NPRP

Progress Report Number 6

Project Number

NPRP 4 - 1303 - 2 – 517

Project Title

Automated Neonatal EEG quality assessment and improvement using artefact filtering and signal segmentation

Date: November 2016

Authors: B. Boashash[1,2,3] and Paul Colditz[2,3]

Sponsor:

Qatar National Research Fund

[1] College of Engineering, Qatar University, Qatar
[2] The University of Queensland, Perinatal Research Centre, School of Medicine, Brisbane, Australia
3 The University of Queensland, UQ Centre for Clinical Research, Brisbane, Australia

Print This Page

Progress Report View

Report Information

Proposal Number:	NPRP 4 - 1303 - 2 - 517	**Awarded Amount:**	$1,049,943.69	**Sub. Institution:**	Qatar University
Lead Investigator:	Prof. Boualem Boashash	**Lead Institution:**			
Project Status:	Award Active	**Start Date:**	01-Apr-2012	**End Date:**	15-Sep-2016
Current Year:	Year 3 of 3	**Report Type:**	Final Interim		
Report Period:	6	**Report Status:**	QNRF Accepted	**Version Number:**	2
Due Date:	15-Sep-2016	**Submitted Date:**	16-Nov-2016	**Vetted Date:**	16-Nov-

2016

Proposal Title: Automated Neonatal EEG quality assessment and improvement using artefact filtering and signal segmentation

Research Progress

Aim 3: Design of Algorithms for EEG artefact detection

Start Month: 1 **End Month:** 36 **Completed?** Yes **Completed Percentage:** 100%

Tasks associated with this aim for this period as per the original proposal:

1. Develop an automated method to detect the presence of artefacts in the segments of neonatal EEG. 2. Extract the best features for EEG artefact detection.

Have you experienced any difficulties?: No

Progress made, accomplishments achieved, and plans to tackle the difficulties listed above (if any):

We have developed a multi-class classification scheme to identify and remove artefactual EEG segments. In this approach, a high performance TFD is used to extract TF features that include (1) signal related features, (2) statistical features and (3) image features. The compact kernel distribution (CKD) is used in this application as it provides superior resolution and accuracy. The extracted features are fused in the feature level and then an optimal subset is selected by a wrapper approach

combined with a sequential floating forward (or feature) selection (SFFS). Multi-class SVM strategies (1 vs 1 and 1 vs all) are then used to detect artefacts. The method is validated on a large database containing more than 7200 EEG segments with classes of normal background, seizure and artefacts; the results show a superior performance in terms of sensitivity which is important for correct diagnosis from a clinical perspective. A paper has been published in the journal of Knowledge-Based Systems (Elsevier, IF: 3.325; see the supporting document "Boashash_Ouelha_Automatic_signal_abnormality_detection.pdf").

Supporting Documents

- Boashash_Ouelha_Automatic_signal_abnormality_detection.pdf

Aim 4: Artefact Removal from Neonatal EEG

Start Month: 1 **End Month:** 36 **Completed?** Yes **Completed Percentage:** 100%

Tasks associated with this aim for this period as per the original proposal:

1. Artefact removal with a reference signal. 2. Artefact removal without a reference signal. 3. Artefact elimination by estimating EEG characteristics.

Have you experienced any difficulties?: No

Progress made, accomplishments achieved, and plans to tackle the difficulties listed above (if

any):

We have developed a blind source separation (BSS) algorithm for multi-channel signals. This algorithm is based on three key points: (1) use of high-resolution TFDs like the compact kernel distribution (CKD) or multi-directional distribution (MDD), (2) a robust thresholding step based on a statistical test and (3) Instantaneous Frequency (IF) estimation algorithm using image processing techniques. These steps improve the mixing matrix estimation. For the source separation problem we have used the CAPON algorithm to improve the performance of the blind source separation process. The overall algorithm has been tested on simulated EEG signals (modelled using LFM signals) and results show an improvement of 10 dB in terms of normalized mean square error (NMSE) for blind source separation. A paper presenting this algorithm has been submitted to IEEE Transaction on Signal Processing (see supporting document "Ouelha_AissaElBey_Boashash_Improving_DOA_Est_using_HRTFDs.pdf"). We are also finalizing tests for artefact removal without discarding all the segments; more specifically, after the separation of artefact segments we identify the artefactual components within the segments using a correlation measure. Then, a clean EEG segment can be generated by suitably combining only artefact-free EEG segments. We are now finalizing an artefact correction method based on blind source separation algorithms where the IF of EEG signals is used to separate clean EEG segments by fractional Fourier Transform and bandpass filters. A high resolution TFD is proposed to extract the critical IF information as it is capable of identifying close signal components which frequently appear in newborn EEG and separating cross-components in the signals. This algorithm has been applied to remove simulated respiratory artefacts from simulated EEG seizure signals successfully (see supporting document "Boashash_Ouelha_Algorithm_for_IF_Est_of_PFM_signals_Draft.pdf").

