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| Faculty of Engineering & Technology | | | | | | | | | |
| Ramaiah University of Applied Sciences | | | | | | | | | |
| Department | Electronic and Communication Engineering | | | | | | | | |
| Programme | M.Tech in Machine Learning and Intelligent Systems | | | | | | | | |
| Batch | Full-Time  Part-Time  2018 | | Module Start Date | | 26-01-2019 | | | | |
| Module Code | | SIP507 | | | | | | | |
| Module Title | | **Statistical Detection and Estimation** | | Laboratory | | Y |  | N |  |
| Module Leader(s) | | Dr. Pallaviram Sure | | | | | | | |

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| Module Assessment | | | |
| Reg.No. |  | Name of the Student |  |

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| Component -1:(Assignment, Presentation on assignment submitted and Laboratory Test) (1.A+1.B+1.C) | | | | | | | | | |
| 1.AAssignment (100 Marks) | | | | | | | | | |
| Sections | Marking Scheme | | | | Marks | | | | |
| Max Marks | | First Examiner Marks | Part Total | SecondExaminer Marks |
| Part-A | 1.1 | Signal detection problem | | | 7 | |  |  |  |
| 1.2 | Statistical and machine learning based solution approaches | | | 8 | |  |
| 1.3 | Performance evaluation and comparison | | | 8 | |  |
| 1.4 | Justification of the stance and conclusion | | | 7 | |  |
|  | Part-A Max Marks | | | 30 | |  |
| Part-B | 2.1 | Formulation of model equations at the fusion center | | | 5 | |  |  |  |
| 2.2 | Development of non-linear ML equations | | | 10 | |  |
| 2.3 | Development of an algorithm | | | 7 | |  |
| 2.4 | Comments on the performance of ML algorithm | | | 8 | |  |
|  | Part-B Max Marks | | | 30 | |  |
| Part-C | 3.1 | Formulation of HTP for the anomaly detection | | | 8 | |  |  |  |
| 3.2 | Development of LRT | | | 10 | |  |
| 3.3 | Simulations and Results | | | 10 | |  |
| 3.4 | Analysis of obtained hypothesis results | | | 7 | |  |
| -- | References and citation of references | | | 3 | |  |
| -- | Benefits you have derived by solving this assignment. Whether the assignment was able to assess module learning outcomes or not? | | | 2 | |  |
|  | Part-C Max Marks | | | 40 | |  |
| **Total Assignment Marks** | | | | | 100 | |  |  |  |
| **If the module has Laboratory element, 30% weight of Total Assignment Marks**  (i.e. **1.AMarks** = Total Assignment Marks X 0.3) | | | | | | | |  |  |
| **If the module does not have Laboratory element, 40% weight of Total Assignment Marks**  (i.e. **1.AMarks** = Total Assignment Marks X 0.4) | | | | | | | |  |  |
| 1.B Presentation on assignment submitted (20 Marks) | | | | | | | | | |
| Attribute | | | Max Marks | First Examiner Marks | | Second Examiner Marks | | | |
| Technical Content | | | 05 |  | |  | | | |
| Grasp and Explanation | | | 05 |  | |  | | | |
| Quality of Slides and Delivery | | | 05 |  | |  | | | |
| Q & A | | | 05 |  | |  | | | |
|  | Total | | 20 |  | |  | | | |
| (20 marks reduced to 10 Marks) Total 1.b Marks | | | |  | |  | | | |

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| 1.C Laboratory Exam / Tool Test(20 Marks)  IMPORTANT: If a module does not have laboratory content, 1.c should be shown as ‘0 Marks’ | | | | |
| Attribute | | Max Marks | First Examiner Marks | Second Examiner Marks |
| Laboratory Examination / Tool Test | | 15 |  |  |
| Viva Voce | | 05 |  |  |
|  | Total | 20 |  |  |
| (20 marks reduced to 10 Marks) Total 1.c Marks | | |  |  |

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| Component -2: Examination | | | |
| Examination | Max Marks | First Examiner Marks | Moderator Marks |
| Written examination | 100 |  |  |
| Written examination marks reduced to 50 Marks | |  |  | XX |

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| **Module Marks Tabulation** | | | | | | |
| Component-1:Assignment | First Examiner | Second Examiner Marks | **Result** | | | |
| 1.A |  |  |
| 1.B |  |  |
| 1.C |  |  |
| Component-1 Total |  |  | Pass |  | Fail |  |
| Component-2: Examination |  |  | Pass |  | Fail |  |
| Module Marks (Max 100 ) |  | | Pass |  | Fail |  |
| IMPORTANT: 1. Component 1 and 2 total marks have to be rounded off to the next higher integer and entered in the above fields.  2. A minimum of 40% required for a pass in both components. | | | | | | |
| **Signature of First Examiner Signature of Second Examiner** | | | | | | |

**Please note:**

1. Documental evidence for all the components/parts of the assessment such as the reports, presentation slides, posters, laboratory exam / tool tests are required to be attached to the assignment report in a proper order.
2. The First Examiner is required to mark the comments in RED ink and the Second Examiner’s comments should be in GREEN ink.
3. The marks for all the questions of the assignment have to be written only in the **Component -1: Assignment** table.
4. The individual question marks have to be entered on the table of the **Answer book** for **written exam** and only the total marks are entered in **Component-2: Examination** table.
5. The First Examiner (Module Leader) has to submit the following to Examination and Assessment Section after the review process: Assignment documents, Grade-sheet data file and Module marks card(PMAR).
6. If the variation between the marks awarded by the first examiner and the second examiner lies within +/- 3 marks, then the marks allotted by the first examiner is considered to be final. If the variation is more than +/- 3 marks then both the examiners should resolve the issue in consultation with the Chairman BoE.

