Computation and Communication Technologies

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Preface

I am happy to write the preface for the IDES joint International conferences. The joint conferences have attracted 39 papers for registration for the conference. The topics are Computer Science, Electrical and Electronics. There has been good response for the conference from the different parts of the world. However keeping in concern the quality of the conference and the current need to reach quality to the audience, the organizers has made sincere effort to keep the quality of the conference high.

The conference has attracted papers in areas of computer science in thrust areas of machine learning, networking, cloud computing. There has been papers accepted giving focus to modelling in applications like facial recognition systems. Certain papers have good quality as it shows several months of extensive research being done in the same area. I wish the conference organizers a grand success and suggest them to conduct more quality conferences in the future for the research community. I suggest the participants to present the papers in good spirit and take discussions with the research experts as part of the conference.

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Amrita School of Engineering, India

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Adeetya Sawant [1] and Sudha Gupta [2]

Iris Recognition using Support Vector Machine

Abstract: Biometrics involves identification of an individual from certain secernating features of human beings. These include speech, retina, iris, fingerprints, facial features, script and hand geometry. Amongst these, iris is unique, has highly discerning pattern, does not change with age and is easy to acquire. This work concentrates on iris recognition system that consists of an automatic segmentation system based on Hough transform, which separates out the circular iris and pupil region, occlusion of eyelids and eyelashes, and reflections. The extracted iris region was then normalized to constant dimensions to eliminate imaging inconsistencies. Further, 1D Log-Gabor filter was extracted and quantized to four levels to encode the epigenetic pattern of the iris into a bit-wise biometric template. SVM has been used for classification purposes which is a kernel-based supervised method. RBF kernel proves to be more prominent over Polynomial kernel.

Keywords: Iris Recognition; Hough transform; Normalisation; Support Vector Machine; Kernel function

1 Introduction

The field of biometrics contributes significantly to systems wherein security and personal authentication are of utmost importance. The need of a robust biometric technology arises due to the increase in number of frauds and security breaches. The traditional technologies currently used for personal identification and data privacy, such as passwords (something you know and can be easily forgotten), cards or keys (something you have and can be copied), are proving unreliable [8]. Thus, biometric technology outwits the conventional methods of identification and verification since it involves recognition of an individual by incorporating directly the peculiar characteristics of human beings which

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cannot be borrowed, stolen or forged by any means. Biometric-based systems provide trustworthy solutions to safeguard confidential transactions and personal information. The demand for biometrics can be found in federal, state and local governments, in the military, and in commercial applications. The iris is an externally visible, yet protected organ whose unique epigenetic pattern remains unchanged throughout adult life [5].In the training process, features which are extracted are stored in the database, while the matching process correlates the extracted features with stored features. Both training and matching process consists of image acquisition, iris localization [10] using Hough transform followed by Canny edge detection [3], iris normalization [1], and feature extraction with the help of Gabor wavelet [7]. As suggested in [9][6], Support Vector Machine performs more efficiently for biometric classification.
The vision behind this work is:

- To obtain features which best distinguishes the data.
- To evaluate Support Vector Machine for Iris recognition.
- To find out the optimum kernel parameter and cost function to obtain acceptable performance.

The organization of this paper is as follows. First, section II describes the related work on image pre-processing for iris recognition. Feature extraction technique is described in Section III. Matching approach using Support Vector Machine has been discussed in Section IV. Experimental approaches and results are analyzed in section V. Finally, section VI concludes this paper.

2 Image Preprocessing

Image Preprocessing is performed to increase recognition accuracy [5]. This mainly includes segmentation and normalization. Along with Iris, eye region is comprised of certain regions such as pupil, sclera, eyelids, eyelashes, eyebrows and reflections, which are redundant. Segmentation aims to eliminate such inconsistencies. The steps for recognition can be summarized in Figure. 1.

3 Image Acquisition

Samples of iris are taken from CASIA database [5]. Good segmentation is provided by this database, since iris pupil boundary and sclera boundary is clearly distinguished, samples from this database is taken for iris recognition specifically. Iris radius range varies from 90 to 150 pixels, while that of pupil radius ranges from 28 to 75 pixels.

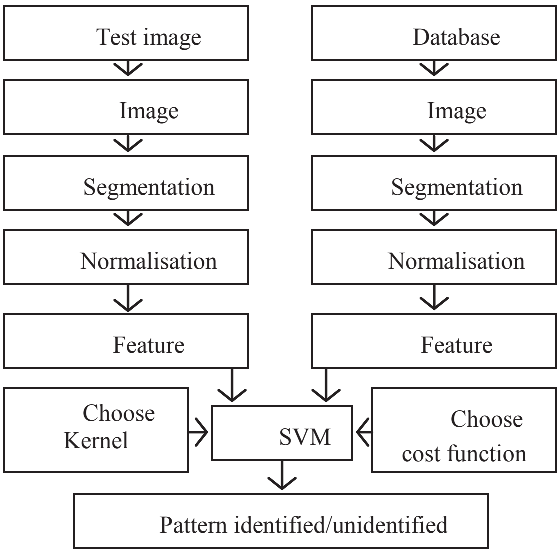

Figure. 1: Flow diagram of the system

3.1 Iris Localisation

The technique used to identify the iris and pupil boundaries is Circular Hough transform [3]. At first Edge map is generated by employing Canny edge detection. Gradients were based in the vertical direction for the outer iris/sclera boundary. Vertical and horizontal gradients were weighted equally for the inner iris/pupil boundary.

Initially the Hough transform for the iris/sclera boundary was computed followed by the Hough transform for the iris/pupil boundary within the iris region. This ensures an efficient and accurate process for circle detection, since detecting the pupil within the iris region would be easier instead of the whole eye region. Once the above process is complete, six parameters are recorded, the radius, and x and y center coordinates for both circles.

3.2 Eyelid Occlusion

The linear Hough transform is applied to the upper and lower eyelids and they were isolated by first fitting a line [5]. Then, a horizontal line is fitted, such that it intersects with the first line at the edge of iris nearest to the pupil. Eyelid regions are isolated to a maximum by the horizontal line. Only horizontal gradient information is retained from the edge map created by using Canny edge detection. The eyelid detection system was found to be effective, and fairly managed to detach most occluding eyelid regions.

