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ISETC2025

2ND INTERNATIONAL SCIENCE,
ENGINEERING AND TECHNOLOGY
COLLOQUIUM



THE POWER OF SCIENTIFIC INNOVATION

INTELLIGENT SOLUTIONS FOR A
SUSTAINABLE WORLD

ORGANIZED BY:
FACULTY OF APPLIED SCIENCES
UNIVERSITI TEKNOLOGI MARA
PERAK BRANCH, TAPAH CAMPUS
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(ISETC 2025)**

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PREFACE

Welcome to the 2nd International Science, Engineering and Technology Colloquium 2025 (ISETC 2025)!

It is with great pleasure that we present this year's colloquium, a distinguished gathering of scholars, researchers, and professionals dedicated to the advancement of applied sciences. Held virtually on 9th July 2025, ISETC 2025 serves as a platform to highlight cutting-edge research, foster meaningful networking, encourage collaborations, and explore innovative solutions to global challenges.

This year's theme, "The Power of Scientific Innovation: Intelligent Solutions for a Sustainable World" highlights our shared goal to solve global challenges through applied science. It celebrates innovation as a key to building a more sustainable and resilient future. We're proud to feature keynote speakers and presenters who bring fresh insights, bold ideas, and breakthroughs shaping tomorrow's world.

We would like to extend our heartfelt appreciation to the Faculty of Applied Sciences, Universiti Teknologi MARA, Perak Branch, Tapah Campus, for their outstanding support and assistance throughout the planning and execution of the event. Their dedication has been instrumental to the success of this colloquium. We would like to sincerely thank all participants and researchers for their valuable contributions. We also appreciate the reviewers for their careful evaluations and helpful feedback. Your hard work and support mean a lot to us.

As editors, we are proud to present this collection of proceedings. It is an honour to bring together the interesting and meaningful work of our speakers and authors. We hope the ideas shared will lead to new discoveries, encourage more research, and help solve global challenges through science and innovation.

Warm regards,

Dr. Emi Norzehan Mohamad Mahbob

Dr. Saiyidah Nafisah Hashim

Ms. Lili Widarti Zainuddin

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ISETC 2025 Proceedings Editors

CLUSTERING ANALYSIS OF fEEG IMAGES USING FUZZY C-MEANS AND K-MEANS ALGORITHMS

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Abstract: This study presents an unsupervised clustering method for the segmentation and analysis of flat EEG (fEEG) images. Clustering identifies and groups distinct patterns or structural features within image data. The fEEG images are categorized using two established clustering methods: k-means for hard clustering and fuzzy c-means (FCM) for soft clustering. Hard clustering assigns each data point to a single cluster, whereas soft clustering clusters pixels into groups based on similarity. The k-means algorithm provides rapid segmentation with crisp boundaries. Meanwhile, FCM captures transitional zones and ambiguity through degrees of membership. Comparative results highlight the strengths of each technique, demonstrating the superior sensitivity of FCM in uncertain regions and the computational efficiency of K-Means.

Keywords: Clustering, k-means, fuzzy c-means, flat electroencephalography

INTRODUCTION

Electroencephalography (EEG) is a system that measures and records electrical activity of the brain such that it reads voltage differences on the head relative to a given point (Shorvon, 2011). Meanwhile, Flat EEG (fEEG) is a method for mapping high dimensional signal, namely EEG into a low dimensional space (Zakaria, 2008). The image of fEEG which is in grayscale form is obtained from digital fEEG by using fuzzy approach (Abdy, 2014). Accurate segmentation of fEEG images is essential for identifying regions of interest and interpreting signal intensity. Traditional clustering method such as K-means provides hard clustering, meanwhile Fuzzy C-means (FCM) offers soft clustering that capture uncertainty in pixel membership. This study aims to compare these methods and highlight their respective advantages in fEEG analysis.

