CMSE 890 Applied Machine Learning

Final Project Proposal

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Project Proposal for Facial Recognition Pet Dog Using Machine Learning

The ultimate goal of this project is to build a facial recognition pet dog. This synthetic dog will perfoma facial recognition technologies to differentiate between known and unknown individuals, providing a dual function of security and companionship in environments where pets are traditionally prohibited.

The constraint of pet ownership in apartment and some residential areas poses a tension between community environment and personal security and companionship. My project aims to bridge this gap with a synthetic alternative that does more than mimic a pet's physical presence—it enhances residential security and provides emotional comfort using technologies like machine learning.

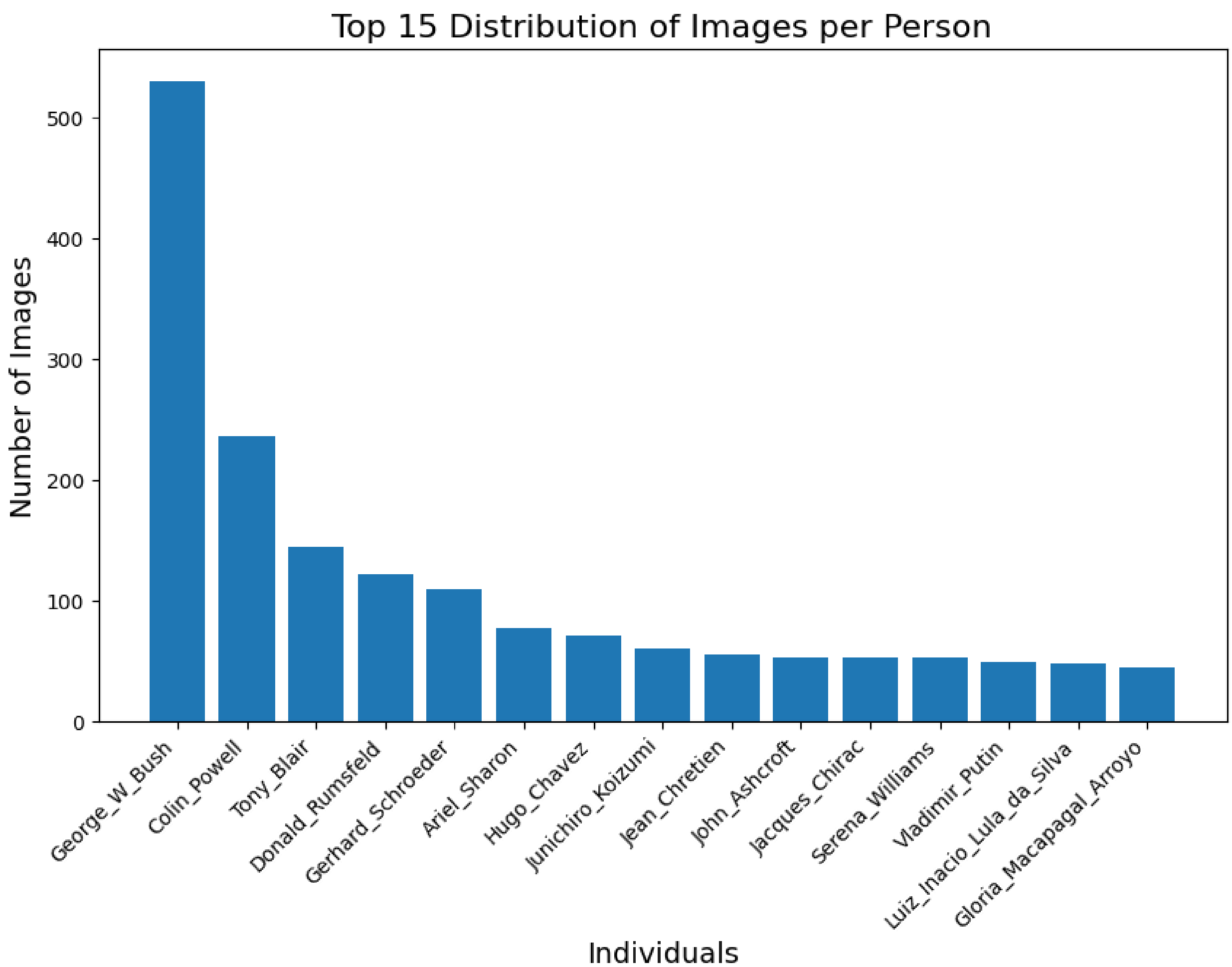
The solution is not about just replicating a pet's functionality but reimagining the role of companionship and security in restricted environments. Using the "Labeled Faces in the Wild" dataset, the machine learning models are designed to recognize faces with high accuracy, adapting over time to new individuals without manual intervention. This evolving capability introduces a new paradigm in how machines can sustain complex social interactions and security simultaneously.