3.3 Normalisation

The next stage after productive segmentation of the iris region from an eye image is to transform the iris region so that it has fixed dimensions in order to make comparisons possible [10]. The disparities in dimensions between eye images result from stretching of the iris due to pupil dilation caused by varying levels of illumination. Other sources of inconsistency include rotation of the eye within the eye socket, fluctuating imaging distance, turning of the camera and head tilt. The result of the normalization process enables iris regions to have fix dimensions, so that two images of the same iris under contrast circumstances will have characteristics with same location in feature space. For normalization of iris regions a technique based on Daugman's rubber sheet model is employed as shown in Figure. 2.

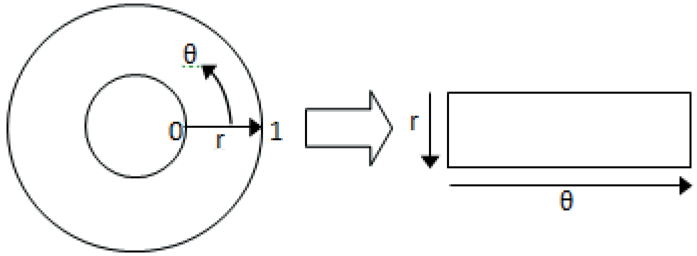

Figure. 2: Daugman's rubber sheet model

The remapping of the iris region from *(x, y)* Cartesian coordinates to the normalized non-concentric polar representation is modeled as

$$I(x(r,\theta)y(r,\theta)) \rightarrow I(r,\theta) \quad (1)$$

With

$$x(r,\theta) \rightarrow (1-r)x_n(\theta) + rx_l(\theta) \quad (2)$$
$$y(r,\theta) \rightarrow (1-r)y_n(\theta) + ry_l(\theta) \quad (3)$$

Where *I(x, y)* is the iris region image, *(x, y)* are the original Cartesian coordinates, *(r, θ)* are the corresponding normalised polar coordinates, and x_p, x_p and x_l, y_l are the coordinates of the pupil and iris boundaries along the θ direction.

4 Feature Extraction

Accurate recognition of an individual can be achieved by extracting the most distinguishing information contained in an iris pattern. Only the noteworthy features of the iris are encoded so that comparisons between templates can be made. Feature encoding is implemented by convolving the normalised iris pattern with 1D Log-Gabor wavelets [5]. The 2D normalised pattern is broken up into a number of 1D signals. Then these 1D signals are convolved with 1D Gabor wavelets.

$$G(f) = \exp\left(\frac{-\left(\log\left(\frac{f}{f_0}\right)\right)^2}{2(log(\frac{\sigma}{f_0}))^2}\right) \quad (4)$$

Where f_0 and σ are parameters of the filters, f_0 will give centre frequency and σ gives bandwidth of filter.

The Feature matrix consists of three features:

- Difference between radius of pupil and sclera.
- Distance between centre coordinates of pupil and sclera.
- Iris patterns (using 1-D Log Gabor wavelet).

5 Classification Algorithm

Support Vector Machine has been used as a classifier. SVM is supervised kernel based statistical learning theory [5]. A SVM kernel maps the low dimensional points of the input space (feature matrix) to the higher dimensional feature space.

The input data points of various classes are separated by means of a hyperplane which is optimally determined from feature space. This enables the SVM to recognize and classify the patterns. An input to SVM model and SVM is trained in such a way that the direct decision function maximizes the generalization ability for the classification. Consider that M, m dimensional training inputs xi, (i = 1, · · ·, M) belong to class 1 or class 2 and then the associated labels be yi= 1 for class 1 and yi= −1 for class 2. If this data is linearly separable, the decision function is determined by:

$$D(x) = w^T x_i + b \tag{5}$$

Where w is an m dimensional vector, b is a bias term, and i varies from 1 to M.

$$w^T x_i + b \begin{Bmatrix} \leq 1, & for \;\; y_i = -1 \\ \geq 1, & for \;\; y_i = \;\; 1 \end{Bmatrix} \tag{6}$$

This equation can be precisely termed as:

$$y_i(w^T x_i + b) \geq 1, \; for \;\; i = 1,2, \ldots M \tag{7}$$

The convex quadratic optimization problem for w, b and ξ can be solved to obtain optimally separated hyper plane by the following equation.

$$minQ(w, b, \xi) = \frac{1}{2}\|w^2\| + C\sum_{i=1}^{M} \xi_i \tag{8}$$

subject to:

$$y_i(w^T x_i + b) \geq 1 - \xi \;, \xi \geq 0, \; for \; i = 1,2, \ldots\mathrm{M} \tag{9}$$

where, $\xi = (\xi 1, \cdots, \xi M)^T$ is non-negative slack variable ($\xi \geq 0$) and C is the margin parameter which is used to ascertain the trade-off between the maximization of the margin and the minimization of the classification error. Linear separability can be enhanced by employing a kernel function which maps the input feature set to its higher dimensional space known as feature space. In SVM, selection of kernel depends upon the nature of pattern to be classified. Once the kernel is selected, the values of kernel parameter and the margin parameter C can be determined [4]. The value of kernel parameter decides the complexity and the generalization capability of the network, which has an influence on the smoothness of SVM response and it affects the number of support vectors. Hence, to build an optimised classifier, the optimised value of margin parameter and kernel parameter must be determined. This is called as model selection. In this work cross-validation procedure has been used to avoid over fitting problem for model selection [2]. In cross-validation a complete training set is divided into v subsets of fixed size, then sequentially one subset is tested using the classifier trained on the remaining (v − 1) subsets. In this way each instance of the whole training set is predicted once during SVM modeling. Output matrix from 1-D Log Gabor filter is used as input feature vector to SVM for training, testing and classification. SVM modeling steps are as follows:

- Data acquisition: Feature matrix obtained from 1-D Log Gabor wavelet.
- Kernel selection: The different kernels are applied to the input which shows that the RBF kernel gives maximum training accuracy. Hence, RBF kernel has been selected.

Model selection: Using cross-validation, find out the optimal values for kernel parameter and cost function.

