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CHANGE DETECTION AND EXTRACTION OFINFORMATIONINREMOTE SENSINGIMAGES

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Abstract: *Change Detection is a very vital task carried out on this planet and has been colossally performed andalso researched in these recent decades. It has alwaysbeen applied in infrastructure and surface monitoringtechnique, disaster management, theuse in urban dynamics and other fields as well. Current methods always have a very simple mechanism where it has always been dependent for encoding bi-temporal independent images andobjects thus obtaining and performing on their representation vectors, but it ignores the vitality of trifling-layer informationwhich contains high-resolution and fine-grained functions and features which has often led to miss the small targets.In this paper our idea is to propose a system whichis based on densely connected Siamese networkuseful forchangedetectiontechniques.Ourmethodsoothelossoflocalization informationanddatawhichis donebyintroducingthenewmodulenamedattentionmechanismwhichhasbeenapplied atthe back ofinformationtransmissionmoduleinorderto givethat sort of attentionweightandtherequired accuracytoeachtemporal image feature and the classified extraction which eventually enhance the information that is changed for the imageor object we want to predict the change for and improves final change prediction. The idea revolves around the factthat bothquantitative and visualanalyses of the experimental results show that our method improves highly onmany evaluation criteria and the proposed method also has competitiveness and higher predictive ability amongotherchangedetectionmethods.*

KeyWord*: DeepNeuralNetwork, Remote Sensing,Attention Mechanism, Urban dynamics, Satellite Imagery, loss of localization Change Detection.*

I. Introduction

Change detection being a vital concept of image processing field, has a very lengthy history as far asresearch and its rise with the evolution of computer vision is concerned. Change detection can be stated asthe process of accuratelyanalyzing, extracting and determining changes on surface from a particular placehappeningindailylifeoveraperiodoftimeand in varyingperiods.Themainobjectiveandvision of the change prediction system is to firstly give a good-matched binary label to each pixel in an image that is basedon a pair of co-registered object pictures which is taken for given area at different times for the same specifiedlocation. A positively assigned label will show that the area which corresponds to the pixel has shown some changes in it. Thesechanges can be referred to urban expansion, population density, agricultural activities, land and vegetation alteration, disastermanagement and many more. Change detection is an important technology for mapping some important activities like urbanutilization, land utility, agricultural activities, video monitoring, and some types of image based analysis.In short terms,changedetectionmethods canbespecifically categorizedintothreeways:

1) Pixel level:This hasbeenthe most basic unitwhereit hasbeenintensively usedforobject analysisand Change predictiontechnology, and also it prominently and predominantly analyses the exact position where the change actually takes place and detects it accordingly.Butthedisadvantage of this type is thatthe efficiency obtained here is low,another reason is also the spatial and other characteristics which accounts to accurate detection are not considered, and also the anti-interference quality being poor (natural things are included like sun illumination angle as well asthesurfacehumidity).

2) Feature level: The data features & information is extracted from theoriginalimage that includes edge, shape, contour and texturewhichisdonepredominantlybyacertainalgorithmwhicheverfitsthebest,andthentheanalytical extractionandchangedetectionfor those extracted informationarecarriedoutextensivelywiththehelpof algorithm. This method operating on features has maximum operational efficiency than the pixel level-based method,and the feature attributes can also be judged with higher precision, strength and accuracy, thus owing to all theseadvantages it reduces the interference of any such external sources on the acquired outcomes to a certain extent. However, on theone hand, there are also some loopholes which can be found out in this technique which sums up with somedata that is lost in this process of feature extraction carried out with this technique, so it is difficult andtroublesome at times to provide subtle and precise information. Moreover, it also heavily relies on the outcome of featureextractiontoo,buttheprocesscarried out with featuresitselfiscomplex one.

