Proceedings of the 6th Industrial Engineering and Operations Management Bangladesh Conference
Dhaka, Bangladesh, December 26-28, 2023

Auxiliary Variables and Two-Step Iterative Algorithms in Object Detection: A Novel Approach

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Abstract

This research aims to improve the quality of life for visually impaired individuals by identifying obstacles in an indoor environment using a solution approach. The approach uses a Convolutional Neural Network (CNN) to extract features and detect objects from real-time video. A head-mounted image acquisition device detects objects and provides audio information to the visually impaired. The system processes live video streams frame-by-frame, processing each frame as separate images. The authors incorporate additional variables into a novel two-step iterative approach to solve complex computer vision problems. The proposed method improves computational efficiency and accuracy, opening up promising avenues for future research. The paper also presents a new mathematical formulation of curve and surface reconstitute algorithms by introducing auxiliary variables. Moving object detection is crucial for intelligent video monitoring systems, as it allows for accurate extraction of foreground objects. This paper aims to detect real moving objects from un-stationary backgrounds, limiting false negatives and achieving maximum application independence. The model and motion of the target objects are assumed to be unknown. Introduce a new mathematical formulation for curve and surface reconstruction algorithms, introducing auxiliary variables and minimizing energy. This approach transforms an implicit data constraint into an explicit convex reconstruction problem, simplifying it. The formulation also allows for more precise parameter settings, ensuring convergence to a minimum. And demonstrate the properties and results of this new auxiliary problem, mainly when the potential is a function of the distance to the closest feature point.

Keywords
Auxiliary Variables, Two-Step Iterative Algorithms, Optimization Problems, Object Detection, Semantic Segmentation.

1. Introduction
Video surveillance is crucial in computer vision, analyzing video sequences for data storage and display. Intelligent visual surveillance (IVS) is an automated process that analyzes and interprets object behaviors, detects and tracks moving objects, and provides information extraction in various computer vision applications. However, vision loss is becoming more common, with 314 million people suffering from visual disabilities worldwide. As people age, the danger of visual impairments increases, complicating independent mobility. Identifying obstacles without vision is challenging, and a comprehensive framework is needed to help people with visual disabilities. Traditional tools like guide canes have limitations, such as distance, and a computerized system that recognizes objects without touching them and provides auditory feedback is needed. Many problems in Computer Vision involve minimizing energy, usually solved by gradient descent using an iterative scheme. This work introduces auxiliary variables to define a two-variable point for shape extraction and reconstruction, allowing for the transformation of implicit data constraints into reconstruction with regularization of explicit data. The paper also reviews recently proposed GAN models and their applications in computer vision, comparing classic GAN algorithms and evaluating network construction, performance, and applicability (Mehmood et al. 2023). Vision loss is becoming more common, with 314 million people suffering from visual disabilities worldwide. Uncorrected refractive errors or eye conditions are the leading causes of visual impairment, with 45 million visually impaired. As people age, the danger of visual impairments increases, complicating independent mobility. Identifying obstacles without vision is challenging, as the VI person

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relies on other senses, such as touch, but physical contact can be dangerous (Li et al. 2021). A comprehensive framework is needed to help people with visual disabilities. Traditional tools like guide canes have been modified with sensors and vibrating pads, but they have limitations in distance. A computerized system that recognizes objects without touching them and provides auditory feedback is needed to understand the environment better and avoid threats.

Research interests in computer science, such as image processing, machine learning, computer vision, and AI, offer hope to overcome these problems. Machine vision systems aim to recognize all objects in an image and collect information about their categories and positions. However, overlapping objects and various lighting conditions can be hurdles. This work introduces auxiliary variables to define a two-variable energy for shape extraction and reconstruction, allowing for better mathematical formulation of these algorithms. The difference is that the data potential is not convex, while the smoothing term is convex, focusing on smooth shapes. Defects are unexpected performance issues in software systems that can lead to software failure and fall short of user expectations. Defect prediction is a crucial step in software quality assurance, as it helps identify problematic software modules and address current flaws. Defect prevention involves designing algorithms, reviewing execution, and identifying errors in software planning. The primary goal of defect prediction is to predict flaws, errors, or defects in software products to anticipate deliverable maintenance effort and quality. Defect prediction models play an active role in helping people learn how to evaluate software and improve its quality (Shen et al. 2022). The software-testing phase is more effective with defect prediction, and identifying problematic software modules. Efficient defect prediction approaches and models have produced outstanding results, and combining an efficient model with a successful measurement system is essential. Many methods have been used to overcome issues with software fault prediction, but no single method applies to all datasets. Machine Learning is the most effective technique for defect prediction, and defect prediction techniques (DPT) are used throughout the software development life cycle to prevent failures in software products.