This LFW dataset includes a diverse array of human faces, crucial for training the models to operate in highly variable real-world conditions. This dataset will allow our system to learn from a broad spectrum of facial features, expressions, and lighting conditions, which are critical for accurate face recognition.

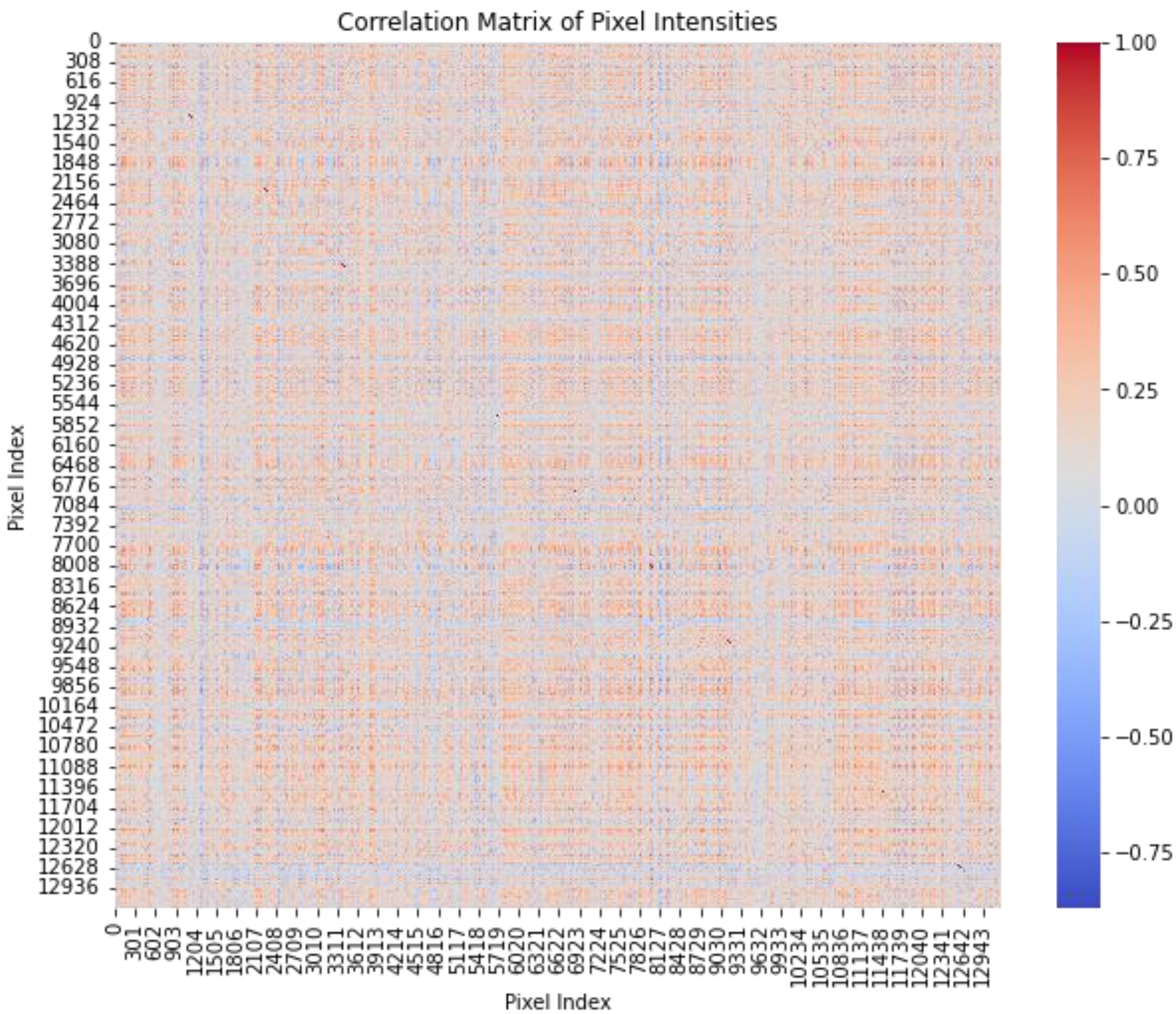
IDA & EDA

In this dataset Labeled Faces in the Wild: All images aligned with deep funneling. Total number of images = 13233 and number of classes (individuals) = 5749

The initial data checks revealed class imbalances and variability in image conditions. For example, in this dataset most label has just one images, but some people have hundreds of images.



An exploratory data analysis was performed to better understand the data distribution and to lay the groundwork for effective preprocessing. Additionally, a correlation analysis among pixel regions was undertaken to identify any redundancy that could be eliminated to optimize the feature extraction process and can identify if there are any high correlations between different pixel regions or features within the images that might suggest redundancy.



Methodology and Workflow

The preprocessing routine for the dataset involved several steps aimed at simplifying the computational complexity of the models. Images were converted to grayscale, resized to a uniform dimension of 250x250 pixels, normalized to scale pixel values, and transformed into a flattened format suitable for model input. For model selection, three main algorithms were considered: CNN for its advanced feature learning capabilities, SVM for its efficiency in high-dimensional spaces, and KNN for its simplicity and effectiveness. Feature engineering was facilitated through Principal Component Analysis (PCA), which helped in reducing dimensionality while preserving essential information for model training. The models were then trained using these features, with performance benchmarks established across different architectures using metrics such as accuracy, precision, and recall.