6 Experimental Results

Selected raw data from CASIA database shown in Figure. 3 being optimally preprocessed is subjected to normalization.

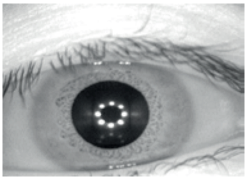

Figure. 3: Original image from CASIA database

Normalization remaps iris image from Cartesian form to non-concentric polar form. Before doing this non-relevant data such as eyelid, eyelashes and pupil has been removed from original image which is shown in Figure. 4

Figure. 4: Occlusion of eyelid, eyelashes and pupil region

Normalized image shown in Figure. 5 has a constant dimension of 250x30 on which then Gabor filter is applied to get feature matrix.

Figure. 5: Normalised image from Original image

Feature matrix of size 54x6, where 54 denotes number of training samples and 6 are number of features, is given as an input to SVM which is use as a classifier. Results show that Radial Basis Function (RBF) kernel gives more accuracy than other (Polynomial) kernel.

The training and testing accuracies for Polynomial and RBF kernel are given in Table 1 and Table 2.

Table 1. Accuracy for Polynomial kernel, γ=0.25

Cost Function C	Training Accuracy %	Testing Accuracy %
0.002	88.86	72.72
0.02	90.74	72.72
0.2	64.81	64.64
0.8	87.03	54.54
1	87.03	54.54
4	87.03	45.45

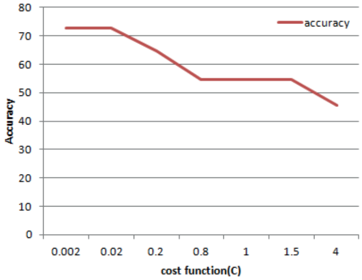

Figure. 6: Accuracy for Polynomial Kernel

Table 2. Accuracy for RBF kernel, C=0.02

Kernel Parameter γ	Training Accuracy %	Testing Accuracy %
0	94.44	81.81
0.5	94.44	81.81
0.2	94.44	81.81
0.25	94.44	90.90
0.35	94.44	90.90

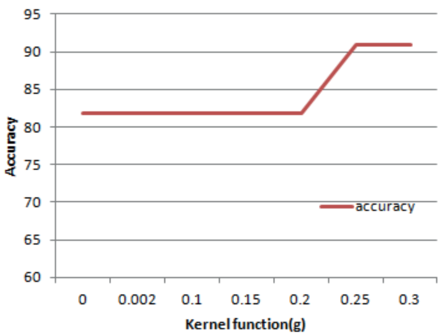

Figure. 7: Accuracy for RBF Kernel

In Figure. 6 Polynomial kernel is chosen where kernel parameter is taken as 0.2 and value of C is varied to get accuracy. It is shown that accuracy is 72.72% maximum for C ≤ 0.02.

Whereas in Figure. 7 RBF kernel is used where C = 0.02 and value of kernel parameter is varied to get optimum accuracy. It is shown that accuracy is 90.90% maximum for ≥ 0.25.

Conclusion

Iris recognition system has been successfully implemented using SVM algorithm and gives highly accurate results for human identification and verification for mentioned feature set. The proposed work can perform better if segmentation algorithm gives eyelid and eyelashes detection more efficiently. Iris liveness detection and fake iris can be a issue that should be handled carefully. Hence for relative high performance multi-modal biometric recognition can be proposed. From the results obtained, we can conclude that RBF kernel of SVM gives maximum testing accuracy. The strategy adopted in this work can prove beneficial for different real world biometric assessment systems.

References

1 Ali, A. N. (2013, November), "Simple features generation method for SVM based iris classification", In 2013 IEEE International Conference on Control System, Computing and Engineering (ICCSCE), pp. 238-242

2 Burges, C. J. (1998), "A tutorial on support vector machines for pattern recognition", Data mining and knowledge discovery, 2(2), pp. 121-167.

3 Elgamal, M., & Al-Biqami, N. (2013), "An efficient feature extraction method for iris recognition based on wavelet transformation", Int. J. Comput. Inf. Technol, 2(03), 521-527.

4 Gonzalez, R. C., Woods, R. E., & Eddins, S. L. (2004), "Digital image processing using MATLAB", Pearson Education India, pp. 407-421.

5 Gupta, S., Doshi, V., Jain, A., & Iyer, S. (2010), "Iris recognition system using biometric template matching technology", International Journal of Computer Applications, 1(2), pp. 1-4.

6 Gupta, S., Kambli, R., Wagh, S., & Kazi, F. (2015), "Support-Vector-Machine-Based Proactive Cascade Prediction in Smart Grid Using Probabilistic Framework", IEEE Transactions on Industrial Electronics, 62(4), pp. 2478-2486.

7 Lee, T. S. (1996), "Image representation using 2D Gabor wavelets", IEEE Transactions on Pattern Analysis and Machine Intelligence, 18(10), pp. 959-971.

8 Mabrukar, S. S., Sonawane, N. S., & Bagban, J. A. (2013), "Biometric system using Iris pattern recognition", International Journal of Innovative Technology and Exploring Engineering, ISSN, 2278-3075.

9 Son, B., Won, H., Kee, G., & Lee, Y. (2004, October), "Discriminant iris feature and support vector machines for iris recognition", In 2004 International Conference on Image Processing (ICIP'04), Vol. 2, pp. 865-868.

10 Zafar, M. F., Zaheer, Z., & Khurshid, J. (2013, January), "Novel iris segmentation and recognition system for human identification", In 2013 10th International Bhurban Conference on Applied Sciences and Technology (IBCAST), pp. 128-131.

Vivek Sharma [1], B. B. Sharma [2] and R. Nath [3]

Nonlinear Unknown Input Sliding Mode Observer for Chaotic Synchronization and Message Recovery

Abstract: Unknown Input Observers (UIOs) have been designed for both linear and nonlinear systems, to estimate the states when excited by some unknown input. These observers find their extensive application in Fault Detection and Isolation (FDI), considering fault to be an unknown input. UIO designed using Sliding Mode approach has the additional advantage of easy reconstruction of unknown input using equivalent output injection. For this reason sliding mode observers (SMO) have also been used in secure communication to recover unknown message signal. Sliding Mode approach is known to be robust against matched uncertainties but its performance degrades in the presence of unmatched uncertainties. In present work, Nonlinear Unknown Input Sliding Mode Observer (NUISMO) is proposed to achieve synchronization and recover message while considering unmatched uncertainty in the chaotic transmitter. First, LMI (Linear Matrix Inequality) condition is derived to decouple the unmatched uncertainty and then sliding mode technique is used for synchronization and message recovery. Simulation results are presented on third order Chua circuit and a Rossler system to show the efficacy of proposed approach.