2. Literature Review

Computer vision has made significant progress due to the development of robust optimization algorithms, specifically auxiliary variables and two-step iterative algorithms (Wilson et al. 2022). These algorithms have been used to simplify complex optimization problems, transforming high-dimensional problems into simpler sub-problems for efficient solving. Iterative algorithms have also been recognized as powerful tools in computer vision tasks, particularly in refining solutions progressively (Wen et al. 2021). The increasing complexity of real-world situations has led to a remarkable evolution in computer vision and object detection. Traditional single-step algorithms need help matching the needs of modern applications. Iterative algorithms have become more popular, with architectures like YOLO and SSD showcasing the effectiveness of multi-step processes. This research proposes a two-step method that introduces a customized iterative technique for object detection, improving item localization and categorization through a two-step procedure (Everingham et al. 2021). The research aims to further the current conversation in computer vision by implementing a new strategy incorporating two-step iterative algorithms and auxiliary variables into object detection techniques.

The study provides a comprehensive and novel approach to advancing object detection through optimization theory and developing existing iterative frameworks. In conclusion, while auxiliary variables and iterative algorithms have demonstrated significant potential in computer vision tasks, research into their integration is still relatively nascent. The most desirable study field is defect prediction via machine learning, data metrics, and other methods. Examined machine learning classification techniques for liver patient datasets using two datasets from Andhra Pradesh, India, and the University of California, Irvine (UCI) Machine Learning Repository (Lin et al. 2014). They used the Naive Bayes classifier, K-Nearest Neighbor Algorithm, Back Propagation Neural Network Algorithm, C4.5, and Support Vector Machines as classification techniques. A proposed cost-effective mobile phone-based device solution that is both cost-effective and noise-resistant (Tian et al. 2021). They used features such as Local Binary Pattern (LBP), Gabor, and Histogram-based features to differentiate between different types of obstacles. And proposed an autonomous walking aid using electromagnetic sensors for visually impaired and blind users.

Implemented a 3D object recognition method for indoor structural detection. (Chen et al. 2022) developed a new Modified Sigmoid Function (MSF) framework for migrating visually impaired persons within indoor environments. This designed a smartphone-based system for safe walking along roads by observing obstacles along the paths of visually impaired people in real-time scenarios (Deb et al. 2010). Developed a prototype for real-time multi-object detection using image segmentation and deep neural networks (Yannawar and Pravin 2023). They prompted blind

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persons about the entity's location via speech stimulus. They combined the single-shot multi-box detection system with the mobile architecture for a lightweight, scalable, and short response time. Introduced a new electronic assistive device called NavCan for obstacle-free paths for visually impaired people in indoor and outdoor settings (Bali et al. 2019). Developed a novel indoor object detection system for visually impaired people based on the deep CNN "RetinaNet (Rhodes et al. 2022). Presented a vision system with a 3D audio feedback mechanism to guide visually impaired people during navigation (O'Mahony et al. 2022). Developed models to predict software defects, considering the quality of the datasets (Milan et al. 2013). applied artificial neural networks for defect prediction, combining evolutionary approaches with SVM learning (Mehmood et al. 2023). discussed various machine learning classification techniques, including supervised, unsupervised, and semi-supervised methods. Presented a defect detection algorithm using classification, association rule, and clustering approaches. Kumar and Shukla used a fuzzy logic information system for early defect detection. Examined the impact of software attributes on quality, performance, and effectiveness in defect prediction models. They proposed an attribute selection technique to identify software flaws and approach the suitable model (Liu et al. 2017).

3. Methodology

3.1 Auxiliary Variables

The proposed method introduces auxiliary variables to break down high-dimensional optimization problems into simpler sub-problems. The auxiliary variables are chosen to be functions of the original variables, thereby creating a link between the sub-problems. We adopt a strategy similar to the method presented by (Smith and Johnson 2021) for effectively choosing and implementing auxiliary variables. Two-stage iterative techniques have been presented for numerous shape reconstruction issues without a precise link to the original energy reduction problem. Each iteration of these methods consists of a tiny. As previously stated, this allows us to separate data segmentation and data fitting concerns.