Reflecting on the goals of this project, every step of our methodology—from data preprocessing to model selection and training—is tailored to support the objectives of security and companionship. For instance, the choice of CNN over simpler models hinges on its ability to process spatial hierarchy in images—a feature critical when the system must distinguish between numerous individuals quickly and accurately.

Model Evaluation and Impact

Using performance metrics aligned with our business objectives, such as AUC-ROC for its interpretability and relevance in classification tasks, our models are rigorously tested to ensure they meet the high standards required for the real-world application. The expected outcome is a system with high accuracy score, can adapts to environment, and significantly reducing false positives.

Implementation

Ultimately, the implementation plan involves detailed system integration strategies for embedding ML models within hardware components like cameras and microphones to simulate the interactive behaviors of a pet. Real-time processing capabilities will be incorporated to ensure immediate system responsiveness. Testing and tuning phases will follow, where in the models and system functionalities will be refined based on performance outcomes to enhance reliability and user experience. A phased deployment strategy is proposed, beginning with controlled environment testing and gradually expanding based on user feedback.

Conclusion

In summary, my project aims to develop a Facial Recognition Pet Dog using Machine Learning, designed to offer both security and companionship where traditional pets are not doable. By utilizing the "Labeled Faces in the Wild" dataset, this synthetic dog will be trained to recognize and differentiate between familiar and unfamiliar faces.

Through the application of advanced algorithms such as CNN, SVM, and KNN, the project harnesses to process and analyze facial data efficiently. The process involves data preprocessing, model training, and evaluations to maintain performance integrity in diverse real-world conditions.