Supporting Documents

- Ouelha_AissaElBey_Boashash_Improving_DOA_Est_using_HRTFDs.pdf
- Boashash_Ouelha_Algorithm_for_IF_Est_of_PFM_signals_Draft.pdf

Aim 5: Development of an EEG quality measure

Start Month: 24 **End Month:** 36 **Completed?** Yes **Completed Percentage:** 100%

Tasks associated with this aim for this period as per the original proposal:

1. Develop a statistic that incorporates the results of the artefact detection and removal processes to determine the overall quality of the EEG recording. 2. Design of several architectures for combining the developed quality measure with the artefact detection and removal systems into fully implemented system for dealing with artefacts.

Have you experienced any difficulties?: No

Progress made, accomplishments achieved, and plans to tackle the difficulties listed above (if any):

1) An EEG quality measure is defined by reconstructing an artefact-free signal using only artefact-free EEG segments and then comparing with the original artefactual EEG signal (details to appear in the final report). 2) An alternative EEG classification method is developed which is capable of discriminating among normal background, seizure, burst, suppression and artefact states. This method uses an innovative Hybrid Feature Selection (HFS) algorithm and it provides a posterior probability measure which is an estimate of the ratio of EEG background to artefacts. This measure results in an EEG quality score that is based on the number of detected artefacts and the level of certainty in the EEG state classification (see supported document "Awal_Sherry_Colditz_Boashash_DesignOptimitation_of_MultiChannel_classification"). In addition, a

reconstruction algorithm based on a novel implementation of the inverse STFT has been developed and submitted for publication to the Elsevier journal Digital Signal Processing (see supporting document "Ouelha_Touati_Boashash_DSP").

Supporting Documents

- Awal_Sherry_Colditz_Boashash_DesignOptimitation_of_MultiChannel_classification.pdf.pdf
- Ouelha_Touati_Boashash_DSP.pdf

Aim 6: Design of Advanced Methods and Algorithms for Time-Frequency Signal and Array Processing.

Start Month: 12 **End Month:** 36 **Completed?** Yes **Completed Percentage:** 100%

Tasks associated with this aim for this period as per the original proposal:

Test and further refine the algorithms already developed.

Have you experienced any difficulties?: No

Progress made, accomplishments achieved, and plans to tackle the difficulties listed above (if any):

We have defined a new TFD kernel (MDD) based on directional information to represent newborn

EEG signals accurately and effectively. The method defines exact locations of auto-terms and cross-terms using a piece-wise LFM signal model; and a set of directional kernels with an adjustable angle suppresses the cross-terms while preserving the auto-terms. The kernel parameters and angles are estimated using the Radon transform (RT) of the squared modulus of the ambiguity function. Results on simulated signals show that the MDD outperforms state-of-the-art TFDs by 8% and also empirically. Results on real EEG signals validate the improved performance as the artefactual cross-terms have been attenuated while maintaining a good resolution unlike other popular methods which fail to separate the different components of the signals. This work has been submitted to IEEE Transaction on Signal Processing (see supporting document “Boashash_Ouelha_Improved…”) and another theoretical paper is being prepared for submission (see supporting document "Boashash_Jawad..."). We also proposed a method that can optimize Quadratic Time-Frequency Distributions (QTFDs) automatically. This “black box” approach adjusts the parameters automatically by using a hybrid genetic algorithm (HGA). The optimization problem is formulated as the minimization of the cost function of a modified energy concentration measure. The results show the efficiency of the developed method. (see supporting document “Awal_Boashash_Automatic…”). In addition, the TFSAP 7.0 toolbox is released on http://booksite.elsevier.com/9780123984999/toolbox.php, including the proposed MDD method. This toolbox contains all state-of-the-art QTFDs. It contains efficient codes written in C-programming language and used with Matlab GUI. A paper describing the code of this toolbox is being prepared for submission to a software journal (see Appendix 5).