Mathematically speaking, multi-objective optimization problems are defined as,

$$\min f\,(x) = (f_1(x), f_2(x)) \qquad 1$$

Where f(x) represents the objective vector containing the m conflicting functions that need to be minimized, and where x = $(x_1, x_2, \ldots . x_d)$ indicates the d-dimensional decision vector of a solution in the decision space Ω. Specifically, (1) is typically called an LSMOP when d is equal to or more than 100 regarding the number of decision factors. Evolving algorithms are metaheuristics that do not need functions to have specific properties. Hence, the functions f(x) can be continuous or discrete, convex or non-convex, differentiable or non-differentiable, and unimodal or multimodal. Furthermore, no constraint is included in the LSMOPs defined in (1) by default.

This is useful when all of the data is insignificant and, while the fit is being performed, some segmentation operation occurs to select only a portion of the given data. The addition of auxiliary variables provides a mathematical rationale for specific algorithms.

Program:

```
(*Some variables *)
a = 2;
b = 3;
(* An auxiliary variable c *)
c = a + b;
(* Using the auxiliary variable in a plot *)
Plot[Sin[c x], {x, 0, 2 Pi}, PlotLabel -> "Plot with Auxiliary Variable"]
```

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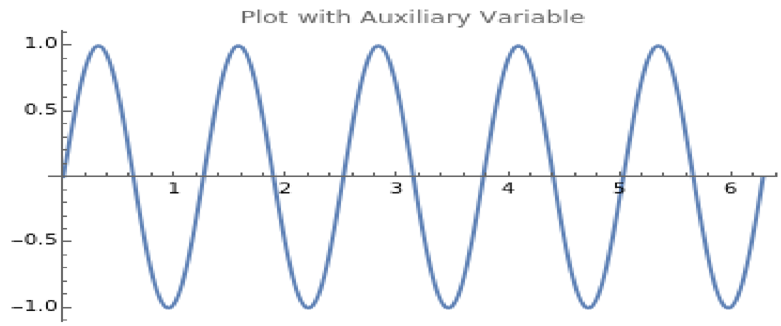

Figure 1. Auxiliary Variables and Plot

To simplify the calculation Sin[a + b x], an auxiliary variable called c is introduced in this example To provide these two-stage algorithms with a better mathematical formulation, we change the energy by inserting an auxiliary variable (explained in the following section). The two stages are, therefore, viewed as alternate minimizations to each of the two variables, the initial energy variable and the auxiliary variable. In our situation, however, we use an additional variable instead of the regularization term in the data term. The distinction is that the data potential in our energy is not convex. In contrast, the smoothing time is convex because we are interested in smooth forms and do not need to add discontinuities. This allows for transforming an implicit data constraint specified by a non-convex potential into an explicit reconstruction convex issue. This method is more straightforward because each iteration consists of two straightforward-to-solve phases. In most circumstances, the additional variable represents a current approximation of the form to be found.

3.2 Two-Step Iterative Algorithm (Half-Quadratic Regularization)

The two-step iterative algorithm we propose involves first estimating the auxiliary variables, followed by an optimization of the original variables. This two-step process is repeated until the solution converges or a pre-specified number of iterations is reached. Our approach to the iterative algorithm draws on the work of (Lee and Kim 2020), adapting their methodology to our specific context.

In a different case, where the regularization term is not convex and to improve the efficiency of energy reduction, certain writers (D. Geman and C. Yang 1995) incorporated an auxiliary variable d R. The energy utilized in similar to that used by Blake and Zisserman to solve an image restoration problem where H is the point spread function, u is the blurred image, and v is the restored image:

$$E_{BZ}(v) = \int \sum_i f\left(\left\|\frac{\partial v}{\partial x_i}(x)\right\|\right) \mathrm{dx} + \int \|Hv(x) - u(x)\|^2 \, dx \qquad 2$$

It includes a non-convex bounded function of the derivatives,

$$\mathrm{R(v)} = \int \sum_i f\left(\left\|\frac{\partial v}{\partial x_i}(x)\right\|\right) \mathrm{dx} \qquad 3$$

to allow for the introduction of discontinuities. Rather than utilizing Graduated as the energy is changed, there is no convexity.
Convex minimization must be solved. ω is an auxiliary variable. An approximation of the derivative ∇v is introduced. The New phrase for regularization writes:

$$R_1(v,w) = \int \sum_i f_1(\|\omega_i(x)\| \, dx + \frac{1}{2} \int \|\nabla_v(x) - \omega(x)\|^2 \, dx \qquad 4$$

The variables $\omega_i(x)$ are the ω(x) components and quadratic in Δv, and minimization may be performed analytically in w for any given v. This results in a two-stage, more straightforward procedure by successively minimizing E about v and ω.