3) Object-based level: These techniques are an integral and vital part and highly employedin the sphere of image analysis based on objects. The concept of images with objects, their feature extraction hasalways beensupported by it and therefore thechange definition administrated forchange detection by the model,can be defined OBCD as "the process of identifying differences". Using object-based image analysis, we have foundsignificant differences in geographic items at different times." OBCD has become extremely important and evenpopular and useful due to its increasing merits over approaches based on pixels which really boost this method. Becauseit's the aptitude to supply more positive outcomes within the extracted features with high distinctiveness of the modelwhich will better put light on the changed maps and parts. It perfectly covers certain particular objects that include roads,buildings,open vegetation,openfieldsandotherentities),andthuspredictschangessupportedtraining and developmentofimageandimagerecognitionapproach.Duringthispaper,wearegoingtopresentauniquespecification which works to combines CNN a best suited algorithm within the field of image classification withbidirectional longSTM network(BiLSTM)alongwiththe additionoftheaccuracy improving modules.Weadditionallyintroduced themechanism based on attentionintothechangepredictiontasksoastoenhancethedetectionperformanceandalsoreducethetrainingandexecutionti meforthepprimarytime.

II. RelatedWork

Lotsofchangedetectiontechniquesalltogetherwithdifferentapproachesandrequirementshavebeendevelopedforrem ote sensing applications. The recentdevelopment hasshownthe evolvementof two specific methods being carried out: one is change detection based on pixels and the other is based on objects which have been discussed earlier. The PBCD category which has been a primary technology utilized in thesector that is constituted of a direct, also comprising transform-related and based, classification related and comparison ofimages based on learning which is cordially done at the classification based on pixels. The Object based category where the objects aretaken into consideration that directly contains, extracted and composite change detection along with classificationat the article level for extraction of features thus doing the change detection results better. Change vector analysis has been developed for prediction of changes in many bands of images became very much famous. Its popularity was an outcome of its quality to calculate by subtraction of pixel vectors of its varied time dates. Previous researches and studies have stated that techniques includingimage differencing and post-classification comparison are the old processesused for predicting change. In these years, techniques like spectral mixture analysis, ANN and addition ofGIS and also to some extent remote sensing data have become very vital processes for change detectionapps.In general, variousalgorithmsare studied tofindthebest suitedchangedetection outcomesforaparticularapplication. Methods likeimagedifferencing,vegetation index differencing, image regression and rationing,change vector analysis and background subtraction are some of thealgebra methods helpful in change detection. The common factor in these algorithms is selecting particular thresholds to search and find out the changed areas. Excluding CVA, all these methods are lucid, and easy to work upon and interpret.The image differencing approach has a conceptual extension called as Change Vector Analysis. It predicts all those changes that are greater than the identified thresholds and also give us the précised change outcomes.Some predominant approaches based on the recent studies like KT,PCA,Chi-squaretransformations and Gramm–Schmidtare very much usefulinminimizingdataredundancy between bands and also to put data in derived components. But they cannotgive us that desired change matrices and also need selection of thresholds in order to guess the changed maps. One more demerit that can be taken out of it is itsdifficulty in guessing and labeling the change data on the classifiedimages. When it comes to changedetection, the recent developments have been seen inthe classification algorithm which gives higher accuracies.There are many such techniques and these include post-classification comparison being much vital one and also EM change. Techniques like hybrid change detection, unsupervised change detection and artificial neural network focus on the quality and quantity of training the given data in order to give us goodqualityresults. Themeritofthesetechniquesistheirqualityofprovidingchangemetrics

information and thus minimizing external effect from outer environmental differences and changes between the images taken temporally in the model