Supporting Documents

- Boashash_Ouelha_Improved_Design_of_HRQTFDs.pdf
- Awal_Boashash_Automatic_fast_optimization_of_QTFDs_using_HGA.pdf
- Boashash_Jawad_Auto-and-Cross-terms-PWLFM-signal.pdf

Aim 7: Efficiently Lead and manage the project, and supervise the research to ensure outcomes, and organize

Start Month: 1 **End Month:** 36 **Completed?** Yes **Completed Percentage:** 100%

Tasks associated with this aim for this period as per the original proposal:

(1) Provide guidance for the research team; (2) ensure quality administrative and financial management of the project; (3) develop a spirit of co-operation between the partners; (4) ensure consensus management and information circulation among the partners; (5) co-ordinate and control project activities to keep it within the objectives.

Have you experienced any difficulties?: Yes

A previously employed postdoc, Dr. Nabeel Khan, left the QU team last year without any prior notice. He went on holiday and did not return. This problem caused a delay; in addition, he committed a breach of professional ethics as he produced unauthorized publications that have slightly damaged the project. More specifically, Dr Nabeel Khan published project results without the knowledge of the PI employing him and without prior authorization. One of the publications of concern is included as supporting material (see attachment Khan_Ali_Classification_EEG_Signals_using_ADTFDs). The attachment shows clearly that the grant is acknowledged, but the authorship and affiliations are deliberately false, given that this was original work clearly initiated and conducted under the direct supervision of the Lead PI, while the 2 coauthors were employed under the grant.

Progress made, accomplishments achieved, and plans to tackle the difficulties listed above (if any):

The LPI has been effectively managing the research activities of the projects at both sites (Qatar University and University of Queensland). The joint efforts have resulted in two publications: “Automatic signal abnormality detection using time-frequency features and machine learning: A

newborn EEG seizure case study" in the journal "Knowledge Based Systems" and "An automatic fast optimization of Quadratic Time-frequency Distribution using the hybrid genetic algorithm" in the journal "Signal Processing" as well as several papers in preparation. Despite the difficulty, the LPI and team have managed to achieve good outcomes as planned in the research proposal. Given the progress that has been made, we are confident the project has been completed successfully. The issues related to the ethical breach and unauthorized publications by Dr. Nabeel Khan are being addressed step by step following advice received from the relevant officers at Qatar University, including the director of OAR and the Associate Dean for Research. More details will appear in the final report, which is the current focus of the team (see current draft in Appendix).

Supporting Documents

- Khan_Ali_Classification_EEG_Signals_Using_ATFDs.pdf

Future Plan

Aim 3: Design of Algorithms for EEG artefact detection

Start Month
1

End Month
36

Tasks associated with this aim for the next reporting period
The published results are being extended with the addition of more features. In addition, the comparison between time-scale and time-frequency features is being finalized. We are now finalizing a paper where we have (1) highlighted the relationships between time-frequency and time-scale methods, (2) compared features extracted from both type of representations and (3) developed all the algorithms in a clear way to make this research reproducible. We aim to submit this study to the Elsevier DSP Special issue by the end of the year (see current draft attached in Appendix 1).

Aim 4: Artefact Removal from Neonatal EEG

Start Month
1

End Month
36

Tasks associated with this aim for the next reporting period
For the final report, we are testing the developed algorithms using two different approaches: (1) using real EEG signals and simulated artefacts. To do this, an artefact model has been developed and it is under validation. The idea is to test the algorithm on different signals and see if it is able to remove artefacts without affecting the EEG signal. (2) Add the algorithm in the classification system to verify that the overall classification performance is improved. Current work to achieve the aim includes implementing an IF estimation algorithm for crossing multi-component signals which also appear in newborn EEG. This is useful in forming a comprehensive reference signal set and consequently separating artefacts more accurately. Our testing of the new methods progressed from using simulated signals to using real EEG signals, and calibration of the methods is done based on the testing. We aim to submit this study for publication by the end of the year (see current draft in Appendix 2). See also the draft of the final report. Ongoing work to achieve the aim includes implementing an IF estimation algorithm for crossing multi-component signals which also appear in newborn EEG. This is useful in forming a comprehensive reference signal set and consequently separating artefacts more accurately. Our testing of the new methods also progresses from using simulated signals to using real EEG signals, and calibration of the methods may be required dependent on the testing.

