Comparative Evaluation of Feature Descriptors Through Bag of Visual Features with Multilayer Perceptron on Embedded GPU System

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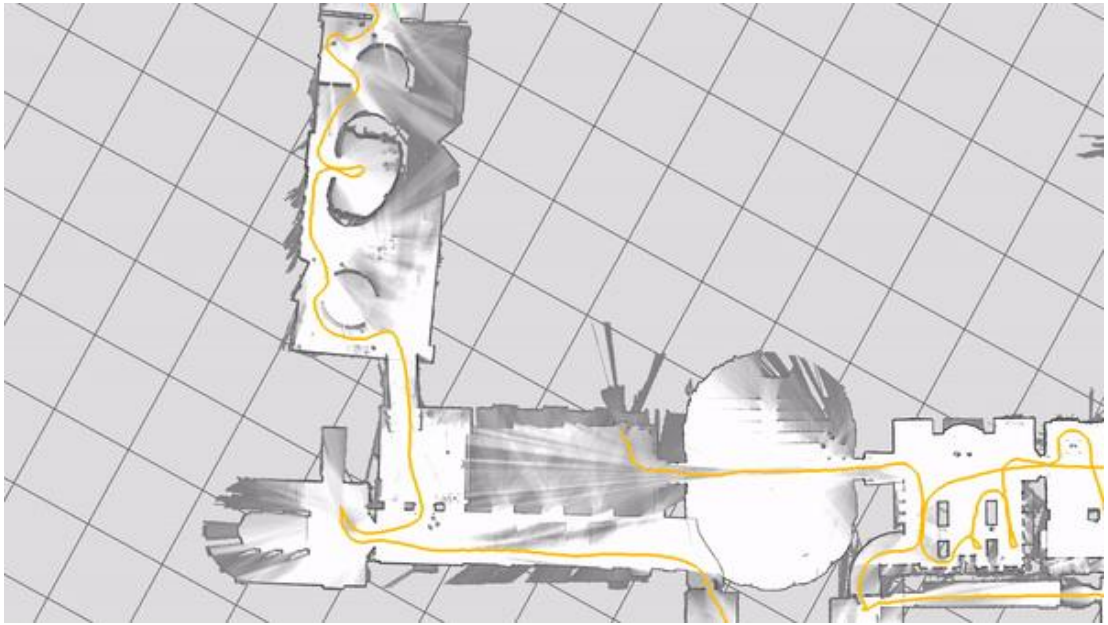
Loop Closure Detection (LCD)



* https://www.youtube.com/watch?v=-EQAJOoRqEQ

Problem Characterization

Many of the state-of-the-art techniques for the LCD problem are based on handcrafted resources and Bag of Visual Words (BoVW).

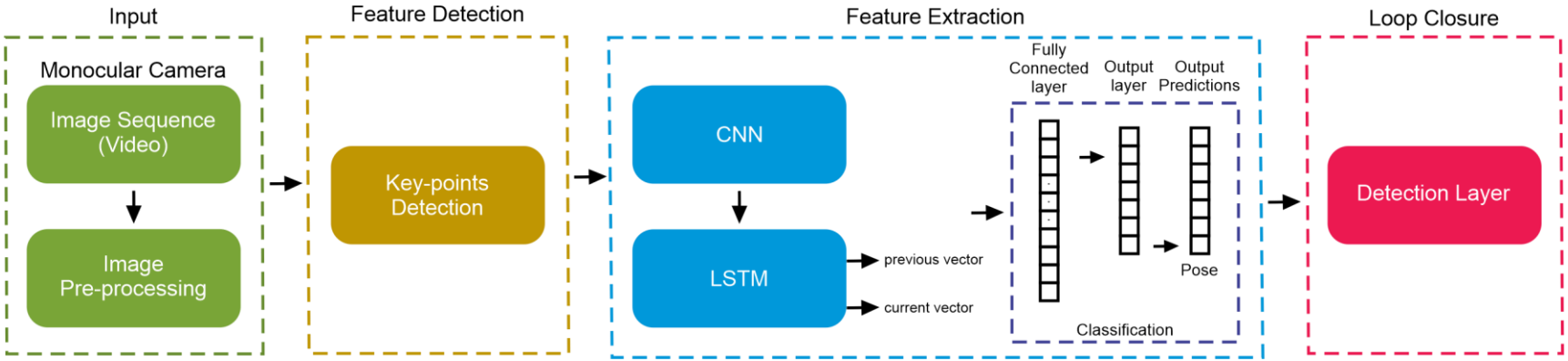
Even with advances in Machine Learning (ML) area, Deep Learning (DL) methods and Convolutional Neural Networks (CNNs) are not fully explored in the LCD problem context.