Table no .1 Literature Surveyfor variouschange detectiontechniques

Sr No	**Author**	**Technique**	**Topic**	**Characteristics**
1	Karthik Amin& Shivakumar B	ImageDifferencing	Imagedifferencing used forChangedetection: A study over areasurroundingKumta,India	Subtractthefirstdataimagefromthesecondone
2	Luigi.T.Luppino& Filippo.M.Bianchi	ImageRegression	Remotesensingimageregression forheterogeneouschangedetection	Relationship pixelvaluessubtractstheregressedimage
3	Sartajvir Singh &Rajneesh Talwar	ChangeVectorAnalysis	A Review over different changevectoranalysisalgorithms-based changedetectionmethods	It givestwooutputsthat are of spectralchange vector and total changemagnitudeperpixel
4	Alina Miron&Atta Badii	BackgroundSubtraction	Change detection based on graphcuts	Background image is subtracted from the base image(original image) to produce new image as an outcome
5	EktaerinaKalinicheva& DinoLenco	UnsupervisedChangeDetection	Unsupervised Change DetectionAnalysisinImageryTimeSeries Using Deep LearningcombinedWithGraph-BasedApproaches	Selection of spectrallysimilargroupofpixelsandclusterdata
6	EktaerinaKalinicheva& DinoLenco	Gramm–Schmidt(GS)	Automaticchangedetectioninmulti-temporal X- and P-bandSARimages usingGram-Schmidtprocess	Spectralvectors which are taken directly from bi- temporalimages are orthagonalized by GS method
7	HakanAlphan&M.AliDerse	Vegetationindexdifferencing	Change detection in SouthernTurkey using normalizeddifference vegetationindex(NDVI)	Vegetationindex is producedfollowed by subtraction of the second-datevegetation index which is subtracted from the first-datevegetationindex
8	X.Liu&R.G. LathropJr	Artificialneuralnetworks	Urbanchangedetectionbasedonanartificialneuralnetwork	The spectral data of theperiod ofchange is the input that is used to train the neuralnetwork
9	Dengsheng Lu,Mateus Batistela&EmilioMoran	Spectralmixturemodel	MultitemporalSpectralMixtureAnalysisforAmazonianLand-Cover ChangeDetection	Usesspectralmixtureanalysistoderivefractionimages.
10	EmilioMoran, PaulMausel, Dengsheng Lu&Eduardo S.Brondízio	Biophysicalparametermethod	Anautomaticapproachforchange detection and landupdates based on integratedNDVI timing	Integrationof fieldmeasurements is done in order to develop a biophysical parameterestimationmodel

III. Methodology

ConvolutionalNeuralNetwork(ConvNet/CNN)canbestatedasadeeplearningalgorithmwhichtakesinaninputimage,as signvitalitytovariousaspectsorwecansayparametersintheimageandbeabletodifferentiate
one from the other which makes it very much useful in change detection. A CNN model we used has hidden layers which are vital to extract informationfrom animage.Thefourvitallayersin CNNare:1]Convolutionlayer. 2]ReLUlayer.3]Poolinglayer.4]Fullyconnectedlayer.

PROPOSED FRAMEWORK

Below diagram elaborately explains the whole network framework. As shown in Fig. 1, the architecture of the method iscomprised of four parts right from bottom to top, which includes convolution module followed by information transmissionmodule carrying out information extraction, the newly addedattentionmoduleandat the end is the outputmodule.TheconvolutionmoduleisaCNNandRNNbasedmoduleincluded in our system which has been configured in order to carry out features extraction on bi-temporal basis on those blocks of input images with the help oftwo convolutional neural networks that are independent and are bestsuited inthe fieldof image classificationandtemporal analysis. Along with the convolutional module, the very important information transmission module that is useful for featureextraction takes help of the feature mapsthat are obtained and extractedby the convolutionmodule as an input which in turn helps to perform the transmission and interaction ofthosefeaturesandtheirfunctionalityoftheimages which are bi-temporal in nature