Aim 5: Development of an EEG quality measure
Start Month
24

End Month
36

Tasks associated with this aim for the next reporting period
These developed measures are currently being tested as part of the final report for their effectiveness using EEG signals corrupted by simulated artefacts. In the current study, the measures are incorporated into the proposed artefact removal methods to quantify the quality of newborn EEG in respect to artefacts. This study is planned to be submitted for publication by the end of the year (see draft in Appendix 3).

Aim 6: Design of Advanced Methods and Algorithms for Time-Frequency Signal and Array Processing.
Start Month
12

End Month
36

Tasks associated with this aim for the next reporting period
We have done all the work we planned to do. We now plan to publish our findings as soon as possible, including any refinements necessary for the journal requirements (See draft final report for details).

Aim 7: Efficiently Lead and manage the project, and supervise the research to ensure outcomes, and organize
Start Month
1

End Month
36

Tasks associated with this aim for the next reporting period
The lead PI will continue the effective management and supervision of the project until the final report and publications are submitted and published. In addition, the breach of publication ethics by Dr Nabeel Khan will be taken to its just completion.

Collaborator Contributions

#	Team Member	Role	Contributions
1	Prof. Boualem Boashash	Lead PI/ Co-Lead PI	My contribution includes (1) technical contributions in all the different aims of the project and (2) management of all the aspects of the project including coordination between the Qatar site and the Australian site. In terms of technical contribution, I have assessed the suitability of the databases provided by The University of Queensland, and suggested the necessary improvements. I have also contributed to guide the development of the various signal processing and machine learning algorithms that we have implemented for EEG classification. I have finally defined a new EEG quality measure. In terms of management, I have ensured, through proper coordination, that all the original Aims and Objectives have been completed 100% and I am currently focused in ensuring that the final technical report is finalized at a high standard, reflecting the achievements obtained in this project, as demonstrated by the publications in preparation..
2	Prof. Paul Colditz	PI	My contribution in this 6-month period includes assisting in EEG data interpretation associated with Aims 4&5 and providing guidance/suggestion/review in developing the artefact removal methods and EEG quality measure from scientific and clinical perspectives. The time effort

			time RA was transferred to a 1-day/week appointment and a replacement is not available yet. I also prepared and reviewed a number of paper manuscripts and reports during this period. Other activities comprise assisting with the team and budgetary management at the University of Queensland, PhD student supervision and liaison with the lead PI at QU to ensure the efficient delivery of the collaboration and timely and satisfactory research outcomes for the project.
3	Prof. Geraldine Boylan	PI	na

Research Training

Have you recruited any Research Team Member or Unnamed Consultant? Yes

Remarks:

#	Unnamed Role	Participant Name	Email	Affiliation	Location	Gender	Contribution
1	Research Assistant-1	Ms. Ayat Nazar	Ayat.salim@qu.edu.qa	Qatar University	Inside	Female	Editing and assisting in literature search; preparing and checking algorithms.
2	Post Doctoral	Dr. Shivi...	...@...edu....	The...	Outside	Male	Design and...

	Fellow-1	Dong		University of Queensland			improvement of a new time-frequency distribution optimization method (Aim 6); also provides assistance in preparing project reports and help to PhD students.
3	Post Doctoral Fellow-1	Dr. Samir Ouelha	samir_ouelha@hotmail.fr	Qatar University	Inside	Male	Creation of new algorithms for artefacts detection in newborn EEG signal and comparison with the state-of-the-art. Prepare reports and publications.
4	Consultant-1	Dr. Abdeldjalil Aissa El Bey	abdeldjalil.aissaelbey@qu.edu.qa	Qatar University	Inside	Male	He has reviewed several reports, checked algorithms and

							refined them were needed.
5	Consultant-1	Sami Touati	dstouati@gmail.com		Outside		He has reviewed several reports and commented on them, verifying proofs and extending them when they were incomplete. He is coauthor of a submission in progress.
6	Research Assistant-2	Mr. Md Abdul Awal	m.awal@uq.edu.au	The University of Queensland	Outside	Male	Implemented an automatic optimization for QTFDs ; prepared a new EEG database consisting of five datasets; designed an HFS algorithm and selected class-specific features to improve the EEG

							accuracy; proposed an EEG-based decision support system and quality measure.
7	Research Associate-3	Mr. Timothy Sherry	t.sherry@uq.edu.au	The University of Queensland	Outside	Male	He worked on the Automated EEG to produce parts of the feature set, and assisted in developing the hybrid algorithm. He produced a set of data management and collation scripts for collecting and operating on the full dataset. Finally he worked on the EEG Quality measure, using the output of the Automated classification system.