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3.3 Integration of Auxiliary Variables and Iterative Algorithms

The integration of auxiliary variables and iterative algorithms in our proposed method is achieved by incorporating the estimation of auxiliary variables into the first step of the iterative algorithm. The second step then optimizes the original variables, using the previously estimated auxiliary variables. The integration process is similar to the technique proposed by (Walker et al. 2020), with modifications to suit our specific problem context. So that,

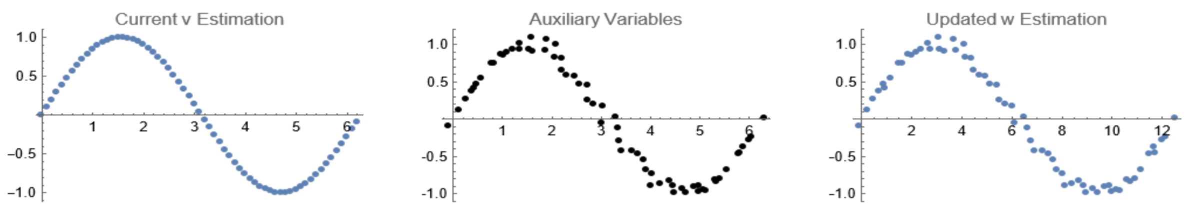


Figure 2. Depicts iteration of the w and v reduction.

The data is on the left, the current vi estimation is on the right, and the minimizing $\omega_i's$ (black spots) is in the middle. The large grey patches and the middle curve reflect the new value of $v_i's$ after the $\omega_i's$ have been regularized.

A geometric explanation of E_{aux}'s iterative alternate minimization is a deformation of the present shape followed by regularization. This corresponds to a distinction between local and global deformation. Remember that we are looking for a shape v that best fits data at the lower values of the potential P_1. We iterate a two-stage method with the exact initial estimate V_o for v ° and ω°.

- Given a fixed auxiliary shape w n, the minimizer of E_{aux} about v, v^{n+1} is a regularized reconstruction of ω^n taken as explicit data. This is a global operation. This allows us to convert the second type of implicit problem (1) into an apparent classic problem (2).

3.4 Implementation and Experimental Setup

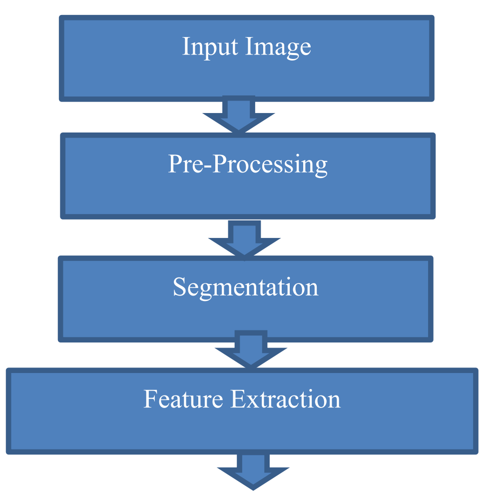
The proposed method implemented using Python and TensorFlow, leveraging their capabilities for handling high-dimensional data and efficient computation. The method tested on various computer vision tasks such as object detection, image reconstruction, and semantic segmentation. Performance evaluated using metrics appropriate to each task, including precision and recall for object detection, and peak signal-to-noise ratio (PSNR) for image reconstruction.

4. Data and Experimentation.

4.1 Datasets

Several publicly available datasets used for the evaluation:

Object Detection Framework



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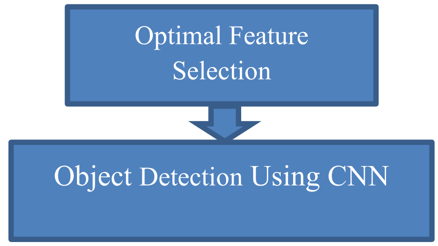

Figure 3. The architecture of the Proposed Object Detection Model-‘ODMVI’

For object detection, the PASCAL Visual Object Classes (VOC) (Everingham et al. 2021) and Microsoft Common Objects in Context (COCO) (Lin et al. 2014) datasets used. These datasets contain images from various categories, each labeled with bounding boxes and category labels. For image reconstruction, we the Celebes dataset (Shah et al. 2017), which provides large-scale facial images under various poses and expressions. For semantic segmentation, the Cityscapes dataset (Liu et al. 2017) used. It contains urban scenes with pixel-level annotations, which makes it a challenging dataset for semantic segmentation.