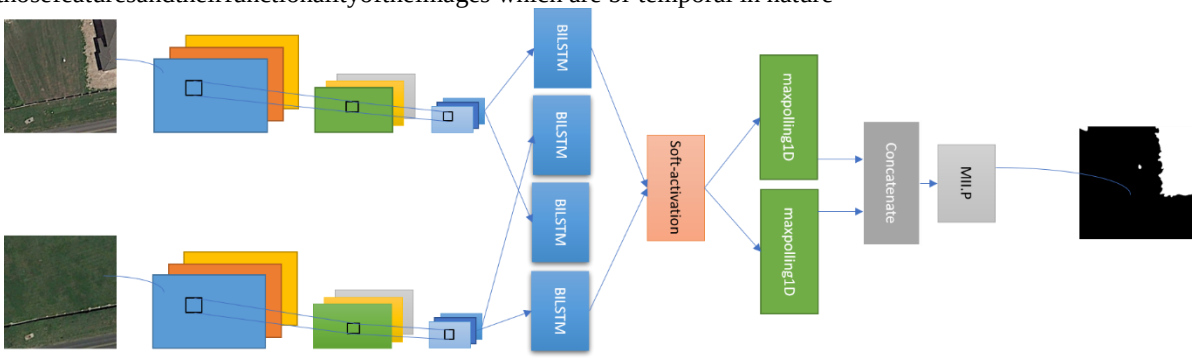

Fig.1TheOverallFrameworkofProposedModel

NOVELTY OF OUR WORK

The third and the newly added module in our system which is an attention module that give us the specific weight which we call as attention weight to the state that is hidden of each and every branch image feature of our model. Thus, has helped us achieve higheraccuracy as compared to the existing system. The attention module has not only precisely predicted the change buthas also helped in reducing the computational time. The output module is a comprised and constituted of layers that are full connected and widely used in models covering classification problems.We can also deploy a specific part of thechanged and unchanged parts in the form of training set and other one as test set which has helped us to generate change detection imageswith the utility of deep neural network and thus we can evaluate them for further prediction. Even though differentmodules have made the network,it canbe trained,checkedandvalidated end-to-end withthe help of back-propagation algorithm. We found that the manual extraction of image features is very much time consuming and tedious job to do whichis also quite troublesome at times, and the image features which are then extracted are relatively too simple, the spectral spatial featuresare thus extracted directly with the powerful feature extraction ability of CNN that is used for image classification. We deployedBiLSTM in order to capture the feature dependencies bidirectional in nature. We also have to take the feature representations into accountability.Therefore,theadditionalinformation transfer moduleis proposed, addedand integrated for this purposethroughoutthenetwork framework in our model.

In recent years, the integration of deep learning and visual attention mechanism has mostly been focused on the useof mask in order to form attention mechanism. The principle of attention mask is to identify the key features in theimage data by another layerof weight, and throughlearning and training,the deep neural network canlearn theareas and locations that need attention in every new picture. The attention module and its output shapehave alwaysbeentwodimensional,whiletheinputshapesofthefullyconnected layeralways beenone-dimensional.

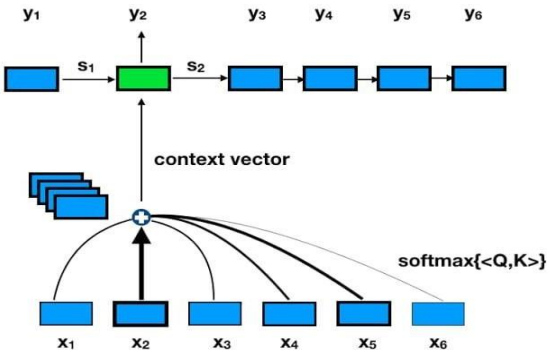

Fig.2TheInternalStructureofAttentionModel

IV. ExperimentalResults

The proposed system and model was experimented by us, also evaluated and thus tested with the help of the real images. For generating datasets we used remote sensing images that were season-varyingobtained from official sites. We got such various pairs of images having suitable resolution of 3000x2000 pixels forcreation of manual ground truth andalsogot imagepairs which were also varying alongwith smallchangesandtheir resolutions were taken as 1700×1200 pixels for addition of the additional images that was done manually. Images obtained spatial resolutions varying from 3-100 cm/px. Objects withdifferent sizes were taken into account as a result of this.It also led to take different objects varying also from season changes of natural objects Datasets was thus finally generated with the help of cropping of 256×256 fragments which were randomly rotated where that location had at least a part of the main aimentity, image or object on it. Therefore, there was a huge difference in the object centercoordinates and distance between object centers was 32 pixels which were fixed. At the end,9000image sets were constituted in datasetsthat had an image size of 256×256pixels:we worked upon 10000trainingsetsand precisely on 6000validation and testingsets. We found the accuracy to be 99% and F1 score came out to be 96% which was higher than theexistingmodelsusedforthechangedetectiontechniques.