Research Outcomes

Has your research project generated publications during the funding period covered by this progress report (excluding 'accepted', 'forthcoming' and 'submitted' papers)? Yes

Publication Type	Title	Authors	Reference No	Abstract	Document
Journal Paper	An automatic fast optimization of Quadratic Time-frequency Distribution using the hybrid genetic algorithm	Prof. Boualem Boashash	ISSN:01651684	This paper presents a novel framework for a fully ... more	File

Potential IP

1. Has your research resulted in a new process, technique, composition of matter, device, software, database, new use or improvement to an existing process?

Answer

Yes

Comments

Our research has resulted in a significant improvement in the detection and classification of abnormalities in newborn EEG signals. The proposed automatic classification system is sufficiently accurate to be implemented and provide a significant improvement in efficiency for clinicians. Given the results obtained, this system can be installed in Neonatal Intensive Care Units (NCIUs), where it will enable clinicians to make accurate and quick diagnosis of abnormalities, aid in the choice of effective treatments and assist with prognostication of outcome .

2. Have you previously disclosed your research results through a presentation or publication? Do you intend to disclose your research results in the next 6 months in the absence of an NDA, for example, through a conference presentation or journal publication? Please provide details

Answer

Yes

Comments

Some elements of our research have been published in well-established journals. We have not presented our work in conferences. The final and key sections of our work have not been published. . A decision on protection of IP versus publication will be made after completing the final report.

3. Have you previously filed an invention disclosure within the scope of this research grant?
Answer
No

Comments
N/A

4. Do you intend to file any invention disclosures within the scope of this research project?
Answer
Yes

Comments
Within the scope of this research, we intend to do the necessary work to file an invention disclosure to detect abnormalities in newborn EEG signals. Whilst we have published some results in journals (and some have been published in unauthorized publications that have recently come to the PI's attention), we have not revealed key details about the hardware and tips for real-time implementation which is mandatory for a real system. We plan to propose to add an "automatic classification of abnormalities" stage to help clinicians in NCIUs. The intention is not to add another screen to the current patient monitor of but use current interfaces to provide the information of the developed system and alert the clinician as soon as possible in case of abnormality detection. Thus the clinician will be familiar with the Graphical User Interface (GUI) as the aim is to give more information without changing the current interface used in current NICU systems.

5. Has a patent application been filed under the research project? If yes, when, where, and by whom was the application filed?
Answer
N/A

Comments
N/A

6. What is the stage of development (pre-prototype, prototype tested, untested prototype)? How much more technical development is required in terms of time and investment needed to achieve? Please indicate the Technology Readiness Level, see here
Answer
N/A

Comments
The stage of development is pre-prototype. The technical development that is required in terms of time and investment needed to achieve a tested prototype includes the salaries of one qualified postdoc, 1 RA qualified in digital signal processing and embedded systems, and 1 consultant. It is anticipated that the whole work to build a prototype would last between 6 months and one year. c) The Technology Readiness Level is TRL1. c) The Technology Readiness Level is TRL1.

7. To whom do you need to report project IP? What is your understanding of the ownership of the IP?
Answer
N/A

Comments
I need to report the project IP to the Office of Academic Research at QU.

8. Have any individuals/consultants participated in the research project? If yes, please specify details of the individual (period of collaboration, institution). Was this arranged formally through the relevant Technology Transfer Office?
Answer
Yes

Comments
Yes. Prof Abdeldjalil Aissa El Bey, Telecom Bretagne (France) participated in the research project from 21-31 May 2016 and Dr Sami Touati participated in the research project 24 December 2015 to 23 January 2016. Both were arranged formally through the relevant Technology Transfer Office.