Keywords: Unknown Input Observer (UIO), Linear Matrix Inequality (LMI), Sliding Mode Observer (SMO), Chaos Synchronization and message recovery.

1 Introduction

Design of observers for linear and nonlinear systems has been a benchmark problem in control engineering. Sliding mode control and observer design

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technique is used extensively in systems having uncertainties associated with their dynamics. In sliding mode control the system is constrained on sliding surface using discontinuous control and operates with the reduced order dynamics while in sliding mode. Moreover, it is known for its ability to be robust against matched disturbances and uncertainties. Sliding mode control became popular since the pioneer work of Utkin (Vadim, 1977) in Soviet Union. Sliding mode control is considered problematic for many control applications because of its discontinuous nature and chattering, but in observer design it is easily implemented in software (Spurgeon K. S., 2008). One of the early contribution in sliding mode observer design came from (Slotine, Hedrick, & Misawa, 1987). (Walcott & Zak, 1987) gave structural conditions which linear systems must qualify for the existence of sliding mode observer. (Edwards & Spurgeon, 1998) proposed coordinate transformation to represent linear system in canonical form and further gave necessary and sufficient conditions for the existence of sliding mode observer based on this canonical form. Unknown input observers are important for systems subject to disturbances or with inaccessible inputs, and are of use in many applications such as fault detection and isolation (FDI) (Venkatasubramanian, 2003) or parameter identification. (De Persis, 2001) used differential geometry approach to the problem of FDI for nonlinear systems. (Patton, 1997) addressed robustness issue in FDI using unknown input observers. Unknown input observer for linear system have been proposed by (Darouach, Zasadzinski, Xu, & al, 1994) and (Chen, Patton, & Zhang, 1996). The concept of decoupled unknown input used by (Chen, Patton, & Zhang, 1996) was extended to nonlinear systems by (Chen & Saif, 2006) and (Imsland, Johansen, Grip, & Fossen, 2007). Similar to equivalent control, (Edwards, Spurgeon, & Patton, 2000) developed the methodology of equivalent output injection to reconstruct the actuator fault signal. Later, the work was extended to include sensor fault (Tan & Edwards, 2002) and fault reconstruction in the presence of uncertainties (Yan & Edwards, 2007). While the error trajectories are in sliding mode, because of the designed dynamics on sliding mode error converges to zero. When error has significantly converged to zero, unknown input because of fault can be recovered from equivalent output injection.

Such Unknown input observers for fault detection and isolation have also been extended to recover message signal in secure communication using chaotic transmitter and receiver (Observer), considering message signal to be unknown input (Bowong & Tewa, 2008). Chaotic systems are the subclass of nonlinear systems which show high sensitivity to their initial conditions and exhibit oscillatory behavior but these oscillations are non-periodic in nature (Boccaletti & al., 2002). In the pioneering work of (Pecora & Carroll, 1990), it was proposed that chaos synchronization can be used for secure communication. Since then, chaos synchronization for secure communication has been explored to a great extent (Kocarev, Halle, Eckert, Chua, & Parlitz, 1992), (Fallahi & Leung, 2010), (Theesar & Balasubramaniam, 2014), (Sharma & Kar, 2009), (Sharma & Kar, 2011) using various methodologies. (Fallahi & Leung, 2010) proposed chaotic multiplication modulation, and for message recovery Extended Kalman filter (EKF) based receiver was designed. (Theesar & Balasubramaniam, 2014) used sampled data feedback controller is for the synchronization of chaotic Lur'e system. Along with other techniques, sliding mode has been used for its ability to be robust against matched uncertainties but its performance degrades in case of unmatched uncertainties. To make it robust against unmatched disturbances, strategy has been to use hybrid approach (Spurgeon & Davies, 1993), like design of optimal sliding surface using min-max control (Poznyak, Shtessel, & Gallegos, 2003), or LMI based approach in which sliding mode dynamics becomes invariant to mismatched uncertainties (Choi, 2003).

Keeping in view the present state of art in the field of nonlinear unknown input observer (NUIO) and their applications, nonlinear unknown input sliding mode observer (NUISMO) based synchronization scheme is presented in the presence of unmatched uncertainty. Methodology adopted here assumes bounded nature of nonlinearities which is common in many nonlinear systems, especially chaotic systems. Using the scheme, secure communication using chaotic transmitter – receiver configuration, in the presence of unmatched uncertainties is proposed. Here LMI condition is derived for the existence of NUIO, which can decouple the unmatched uncertainties and further the error dynamics become independent of unmatched uncertainties. Along with that, existence conditions for the feasibility of LMI solution are also proposed. Synchronization between system and observer is achieved under the influence of coupling based on sliding mode approach. Effectiveness of the proposed sliding mode coupling is proved using Lyapunove theory. Effective message recovery is shown using equivalent output injection. Moreover, Lipschitz condition on nonlinearity is relaxed, which enhances the scope of the proposed approach. The simulation results presented in the end justifies the effectiveness of proposed theory.

The paper is organized as follows: Problem formulation for the proposed class of nonlinear system is given in Section 2. In Section 3 Main results of the paper are presented. First, LMI formulation along with methodology to decouple the error dynamics from unmatched uncertainty is presented. Further, design of sliding mode controller to stabilize the error dynamics is presented.

Later, methodology to recover message is also given. Section 4 shows the simulation results to justify the proposed claim.