Objective

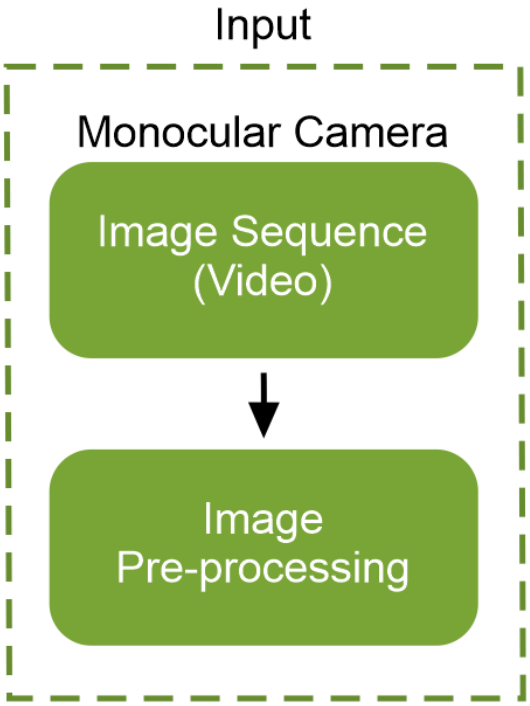
Construction of a system capable of solving the loop closure detection problem, with the purpose of correcting the drift in the estimated calculations of Visual Odometry for a VSLAM system.

Combining the use of an integrated Monocular camera with an adaptation of a hybrid model of Artificial Neural Network architecture - the Long Term Recurrent Convolutional Network for deployment on an embedded GPU system: NVIDIA’s Jetson Nano.