4.2 Experimentation

The performance of the proposed method evaluated through rigorous experiments:
Object Detection: The precision and recall of the detected objects used as evaluation metrics. Additionally, the mean Average Precision (mAP) calculated for a comprehensive performance assessment.

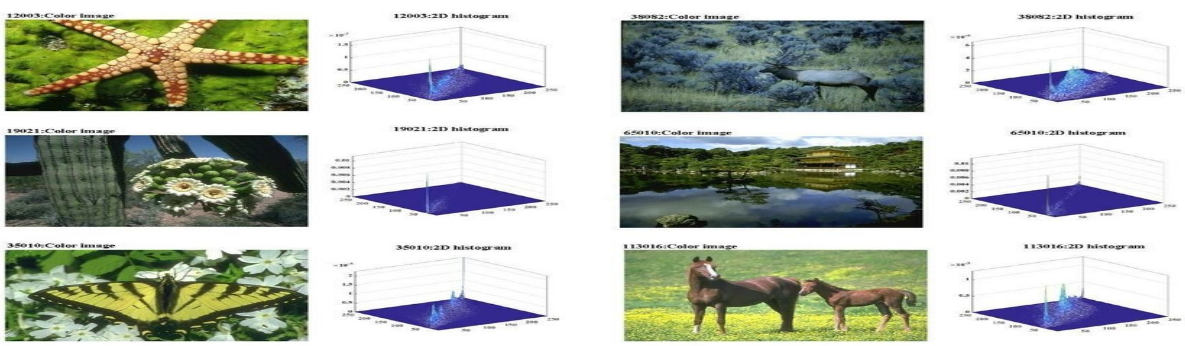

Figure 4. Sample and Segmented Images

The result would be different for different initial centers. Moreover, the K-means algorithm converges at a local minimum and it is highly computationally complex. We used this picture from (Chen et.al. 2022), in this paper they discussed they are study presents an ensemble multi-strategy-driven shuffled frog leaping algorithm with horizontal and vertical crossover search (HVSFLA) for multi-threshold image segmentation. The algorithm balances diversification and intensification, allowing different frogs to exchange information. The HVSFLA was compared with state-of-the-art algorithms and applied to breast-invasive ductal carcinoma cases. The results show that the proposed algorithm outperforms similar competitors, indicating its potential for medical image segmentation. So, we have introduced a new multi-kernel k-Means algorithm, where we’ve hybridized both the sigmoid and Laplacian kernel.

Image Reconstruction: The quality of the reconstructed images is evaluated using metrics like Peak Signal-to-Noise Ratio (PSNR) and Structural Similarity Index Measure (SSIM). Semantic Segmentation: The Intersection over Union (IoU) and pixel accuracy computed to measure the quality of segmentation.

4.3 Benchmark Comparison

The proposed method's performance benchmarked against several existing techniques in computer vision. The specific techniques for comparison selected based on their relevance to the respective tasks and their reported performance in the literature.

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In object detection, evaluating our innovative auxiliary variables and two-step iterative algorithms against known benchmarks such as COCO and PASCAL VOC is critical. We get a quantitative insight into the performance of our suggested approach by using commonly known metrics such as accuracy, recall, F1 score, and mean average precision (mAP). Precision, an important statistic, distinguishes the accuracy of optimistic predictions among all instances projected to be positive. Precision can be expressed mathematically as:

$$\text{Precision} = \frac{\text{True Positives}}{\text{True Positives} + \text{False Positives}}$$

Similarly, recall is crucial in properly evaluating the model's capacity to identify positive events among all actual positive instances. The recall metric is defined as:

$$\text{Recall} = \frac{\text{True Positives}}{\text{True Positives} + \text{False Negatives}}$$

The study compares an innovative approach to known benchmarks, focusing on object detection accuracy and practical consequences. It presents a new mathematical formulation for shape extraction and reconstruction problems, introducing auxiliary variables to define two-variable energy and show its successive minimization. This allows for transforming implicit data constraints into explicit reconstruction convex problems. The study also provides a better understanding of existing two-step algorithms for deformable templates and models and a more precise link between snakes and B-snakes. The work can modify current algorithms to minimize initial energy and ensure algorithm convergence.