2 Problem Formulation

In this section, observer frame work required for the proposed class of nonlinear systems is presented. Consider the master chaotic system subject to unmatched uncertainties and the unknown input. Unknown input is a message signal and is to be recovered at the receiver side.

$$\begin{aligned} \dot{x} &= Ax + Bf(x) + Bu + g(y,u_1) + Dv(t) \\ y &= Cx \end{aligned} \tag{1}$$

where $x \in \Re^n$ is the state vector, $y \in \Re^p$ is the output vector, $u \in \Re^m$ is the message signal, $v \in \Re^k$ is the unmatched uncertainty, $f(x) : \Re^n \to \Re^m$ is the nonlinear vector function. $A \in \Re^{n\times n}$ is the linear part of the system dynamics. $B \in \Re^{n\times m}$ associates the nonlinear part of the dynamics, $g(\cdot) \in \Re^n$, u_1 is known part of input, $D \in \Re^{n\times k}$ is uncertainty distribution matrix and $C \in \Re^{p\times n}$ is the output matrix.

Assumption 1: It is assumed that there exists $K > 0$ for the operating range of x such that $\sup\left|f(x)\right| < K$.

Remark 1: The above assumption is realistic in many nonlinear systems especially chaotic systems where system states are bounded over the entire range of operation.

Assumption 1: D is a full column rank matrix.

With above assumptions nonlinear unknown input observer for the given system (1) is proposed as

$$\begin{aligned} \dot{z} &= Nz + Ly + MBf(\hat{x}) + Mg(y,u_1) + MBv \\ \hat{x} &= z - Ey \end{aligned} \tag{2}$$

where $z \in \Re^n$, $\hat{x} \in \Re^n$ is the state estimate, N, L, M and E are matrices of appropriate dimension. v is the coupling to be designed while selecting N, L, M and E suitably.

3 Main Results

State estimation error for the system (1) and the observer (2) is defined as

$$e = \hat{x} - x = z - (I + EC)x \tag{3}$$

For this system – observer pair, error dynamics can be written as

$$\begin{aligned} \dot{e} &= \dot{z} - (I + EC)\dot{x} \\ &= Ne + [N(I + EC) + LC - (I + EC)A]x - (I + EC)Bu \\ &\quad + MBf(\hat{x}) - (I + EC)Bf(x) - (I + EC)Dv + MBv \end{aligned} \tag{4}$$

For (2) to be an observer it is required that the estimated state $\hat{x}$ converges to the system state x. That means error dynamics (4) should be convergent. Moreover, for this observer to be robust against unmatched uncertainties, error dynamics should be somehow independent of unmatched uncertainties. In view of these requirements, in error dynamics (4) it is required that

$$N < 0 \tag{5}$$

$$N(I + EC) + LC - (I + EC)A = 0 \tag{6}$$

$$(I + EC)D = 0 \tag{7}$$

i.e. N has to be stable matrix along with the conditions given in (6) and (7). To meet up these requirements it is proposed that the observer matrices be selected as

$$N \qquad (I + EC)A - KC \tag{8}$$

$$L \qquad K(I + CE) - (I + EC)A \tag{9}$$

$$M \qquad (I + EC) \tag{10}$$

Where E and K are design parameters. Using the matrix conditions for N in (8) and L in (9), requirement (6) can be satisfied. So the problem boils down to finding E and K such that (5) and (7) are satisfied.

To decouple the unmatched uncertainty, design parameter E is to be found such that $(I + EC)D = 0$. Now for $ECD = -D$ to have solution for E following rank conditions should be satisfied:

$$Rank\begin{bmatrix} CD \\ D \end{bmatrix} = Rank\begin{bmatrix} CD \end{bmatrix}$$

Since D is full column rank so CD should also be full column rank. If CD is full column rank, all possible solutions of E using generalized inverse will be

$$E \qquad -D(CD)^{+} + Y(I - (CD)(CD)^{+})$$

$$U + YV \qquad \text{(Say)} \tag{11}$$

Wher
e

$$CD^{+} \qquad [(CD)^T(CD)]^{-1}(CD)^T$$

$$U \qquad -D(CD)^{+}$$

$$V \qquad I-(CD)(CD)^{+}$$

Y is the design parameter. Now the problem is restructured to find Y and K which will satisfy (5).

Lemma 1: If $N<0$ then there exists $P>0$ such that $N^T P + PN < 0$

Remark 2: The above result is straight forward application of Lyapunov equation to stability results (Khalil, 2002).

Theorem 1: If there exist matrices P_Y, P_K and P such that

$$\begin{bmatrix} W^T + W^T & 0 \\ 0 & -P \end{bmatrix} \qquad 0 \tag{12}$$

Wh
ere

$$W \qquad P((I+UC)A) + P_Y VCA - P_K C \tag{13}$$

$$P_Y \qquad PY$$

$$P_K \qquad PK$$

Then the observer states under the effect of coupling

$$v \qquad -sign(e^T P_e MB)[U_{\max} + \beta] - f(\hat{x}) \tag{14}$$

converges asymptotically to system states, where $U_{\max}$ is upper bound on $\left[\|u\| + \|f(x)\|\right]$, β is some positive constant.

Proof: It is stated above that using the definitions in (8) – (10) it can be shown that $[N(I+EC)+LC-(I+EC)A]=0$. Hence error dynamics (4) reduces to

$$\dot{e} = \begin{array}{l} Ne-(I+EC)Bu+MBf(\hat{x})- \\ (I+EC)Bf(x)-(I+EC)Dv+MBv \end{array}$$

$$\dot{e} = \begin{array}{l} Ne-MBu+MBf(\hat{x})-MBf(x)- \\ (I+EC)Dv+MBv \end{array}$$

Now for $N < 0$, from lemma 1 and using the value of N from (8), one can obtain

$$\begin{aligned}&[A^T(I+EC)^T - C^T K^T]P + \\ &P[(I+EC)A - KC] \quad < \ 0\end{aligned}$$

Now replacing the value of E from (11), which comes from the solution of $(I+EC)D = 0$, the above inequality modifies to

$$\begin{aligned}&[A^T(I+(U+YV)C)^T - C^T K^T]P + \\ &P[(I+(U+YV)C)A - KC] \quad < \ 0\end{aligned}$$

Since P, K and Y are unknown above equation is not an LMI in variables P, K and Y. To resolve the issue new variables $P_Y = PY$, and $P_K = PK$ are introduced. By using the definition of W as in (13), the above expression reduces to

$$W^T + W \ < 0$$

The above expression along with condition $P > 0$ gives (12). The LMI (12) is to be solved for feasibility. If Solution of LMI exists it will subsequently provide the values of design parameters K, Y and $P > 0$. Using solution of the LMI i.e. feasible values of Y and K in (11) and (8 – 10), one can obtain observer matrices satisfying the requisite conditions. It also meets out the requirement of decoupling the unmatched uncertainties and $N < 0$. The error dynamics takes the form

$$\dot{e} \ = \ Ne + MB(f(\hat{x}) - f(x) - u) + MBv \qquad (15)$$

In the next stage controller v based on sliding mode control is designed to first stabilize the error dynamics and then recover message signal.