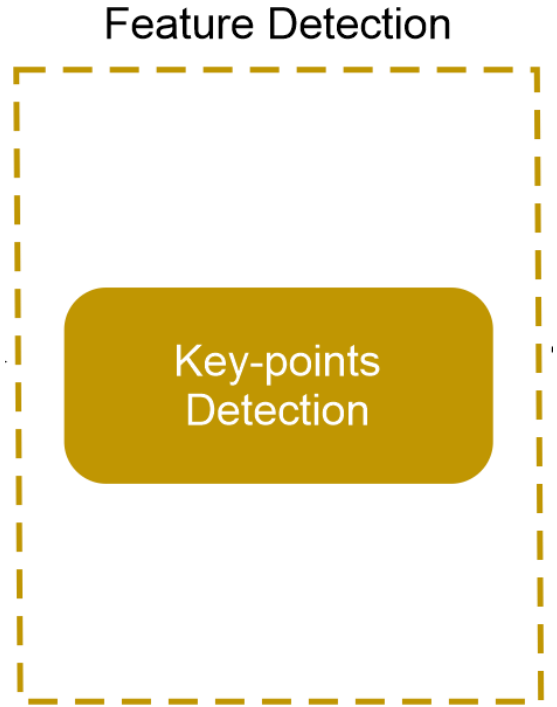
The Proposal



The Proposal



The Proposal



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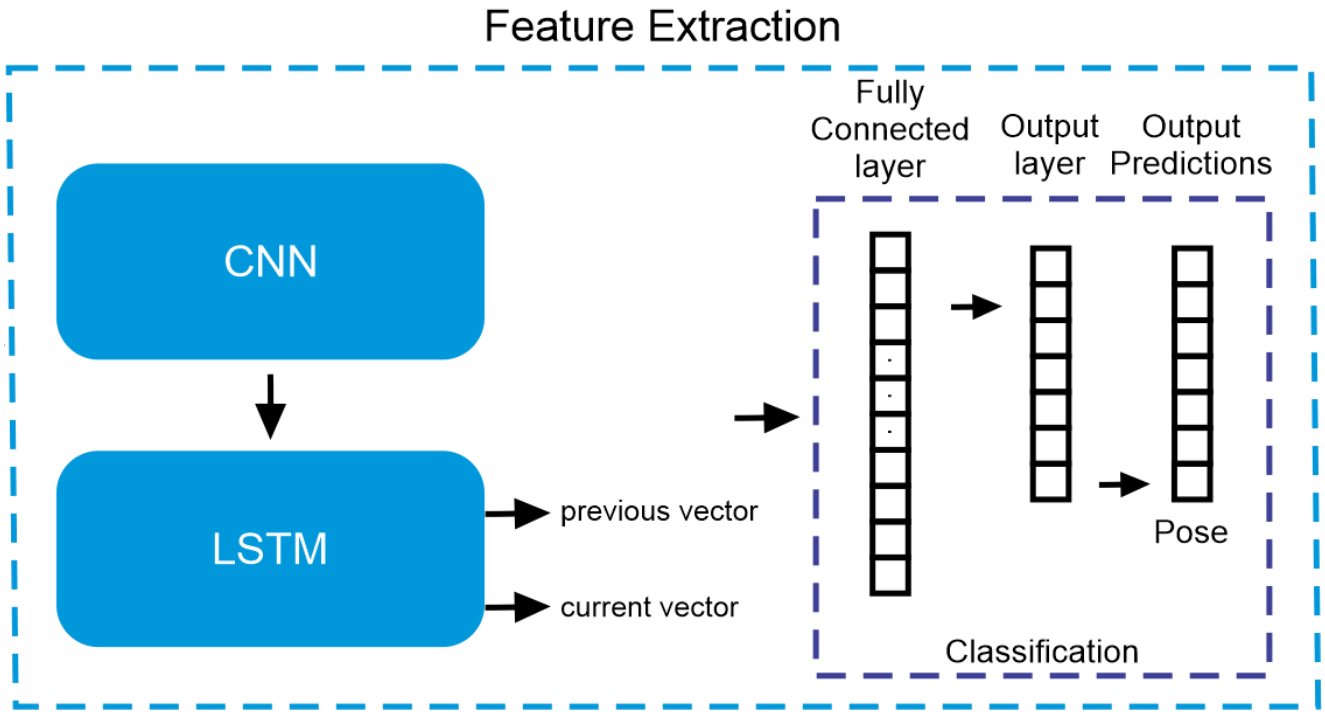
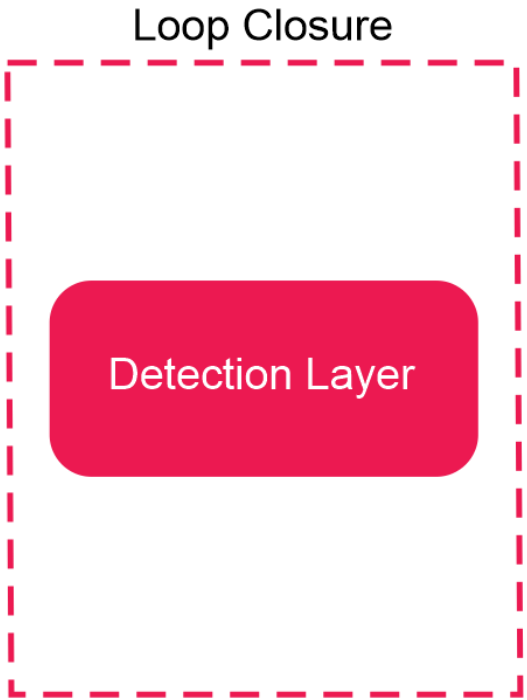


The Proposal



Proposed Approach

Evaluation of a Bag of Visual Features (BoVF) approach;

Extracting features through the Local Feature Descriptors and Local Binary Descriptors;

Recognition and classification tasks on six visual datasets through the Multilayer Perceptron (MLP):

MNIST, JAFFE, Extended CK+, FEI, CIFAR-10, and FER-2013.

Proposed Approach

We expect that the experiment and the preliminary simulations lead us in a right choice of a Descriptor that will be addressed in future work in the Feature Detection step, and reformulated in the Feature Extraction step into convolutional filters of the CNN architecture of the proposed system.

Proposed Approach

Best descriptor evaluation:

Local Binary Descriptors:

BRIEF, ORB, BRISK, AKAZE, and FREAK.

Additionally, three Local Features Descriptors:

SIFT, SURF, and KAZE.

Experiments and Results

JAFFE

48x48

FEI

120x120

MNIST

28x28

Extended CK+

48x48

CIFAR-10

32x32

FER-2013

48x48

Experiments and Results

Algorithms	Visual Datasets			
	MNIST	Extended CK+	CIFAR-10	FER-2013
SIFT	02:37	01:01	02:59	02:51
SURF	00:49	**00:16**	00:54	**00:25**
KAZE	02:59	01:02	02:59	02:52
ORB	**00:32**	00:17	**00:46**	00:39
BRISK	-	00:29	00:57	01:00

