deka
Bhabesh Deka

Name and Signature of Principal Investigator:

Date: 25.02.2016

Bhabesh Deka
Signature of Competent financial/audit authority:
(with seal) _____
Tezpur University
Date: 14.3.16

* DOS: Date of Start of Project