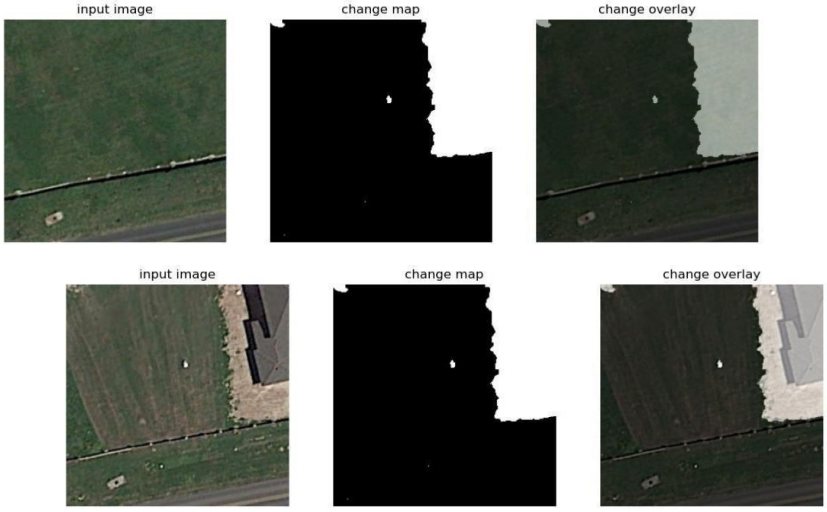

Fig. 3 Output images of Change Detection along with change overlays

IV. Discussion

Change detection in land covers plays a very vital and gigantic role in the study of overall outcomes that havebeen taking place worldwide and causing a very huge impact on the biodiversity of the world. Change in the land and the alterations done by living beings and changes occurring constantly havepredominantly resulted in cutting of trees, land degradation, soil erosion,increasing pollution, global warming and also rapid growth in naturaldisasterslike,earthquakes,etc.Thenaturalalterationstoohave contributed tothepurposeforthesame.These rapid

environmental problems are always coined to land cover changes and its alterations happening around. Thus, whatever data that is available onLand use orwe cansay Land Coverchanges can give us critical input which is functional to decision-making of environmental stability and thus we can predict the future accordingly. The population growth in thearea and increasing socio-economic necessities of man preceded by the increasing demands creates such stress onland use/land cover which is creating havoc. There are several methods developed in literature surveys done in thepastyearslike using postclassificationcomparison,change vectoranalysis,using ANN,imagedifferentiation being one, then image regression, using image ratio, manual on-screen digitizationofchange principal components analysis too, image differencing and lastly multi date image classification. The purpose of the study is to look for landcover changes using the combination of RNN & CNN which is found to be more effective and will prove to be vitalforchangedetectionwiththeadditionofnewattentionmechanismmoduleinthemodel.

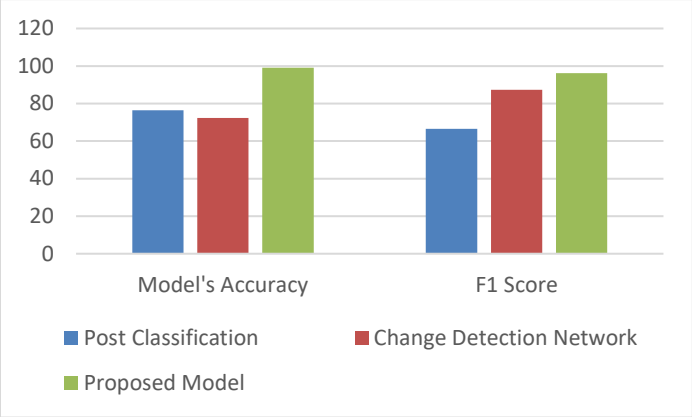

Fig.4ModelAccuracy&F1 Scorescomparison

V. Conclusion

Here, we have proposed a neural network architecture that puts light on attention mechanism as well as information transmission module, the later one being vital to extract spatial temporal features which are joint spectral in naturefrom bi-temporal spectral images, that alsoutilizes the rich feature information. Also, for further capitalizing and improving the information of image change, we added mechanism of attention to our model and thentrained our model for the outcome.All these changes have made it a best suited approach for multi-temporaldata analysis for remote sensing and the best suited approach for change detection. The results from experiments show thatthe method we proposed canalso give a tough battle to the state-of-the-art approaches thenpredictthe changes in the geographicalareapreciselyandevenperforms betterifthedatasetsistrainedeffectivelywithlargenumberofimages.

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