MATERIALS AND METHODS

a) K-means Clustering

Let X_{ij} represents the dataset where $(i = 1, \dots, n \quad j = 1, \dots, m)$. The cluster centroids $C_{kj} (k = 1, \dots, k, j = 1, \dots, m)$ is randomly initialize where C_{kj} represent the j -th coordinate and the k -th cluster centre. To determine the distance of the X_{ij} data at the centre point of the cluster, C_k the Euclidean, d_{ik} formula will be used as in Equation (1)

$$d_{ik} = \sqrt{\sum_{j=1}^m (X_{ij} - C_{kj})^2} \quad (1)$$

Each data point is assigned to the cluster k such that

$$\min \sum_{k=1}^k d_{ik} = \sqrt{\sum_{j=1}^m (X_{ij} - C_{kj})^2} \quad (2)$$

A new middle point value can be calculated by looking for the average value of each member of the group as in Equation (3)

$$C_{kj} = \frac{\sum_{i=1}^P X_{ij}}{P} \quad (3)$$

where X_{ij} is the number of k -clusters and P is the number of members in the group. After that, the algorithm will be repeated again until it is converged (Bora & Gupta, 2014).

b) Fuzzy C-means Clustering

The FCM was introduced by Dunn (1973) and further improved by Bezdek (1981). Let $X = (x_1, x_2, \dots, x_n)$ be the set of N pixel values. The value will be divided into c clustering where x_i will be used as a data. Algorithm is an iterative, always recurring process that will minimize the objective function

$$J = \sum_{j=1}^N \sum_{i=1}^c u_{ij}^m \|x_j - v_i\|^2 \quad (4)$$

u_{ij} is the membership value for pixels x_j in the number of cluster. Next, v_i is known center cluster while $\| \cdot \|$ is a metric norm and m is a constant. The membership function and cluster centre functions will be updated through:

$$u_{ij} = \frac{\|x_j - v_i\|^{-2/(m-1)}}{\sum_{k=1}^c \|x_j - v_k\|^{-2/(m-1)}} \quad (5)$$

The fuzzy clustering matrix will be updated using the following equation:

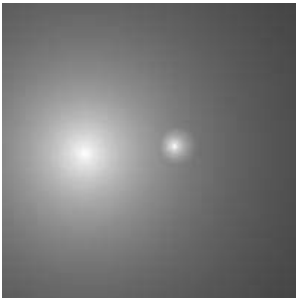
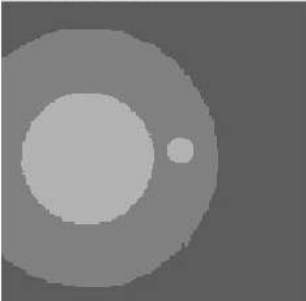
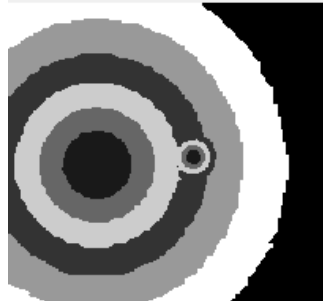
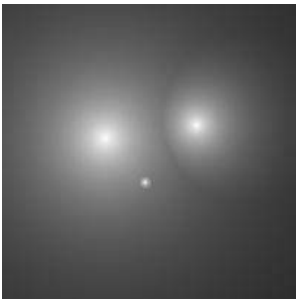
$$v_i = \frac{\sum_{j=1}^N u_{ij}^m x_j}{\sum_{j=1}^N u_{ij}^m} \quad (6)$$

The fuzzy c-mean clustering will converge a solution for v_i representing the local minimum value or saddle point for the objective function.

RESULTS AND DISCUSSION

The methods are implemented on fEEG images during epileptic seizure. At $t = 3$ the input image shows that there are two cluster centres whereas there are three cluster centres that can be observed at $t = 4$. The brightness of the vague boundaries represent the strength of the electrical potential for fEEG image. From Table 1, it shows that Fuzzy c-means gives more meaningful clusters. The FCM gives better results for overlapped data.

Table 1. Comparisons of clustering approach

Input image	K-means	Fuzzy c-means
 t=3		
 t=4		

CONCLUSIONS

K-means simplifies the image by enforcing hard boundaries. It is fast and effective for identifying dominant signal zones but may overlook transitional activity. FCM reveals fuzzy transitions between regions, which is especially valuable in fEEG where brain activity does not always have clear-cut edges. FCM shows more diffused cluster boundaries, suggesting evolving or spreading signal activity that K-means may flatten.

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Surat kami : 700-KPK (PRP.UP.1/20/1)
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3. Tujuan permohonan ini adalah bagi membolehkan akses yang lebih meluas oleh pengguna perpustakaan terhadap semua maklumat yang terkandung di dalam penerbitan melalui laman Web PTAR UiTM Cawangan Perak.

Kelulusan daripada pihak tuan dalam perkara ini amat dihargai.

Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA"

Saya yang menjalankan amanah,

Setuju.

27.1.2023

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