Sliding Mode Controller Design: To stabilize the error dynamics (15) coupling v is proposed as

$$v = v_f + v_s$$

Where

$$v_f = -f(\hat{x})$$

$$v_s = -sign(e^T P_e MB)[U_{\max} + \beta]$$

This reduces the error dynamics (15) to

$$\dot{e} = Ne + MB(-f(x) - u) + MBv_s \qquad (16)$$

To prove the effectiveness of controller to stabilize (15) consider Lyapunov function as $V = (e^T P_e e)/2$ where $P_e > 0$. The rate of change of V w.r.t. time can be written as

$$\dot{V} = (\dot{e}^T P_e e + e^T P_e \dot{e})/2$$

Using the error dynamics (16) in above expression, we get

$$\dot{V} = \frac{(e^T N^T P_e e + (-u - f(x) + v_s)^T B^T M^T P_e e + e^T P_e N e + e^T P_e MB(-u - f(x) + v_s))}{2}$$

Since N is found such that it is negative definite, hence $P_e > 0$ is found such that

$$N^T P_e + P_e N < 0 \qquad (17)$$

$$\Rightarrow \dot{V} \le e^T P_e MB(-u - f(x) + v_s) \qquad (18)$$

Choosing $v_s = -sign(e^T P_e MB)[U_{\max} + \beta]$ makes $\dot{V} < 0$ where $U_{\max}$ is upper bound on $\left[\|u\| + \|f(x)\|\right]$, β is some positive constant. If $f(x)$ is known at the receiver the controller may be modified as

$$v = -sign(e^T P_e MB)[U_{\max} + \beta] - f(\hat{x}) - f(x) \qquad (19)$$

$U_{\max}$ becomes upper bound on $\|u\|$.

Discussion on Coupling: Conventionally in sliding mode control, first sliding surface is designed on which system trajectories show the desired behavior and then discontinuous control is designed to restrain the system on the sliding surface. Here, error dynamics is proved to be convergent using Lyapunov function V and $\dot{V} < 0$. Sliding surface (S) because of discontinuous control becomes $S = e^T P_e MB$.

Remark 3: The observer for the given system will exist under the following existence conditions:

1. $Rank\left[CD\right] = Rank\left[D\right] = k$
2. $((I + EC)A, C)$ pair is detectable. From (5) where $N < 0$ and the definition of N in (8).

Remark 4: It is to be noted that the proposed approach addresses the coupling design problem in the scenario of unknown input and unmatched uncertainty satisfactorily. Though solution may come out to be conservative in nature (Dimassi & Loria, 2011).

Design Steps: The procedure proposed for designing NUISMO is summarized as follows:

1. Solve LMI (12) for design parameters K, Y and $P > 0$.
2. Use the value of Y to evaluate E from (11).
3. Evaluate the Observer matrices N, L and M from (8-10)
4. To design coupling, find P_e by solving LMI (17)

Message Recovery: From (15) when the error trajectories are in sliding mode and error has considerably converged to zero i.e. system states have been estimated effectively, coupling v approximates the unknown message signal $u(t)$. For message recovery, coupling is approximated as v equivalent (v_{eq}) which is given as follows:

$$v_{eq} = \frac{e^T P_e MB}{\|e^T P_e MB\| + \delta}(U_{\max} + \beta) - f(\hat{x}) \tag{20}$$

Where δ is a small positive constant. It is to be noted here that smaller the value of δ closer is v_{eq} to v.

4 Numerical Examples

To validate the proposed scheme of designing NUISMO, results of simulation on two systems i.e. Chua circuit (with piecewise linear nonlinearity function $f(x)$) and Rossler system are presented here.

4.1 Chua Circuit

Dynamics of the Chua circuit with uncertainty is given as

$$\dot{x} = Ax + Bf(x) + Bu(t) + Dv(t)$$

$$y = Cx$$

Where $f(x) = m_1 x + (m_0 - m_1)\dfrac{\|x+1\| - \|x-1\|}{2}$

$$m_0 = -1.143 \qquad m_1 = -0.714$$

$$A = \begin{bmatrix} -c_1 & c_1 & 0 \\ c_2 & -c_2 & c_2 \\ 0 & -c_3 & 0 \end{bmatrix} \qquad B = \begin{bmatrix} -c_1 & 0 & 0 \end{bmatrix}^T$$

$$C = \begin{bmatrix} 0 & 1 & 0 \end{bmatrix} \qquad D = \begin{bmatrix} 1 & 1 & 1 \end{bmatrix}^T$$

Chua circuit exhibits chaotic behavior for $c_1 = 15.6,\ c_2 = 1,\ c_3 = 28$. Comparing to system dynamics defined in (1), here $g(\square) = 0$. Objective here is to design observer matrices $N, L,\ M\ \&\ E$ appropriately, so as to estimate the system states effectively irrespective of the unknown message and unknown disturbance. As mentioned in the design algorithm, observer matrices $N, L,\ M\ \&\ E$ are obtained by solving LMI (12) and further using (11) and (8 – 10)

$$N = \begin{bmatrix} -16.6 & 0 & -1 \\ 0 & -0.5 & 0 \\ -1 & 0 & -1 \end{bmatrix} \qquad MB = \begin{bmatrix} -15.6 & 0 & 0 \end{bmatrix}^T$$

$$L = \begin{bmatrix} -1 & 0 & -29 \end{bmatrix}^T \qquad E = \begin{bmatrix} -1 & -1 & -1 \end{bmatrix}^T$$