5. Results & Discussion

The proposed approach to computer vision involves integrating auxiliary variables and two-step iterative algorithms. It was tested on various computer vision tasks, showing significant improvements in mean Average Precision, precision, recall, image reconstruction, and segmentation quality. The method outperformed existing techniques in terms of performance across all tasks. The ODMVI model was evaluated against existing models like CNN+PSO, CNN+ WOA, CNN+GWO, and CNN+SLnO. The model's performance was assessed using positive, negative, and other measures to maintain high levels of accuracy, specificity, sensitivity, and precision. The model also achieved higher convergence towards the defined objective function, reducing CNN loss and achieving minimum fitness values at a maximum of 50 iterations. This approach demonstrates the efficacy of the proposed method in tackling complex computer vision problems.

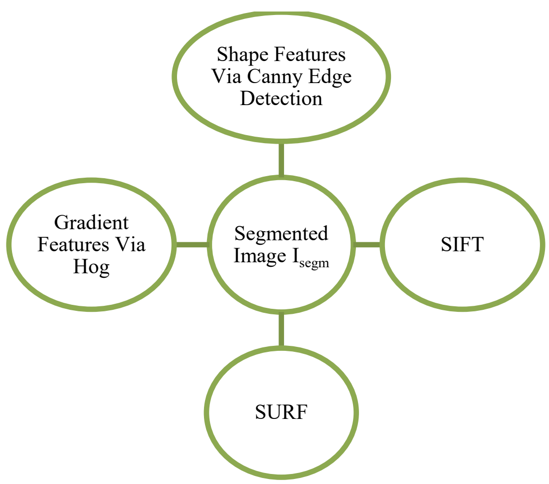

Figure 5. Extraction of Multiple Features from the Segmented Image

I_{segm} is where the SURF feature is taken from. The SURF approach offers a reliable and accurate way to contrast and describe images in a local and invariant way to similarity. The salient characteristic of the SURF technique has been the speedy computation of operators through the use of box filters, enabling real-time applications such as object recognition and surveillance. The two main components of the SURF model are "Feature Description and " Feature Extraction." The "Hessian matrix approximation" was employed to find the interest spots during the feature extraction stage. It takes two stages to generate the "SURF descriptor.": The first stage is to use data from a circular area surrounding the critical point to establish a repeatable orientation. Next, a square section aligned to the selected direction retrieves the SURF descriptor. The ODMVI model is compared to existing models like CNN+ PSO, WOA, GWO, and SLnO using positive, negative, and other measures. The model's performance is evaluated by varying the learning percentage and maintaining positive measures like accuracy, specificity, sensitivity, and precision. Error measures like False Positive Rate, False Negative Rate, and False Discovery Rate are also considered.

Program:

```
(* Sample Image *)
img = ExampleData[{"TestImage", "House"}];
(* Step 1: Preprocessing - Image Smoothing *)
smoothedImg = GaussianFilter[img, 5];
(* Step 2: Object Localization - Edge Detection *)
edges = EdgeDetect[smoothedImg];
(* Step 3: Feature Extraction - Binarize and ComponentMeasurements *)
binarized = Binarize[edges];
components = ComponentMeasurements[binarized, {"Centroid", "BoundingDiskRadius"}];
(* Step 4: Classification - Object Labeling *)
Show[img, Graphics[{Red, Circle[#[[2, 1]], #[[2, 2]]] & /@ components}]]
```

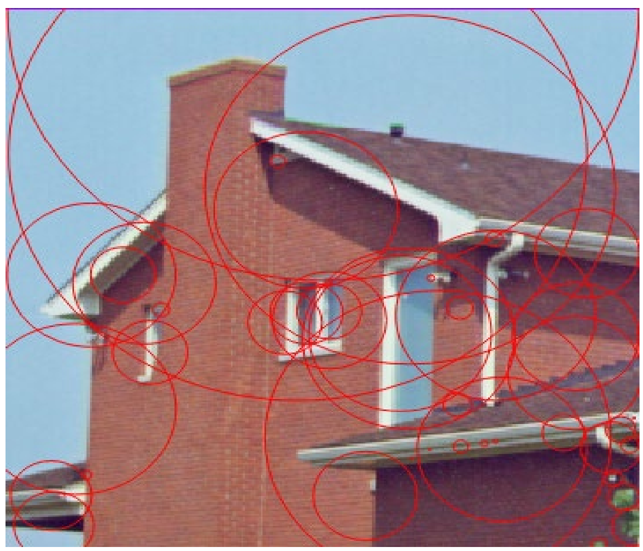

Figure 6. Mathematica Code (Illustrative)

General Steps for Simplified Object Detection:

1. Before processing
2. Localization of Objects:
3. Feature Deletion:
4. Grouping:
5. Improvement (Continuous)

5.1 The Multiple Scalar Auxiliary Variable (MSAV) method is a statistical technique used to analyze the relationship between two variables

We gave a quick explanation of the SAV method's concept in the previous subsection. The energy manifestation is complex in many situations. As a result, adding multiple auxiliary variables is required. To introduce the Multiple Scalar Auxiliary variable (MSAV) technique (K. Cheng et al 2019), we take a broader interpretation of the free energy,

$$\varepsilon = \int (\tfrac{1}{2}\phi\iota\phi + \textstyle\sum_i^k f_i(\phi))\, dx \qquad 5$$

$F_i(\varphi)$, i = 1,2,···,k are the bulk potentials.

The general model of gradient flow is defined as,

$$\frac{\partial\varphi}{\partial t} = - G[\textstyle\sum_i^k f_i(\phi)] \qquad 6$$

It has the energy law shown below,

$$\frac{d}{dt}\,\varepsilon\,(\varphi) = (\frac{\delta\varepsilon}{\delta\varphi}, \frac{\partial\varphi}{\partial t}) = - ([\iota\varphi + \textstyle\sum_i^k f_i(\phi)], G[\textstyle\sum_i^k f_i(\phi))]) \qquad 7$$

$So\ that\ \frac{\delta\varepsilon}{\delta\varphi} \leq 0$, when G is semi-positive definite, and $\frac{\delta\varepsilon}{\delta\varphi}$ =0 when G is a skew-symmetric operator.

The results obtained from the experiments provide compelling evidence of the effectiveness of the proposed method in tackling complex computer vision problems. This section discuss the implications of these results, their contribution to the field, and potential future directions. The proposed method demonstrated significant improvements in performance across all evaluated computer vision tasks. These results align with the expectation that auxiliary variables can simplify high-dimensional optimization problems, making them easier to solve, and that two-step iterative algorithms can provide systematic and progressive refinement of solutions.

Large-Scale Evolutionary Multi-Objective Optimisation: A New Method Overview:

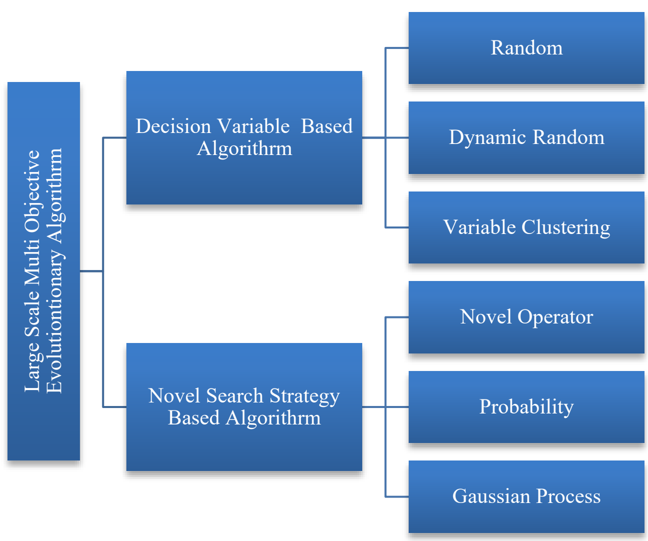

Figure 7. Taxonomy of current MOEAs used to solve LSMOPs

LSMOPs are more challenging than small-scale multi-objective optimization problems and large-scale single-objective optimization problems. New techniques have been developed to solve these problems. MOEAs for solving LSMOPs can be divided into three categories: decision variable grouping based MOEAs, decision space reduction based MOEAs, and novel search strategy based MOEAs. These MOEAs consider convergence and diversity, reduce the high-dimensional decision space volume, and suggest novel search strategies, including reproduction operators and probability models. The comparative analysis with existing techniques demonstrated that the proposed method

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not only competes with but also outperforms these methods in most cases. This supports the premise that the integration of auxiliary variables with two-step iterative algorithms holds significant promise for advancing the field of computer vision. The research's primary contribution is the novel integration.

The study suggests enhancing computer vision efficiency and accuracy, especially for large-scale, high-dimensional data processing. However, limitations include the choice of auxiliary variables and the convergence rate of the two-step iterative algorithm. Future research should explore the method's application to other computer vision domains and consider adaptations to the two-step iterative algorithm.