**Assignment**

**Instructions to students:**

1. The assignment consists of 3 parts.
2. The assignment has to be neatly word processed as per the prescribed format.
3. The maximum number of pages should be restricted to**35**.
4. Use only SI units.
5. **Submission Date: 24/3/2019**
6. **Submission after the due date is not permitted.**
7. Method of evaluation as per the submission and marking scheme
8. At the end, you are required to comment on -
   1. Benefits you have derived by solving this assignment
   2. Whether assignment was able to assess *module learning outcomes* or not?
9. IMPORTANT: It is essential that all the sources used in preparation of the assignment must be suitably referenced in the text.

**Introduction:**

This module is a combination of Applied Mathematics and Signal Processing Schemes to treat the signals as stochastic processes, dealing with their statistical properties. A common signal modeling of many systems is a signal which consists of a deterministic part added with noise. The noise can be modeled in many situations as white Gaussian noise. Such signal models are utilized in statistical detection and estimation of signals and systems parameters using various algorithms. This module deals with variety of detection and estimation schemes and its application to signal and image processing techniques.

This assignment is structured to assess the ability of the student to apply as well as extend the already learnt techniques to typical signal and image processing problems commonly encountered in this discipline. To motivate the student to inculcate the aptitude to develop programs / codes, this assignment is structured to test the proficiency of the students to carry out the typical analysis and verification.

#### Part –A (30 Marks)

Statistical modeling techniques and machine learning approaches are two frontiers of the modern world. Diversified challenges related to wireless sensor networks, signal and image processing involve parameter estimation, optimization, prediction and signal detection. These problems can be addressed using both statistical modeling and machine learning approaches. However, the performances of these methods are application dependent.

**Problem Statement:**

**In this context, debate on the statement: “Statistical approaches to signal detectionalways outperform machine learning approaches”.**

The debate should include:

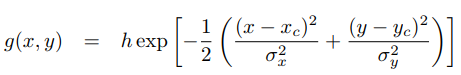
* 1. Introduction to the signal detection problem related to an application area
  2. Discussion on statistical and machine learning based solution approaches
  3. Performance evaluation and comparison of statistical and machine learning approaches
  4. Justification of the stance taken and conclusion

#### Part –B (30 Marks)

Wireless sensor networks (WSNs) are a large number of geographicallydistributed and densely-deployed sensors that cooperate with each other towards a common goal. All the sensors transmit the sensed analog values wirelessly to a remote centre called as a fusion centre. At the fusion centre, distributed parameter estimationis accomplished which further assists event detection and classification problems.

**Problem statement:**

A large group of sensors are deployed in a finite areato estimate the parameters of a two-dimensional influence field given by:



Consider the estimation of the parameter vector. The model of the WSN with the fusion center is shown in Figure 1. The sensors are distributed in the area. Each sensor measures thenoisy influence field, amplifies and transmits to the fusion center. Noise is Gaussian and magnitude of, is Rayleigh distributed. The fusion center processes the received observations using ,.

Develop a Maximum Likelihood (ML) based algorithm for the estimation of

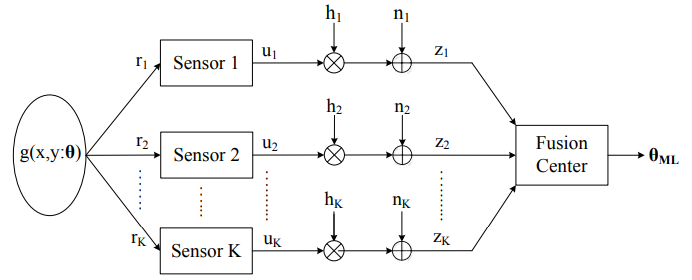


Figure 1

The report should address the following:

* 1. Formulation of model equations at the fusion center
  2. Development of non-linear ML equations for parameter estimation
  3. Development of an algorithm for numerically solving the non-linear ML equations
  4. Comments on the performance of ML algorithm and limitations of the model

**Note: Contact the module leader for the values ofand.**

#### Part –C (35 Marks)

In this part of the assignment, the student is required to formulate a Hypothesis Testing Problem (HTP)to detect an anomalous event.

**Problem statement**

The influence field given in Part-B needs to be monitored for detecting an anomalous event.An anomaly occurs if the value ofis more than. In this regard, formulate a HTP and obtain the probability of the detection for a specific Signal to Noise Ratio (SNR).

The report should address the following:

1. Formulation of HTP for the anomaly detection
2. Development of a Likelihood Ratio Test (LRT) using Neyman Pearson condition for a given false alarm probability
3. Determination of probability of detection for a chosen SNR using simulations
4. Analysis of obtained hypothesis results

**Note: Contact the module leader forthe values offalse alarm probability and SNR.**

In addition, views on the following need to be presented:

* Benefits you have derived by solving this assignment.
* Whether the assignment was able to assess module learning outcomes or not?

Guidelines for Submission

*Citation* of the *references* in the text is necessary in all the parts.

* Restrict your report for Part-A to 3 pages only
* Use of figures could be avoided in Part-A
* Divide your discussions clearly, as per the sections mentioned above.
* Restrict your report for Part-B and C to a maximum of 12 and 20 pages respectively
* Divide your discussions clearly, as per the sections mentioned above and draw the conclusion at the end of each section.
* ***Please note: Marks will be awarded only to the sections and sub-sections clearly indicated as per the problem statement.***
* ***A presentation on the assignment should be given to the Examiner in RUAS format only.***

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