The message signal $u(t)$, which is to be recovered at the observer, and the disturbance signal $v(t)$, for the purpose of simulation are taken as

$$u(t) \qquad 0.2 square(2\pi\, \mathrm{t})$$

$$v(t) \qquad 0.1 Sin(2\pi t)$$

To design coupling , parameter P_e is found by solving LMI (17). MATLAB LMI toolbox has been used to solve LMIs. Using the procedure following positive definite matrix P_e is obtained:

$$P_e = \begin{bmatrix} 0.967 & 0 & 0 \\ 0 & 14.767 & 0 \\ 0 & 0 & 8.066 \end{bmatrix} \times 10^2$$

Coupling is designed as per (19) and (20) with $\delta = 0.1$. Depending on the structure of MB the extra information required for the design of coupling is e_1 which is assumed to be available. e_1 is state estimation error for state x_1.Results of the simulation are shown here. Since initial state of the system is not known at the observer, so system and observer start from different initial conditions. Initial condition for the system and the observer are taken as

$$x(0) = \begin{bmatrix} 0.1 & 0 & 0 \end{bmatrix}; \qquad \hat{x}(0) = \begin{bmatrix} 2.2 & -2.9 & -4.9 \end{bmatrix}$$

Fig 1 shows observer starting from different initial condition to that of system, gradually starts tracking the system states, even in the presence of unknown input $u(t)$ and disturbance $v(t)$. Fig 2 shows the asymptotic convergence of state estimation error to zero. Fig 3 shows the message signal

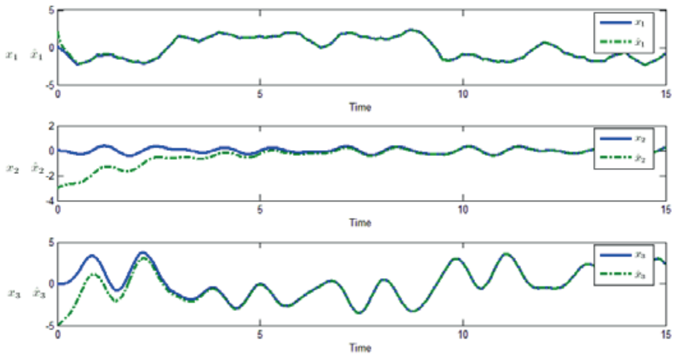

Fig. 1: Convergence of observer and system states $\hat{x}_1$ to x_1, $\hat{x}_2$ to x_2 and $\hat{x}_3$ to x_3

(dotted line) sent encoded in the states of the chaotic transmitter and the message reconstructed (solid line) at the receiver, using the information of two states of the transmitter i.e. x_1 and x_2 . Message is recovered effectively only after the sliding motion is set and state estimation error has converged to zero.

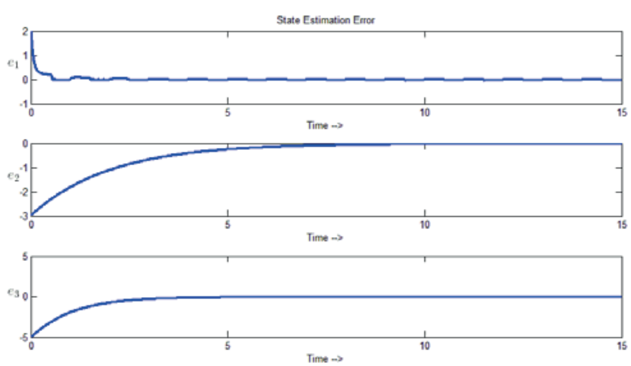

Fig. 2: Convergence of state estimation error e_1, e_2 and e_3 to zero

4.2 Rossler System

To prove the efficacy of proposed approach Rossler system is considered for simulation study, whose dynamics with uncertainty is given as (Stefano Boccaletti, 2002)

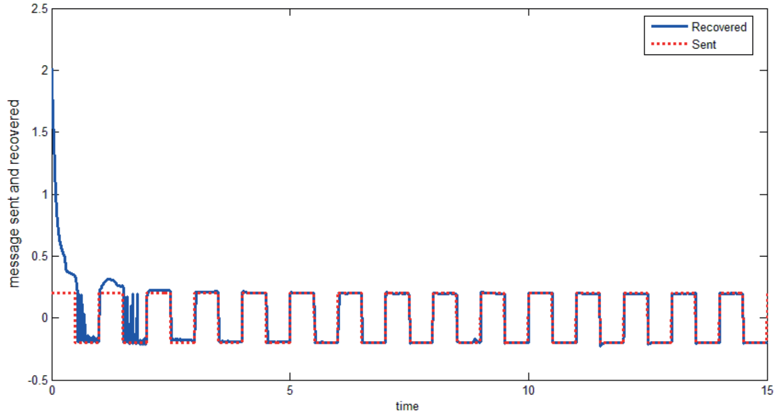

Fig. 3: Message sent from the transmitter (Chua Circuit) and recovered at the observer

$$\dot{x} = Ax + Bf(x) + Bu(t) + g(u_1, y) + Dv(t)$$

Where
$$A = \begin{bmatrix} 0 & -1 & -1 \\ 1 & a & 0 \\ 0 & 0 & -\mu \end{bmatrix} \qquad B = \begin{bmatrix} 0 & 0 & 1 \end{bmatrix}^T$$

$$C = \begin{bmatrix} 0 & 1 & 0 \end{bmatrix} \qquad D = \begin{bmatrix} 1 & 1 & 1 \end{bmatrix}^T \qquad g(\square) = f$$

The considered Rossler system shows chaotic behavior for the parameter values as $a = 0.2,\ f = 0.2,\ \mu=5.7$. Disturbance $v(t)$ and the message signal $u(t)$ are the same as considered in the previous example. solving LMI (12) and following subsequent design procedure observer matrices $N, L, M \;\&\; E$ are obtained as

$$N = \begin{bmatrix} -1 & 0 & -1 \\ 0 & -0.5 & 0 \\ -1 & 0 & -5.7 \end{bmatrix} \qquad MB = \begin{bmatrix} 0 & 0 & 1 \end{bmatrix}^T$$

$$L = \begin{bmatrix} -3.2 & 0 & -6.9 \end{bmatrix}^T \qquad E = \begin{bmatrix} -1 & -1 & -1 \end{bmatrix}^T$$