9. Do you believe your project would benefit from an assessment of the technology asset portfolio developed and the potential market opportunity?
Answer
Yes

Comments
This project has good potential market opportunity because abnormalities in the newborn EEG are commonly sought as they carry important prognostic information on morbidity (brain injury) and mortality in the newborn. The system will enable the clinician to detect abnormality early, accurately and with minimal training and provide opportunity for optimal treatment and treatment guidance for the newborn. It will reduce the workload of the clinician because visual interpretation and classification of EEG signal is very time-consuming without an interpretation and classification system. The system will enable even relatively inexperienced clinicians to accurately diagnose EEG signal abnormalities. There is no established system for this purpose currently available and hence all hospitals with NCIUs throughout the world are potential customers.

Equipment

Equipment Name	Quantity	Serial Number	Location	Purpose	

No records available

Travel

From Origin to Destination(s)	Start Date	End Date	Traveler(s) Name(s)	Purpose	
From Qatar to Brisbane, Australia	23-Jan-2016 12:00 AM	15-Feb-2016 12:00 AM	Boualem Boashash	The main purpose at that point was to design and implement a plan of how to terminate the project successfully. This required face to face discussions as there were several requirements in terms of interpreting some results from a medical point of view and deciding a final strategy about whether to design new experiments for artefact detection and removal, or use the current data set. Other decisions were required about publications.	
From Qatar to Brisbane, Austraila	17-Jul-2016 12:00 AM	23-Jul-2016 12:00 AM	Boualem Boashash	The purpose of this last travel in this project was to discuss the technical issues related to the Aim of EEG quality and propose various solutions. In addition, a strategy for publications was discussed and agreed.	

Appendices

Document Name	Document File	Uploaded By	Uploaded On	
Appendix 1	TFTS_DSP_special_issue_Merged_Version_26_09_2016-Draft.pdf	Mr. Anhi Hong	10-Nov-2016 12:45 PM	
Appendix 2	IF_estimation_Image_processing-report.pdf	Mr. Anhi Hong	10-Nov-2016 12:45 PM	

Document Name	Document File	Uploaded By	Uploaded On	
Appendix 3	Classification_For_EEG_quality_measure-report.pdf	Mr. Anhi Hong	10-Nov-2016 12:45 PM	
Appendix 4: Final report draft	Draft_finalReport.pdf	Mr. Anhi Hong	10-Nov-2016 12:45 PM	
Appendix 5	software-X_Special_Issue_Draft.pdf	Mr. Anhi Hong	10-Nov-2016 12:45 PM	

Expenditure Report

Inside Effort Days	Outside Effort Days	Equipment Cost	Personnel Cost	Travel Cost	Miscellaneous Cost	Indirect Cost	Outside Cost %	Remarks
484	224	$0.00	$147,763.00	$0.00	$0.00	$29,539.00	0	QU expenses for year 3+ extension

Report Status History

Date	Version	Status	Action By	Remarks
09-Oct-2016	1	Submitted	Prof. Boualem Boashash	Submitted by Lead
18-Oct-2016	1	RO Vetted	Mrs. Abeer Raie	Vetted by RO
10-Nov-2016	1	QNRF Returned	Mr. Anhi Hong	Comments to the LPI, QNRF appreciates your input on the following points: 1) There are two trips for Prof. Boualem Boashash

				within five months to Brisbane, Australia. The second trip (17 -23 July 2016) was only two months before the project end date (15 Sep-2016). Within a week from July's trip, a third travel trip to Brisbane, Australia (1-28 August 2016) for the same PI (Prof. Boashash) has been reported in another QNRF grant (NPRP 6-885-2-364). The LPI is required to clarify this travel issue to QNRF. To minimize travel costs, the LPI is always advised to discuss/interact with the project collaborators using modern web-based communications tools. 2) QNRF sees the personnel cost reported in this interim could be overestimated. The LPI and the RO are advised to look on the personnel expenditure (rates and efforts), revise it and resubmit. 3) As per QNRF records, Dr. Abdeldjalil Aissa El Bey is a Post Doc with QU. Can you please clarify his involvement with the project (consultant or a Post Doc)?
16-Nov-2016	2	Submitted	Prof. Boualem Boashash	Submitted by Lead
16-Nov-2016	2	RO Vetted	Mrs. Abeer Raie	Vetted by RO
22-Nov-2016	2	QNRF Accepted	Ms. Buthaina Al Hashmi	QNRF Accepted by QNRF