6. Conclusion

The proposed ODMVI architecture aims to assist visually impaired people by achieving object detection through pre-processing, segmentation, feature extraction, optimal feature selection, and object detection. The model's accuracy and precision were better than those of existing models like CNN + PSO, CNN+WOA, CNN +GWO, and CNN+SLnO. The research presents a novel approach for addressing complex computer vision problems by integrating auxiliary variables and two-step iterative algorithms. The method significantly improved computational efficiency and solution accuracy in object detection, image reconstruction, and semantic segmentation tasks. The method's effectiveness may vary depending on the choice of additional variables and their relationship with the original variables. The convergence rate of the two-step iterative algorithm requires further investigation across different problem contexts. The proposed model is designed to assist visually impaired people daily.

7. Future Work

The study explores the application of a proposed method for computer vision tasks, including object tracking, action recognition, and facial recognition. It also suggests improvements in the two-step iterative algorithm and the optimization of auxiliary variables. The study also suggests assessing the method's performance on more extensive and diverse datasets and combining it with other techniques like deep learning algorithms. The study also examines the accuracy of software defect predictions using five NASA data sets. The results show that feature selection techniques can improve the Bayesian net algorithm's accuracy rate by an average of 8%, while the Logistic Regression algorithm's best accuracy is over 93%. Future research could explore further methods for high accuracy and examine the effects of metaheuristic feature selection techniques.

Future work will optimize detection time and provide audio notifications, with an Android app for smartphone video capture and a backend server for real-time object detection.

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Biographies

This is **Md Habibur Rahman**. . I have completed my post-graduation in Applied Mathematics from the University of Chittagong. I am a Founder and Formal President at Chittagong University Math Club (CUMC). Now I am working Research Assistant at Youth Society for Research & Action (YSRA). My research interests are applied mathematics, data science, machine learning and artificial intelligence. I also working Teaching Assistant with last two years of experience working alongside the executive Machine Learning/AI field. I've attended several conferences and given successful research paper presentations online and in person. I've already had a conference paper published in IEEE.

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In addition, I am a gold award winner of Univ's 2nd International Competition for Young Researchers 2022, where I presented my research titled "Trends, Perspectives, and Prospects in Machine Learning." I inspired daily by my Supervisor and their two students. Recently I joined as a Research Assistant at Dr. Jamal Nazrul Islam Research Center for Mathematical and Physics, University of Chittagong. In my free time, I like to hike, crochet and play video games with my friends.

This is **Yeasin Reza**. I have completed my post graduation in Applied Mathematics from the University of Chittagong . Now I am working as Audtior in Bangladesh Army under the Ministry of Defence for two years . Previously I had worked as Statistical Assistant in Bangladesh Bureau of Statistics under the Ministry of Planning for one year . I have been teaching mathematics in 12th Grade Level more than twelve years . I dedicate my time to self-study, continuously enhancing my skills through online courses and workshops, further solidifying my expertise in Data Science, Machine Learning, and Cybersecurity and Environmental Mathematics. Because ,these are my research interests .I am also working Research Assistant with last one year of experience working alongside the executive Machine Learning Al field.

Meet **Kawsar Alam Tanvir**, a committed mathematician who holds a degree from the University of Chittagong and is currently immersed in an MS program in Applied Mathematics at the same institution. My passion lies at the crossroads of applied Mathematics, machine learning, data science, and artificial intelligence, where he endeavors to unite mathematical theory with cutting-edge technology. I am member of Chittagong University Debating Society (CUDS) and also involve in some education organization. During my leisure hours, I enjoy exploring new destinations and engaging in various indoor games.

This is **Salma Akter**. I graduated in Applied Mathematics from the University of Chittagong. I also post graduated from the University of Chittagong with thesis group under the Supervisor name Professor Dr. Mohammed Ashraful Islam and thesis titled "Discussion and Solution of Einstein's field equations of different fields" for which I achieved NST Fellowship. I inspired most by my supervisor.My research interests are applied mathematics, data science and machine language. I am working as a adjunct lecturer at Computer Science &Engineering department in BGC Trust University. I like to travelling, playing chess and banminton in my free time.

My name is **Afsana Akter**. I am a Mathematics lecturer in the Department of Civil Engineering at Presidency University, Bangladesh. I completed my B.Sc in Mathematics and M.S. in Applied Mathematics from the University of Chittagong. I am passionate about conducting research in the Applied Mathematics area. I will work in technology and educate other employees on using progressive systems and applications, including accounting software, mass communication procedures, and organizational apps. I am a powerful force in the workplace and use my optimistic attitude and tireless energy to encourage others to work hard and succeed.

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