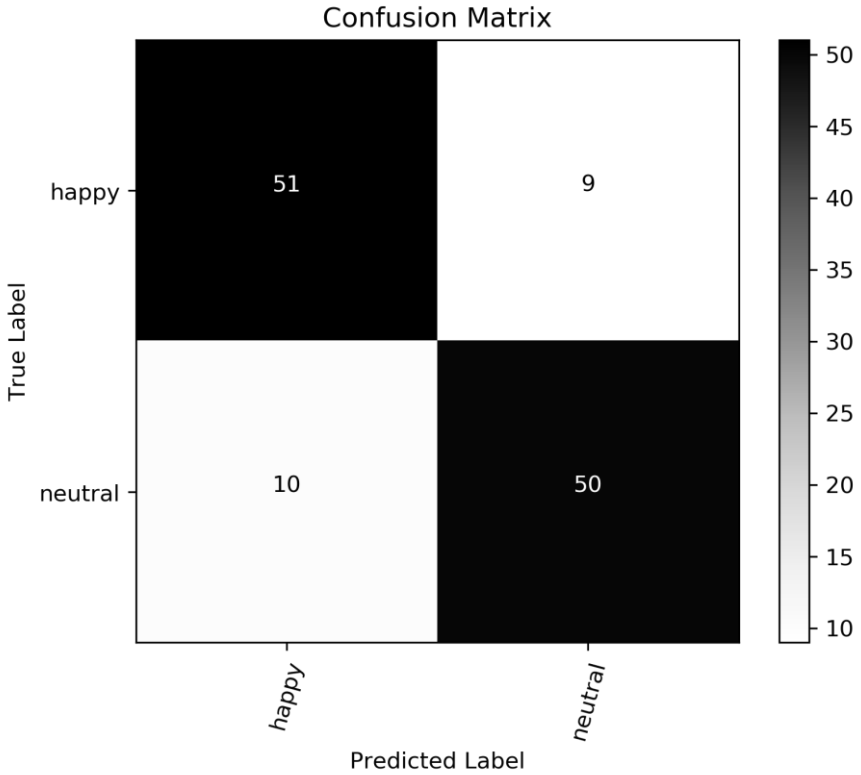
Experiments and Results

Algorithms	BoFV Indices Generation	Visual Datasets			
		MNIST	Extended CK+	CIFAR-10	FER-2013
SIFT	Training-set	01:04	00:11	00:56	00:33
	Test-set	00:35	00:04	00:46	00:25
SURF	Training-set	**00:13**	**00:10**	00:20	00:29
	Test-set	**00:09**	**00:01**	00:08	00:06
KAZE	Training-set	01:04	00:11	00:56	00:33
	Test-set	00:39	00:04	00:46	00:25
ORB	Training-set	01:02	00:12	00:55	00:33
	Test-set	00:16	00:01	00:20	00:09
BRISK	Training-set	-	00:10	**00:01**	**00:19**
	Test-set	-	00:02	**00:11**	**00:09**

Experiments and Results

Algorithms	Visual Dataset	Multilayer Percepton Models					
		MLP1	MLP2	MLP3	MLP4	MLP5	MLP6
SIFT	FEI	0.69	0.67	0.63	0.75	0.76	0.72
SURF		0.72	0.74	0.61	0.74	0.72	0.74
KAZE		0.62	0.62	0.63	0.58	0.67	0.68
BRIEF		0.78	0.74	0.77	0.76	0.82	0.85
ORB		0.50	0.57	0.58	0.65	0.64	0.70
BRISK		0.82	0.82	0.82	**0.85**	**0.84**	0.82
AKAZE		**0.85**	**0.87**	**0.83**	0.84	0.83	**0.86**
FREAK		0.47	0.47	0.47	0.51	0.51	0.54

Experiments and Results



Experiments and Results

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Datasets	Initial commit MNIST dataset	6 months ago
Figures/Datasets	Initial commit MNIST Training Losses	6 months ago
Outputs/Datasets	Initial commit MNIST SURF-outputs.txt	6 months ago
Saves/Datasets	Initial commit MNIST SURF MLP Models	6 months ago
LICENSE	Initial commit	7 months ago
README.md	Update README.md	7 days ago
datasets.py	Initial commit datasets.py	6 months ago
features.py	Initial commit features.py	6 months ago
globals.py	Initial commit globals.py	6 months ago
main.py	Correction of outputs files directory	5 months ago
multilayer.py	Initial commit multilayer.py	6 months ago

About

Comparative Evaluation of Feature Descriptors Through Bag of Visual Features with Multilayer Perceptron on Embedded GPU System, published in 17th IEEE Latin American Robotics Symposium/8th Brazilian Symposium of Robotics (LARS/SBR 2020)

opencv | python | opencv-python | feature-descriptors | sift | surf | kaze | brief | orb | brisk | akaze | freak | bag-of-visual-features | bovf | multilayer-perceptron | mlp | classifier | mlp-classifier | embedded-systems | nvidia-jetson-nano

Readme

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* https://github.com/whoisraibolt/BoVF-with-MLP-classifier

Conclusion

The descriptor to be addressed in future work of the proposed system has been defined, and now we can advance in the next steps in future work.

Our approach is promising, where we expect in the next steps of this work to demonstrate that the proposed methods reduce the computational complexity of the model and have the potential to perform the task of LCD for a VSLAM system.

Acknowledgment