Coupling parameter $P_e > 0$ by solving LMI (17) is obtained as

$$P_e = \begin{bmatrix} 62.01 & 0 & 0 \\ 0 & 96.22 & 0 \\ 0 & 0 & 15.05 \end{bmatrix}$$

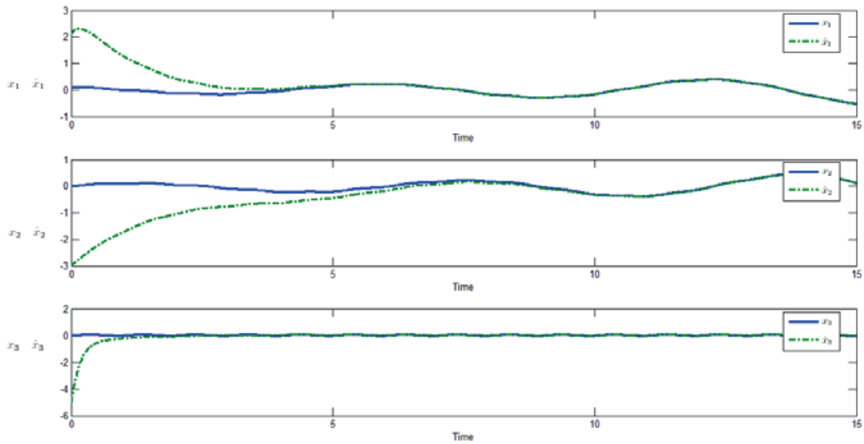

Fig. 4: Convergence of observer and Rossler system states $\hat{x}_1$ to x_1, $\hat{x}_2$ to x_2 and $\hat{x}_3$ to x_3

Coupling is implemented as per equation (20). For simulation study initial condition of observer are taken different from system as

$$x(0) = \begin{bmatrix} 0.1 & 0 & 0 \end{bmatrix}; \qquad \hat{x}(0) = \begin{bmatrix} 2.2 & -2.9 & -4.9 \end{bmatrix}$$

Figure (4) shows the convergence of the system states to the observer states. Figure (5) shows the convergence of state estimation error to zero, and hence the proposed observer with specified observer matrices is an effective observer. Figure (6) shows sufficiently accurate message recovery after 5 sec onwards.

Conclusion

Here problem of designing nonlinear unknown input sliding mode observer (NUISMO) for a class of nonlinear systems with bounded nonlinearities is presented. Moreover the existence conditions for the observer are proposed while relaxing Lipschitz condition on nonlinearities. From the theory and the simulation results presented it may be concluded that, the designed NUISMO is an effective observer to estimate the states of the system, even in the presence of unmatched uncertainties. Moreover, the proposed methodology of using equivalent output injection in sliding mode coupling is effective for message recovery in secure communication, in the presence of unmatched uncertainty.

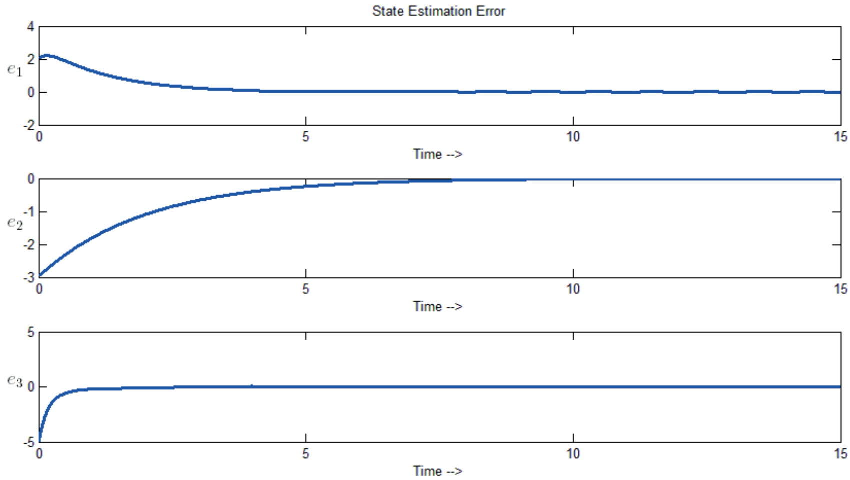

Fig. 5: Convergence of state estimation error e_1, e_2 and e_3 to zero

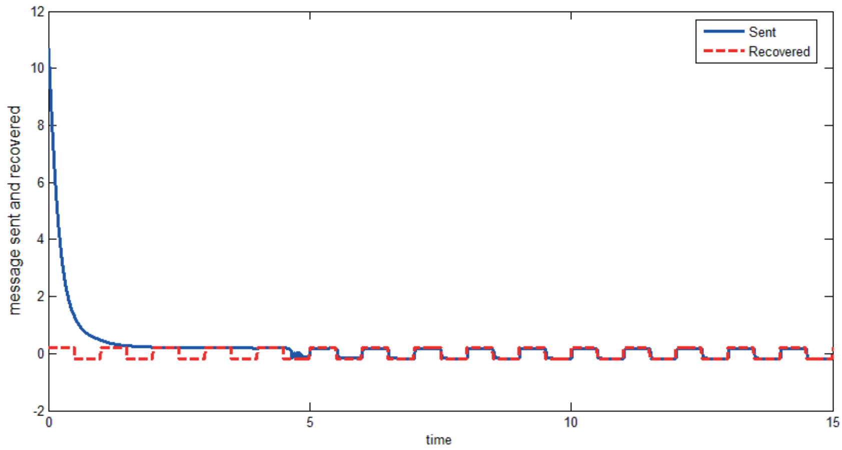

Fig. 6: Message sent from the transmitter (Rossler system) and recovered at the observer

References

1 Boccaletti, S., & al., e. (2002). The synchronization of chaotic systems. Physics reports , 366 (1), 1-101.
2 Bowong, S., & Tewa, J. J. (2008). Unknown inputs adaptive observer for a class of chaotic systems with uncertainties. Mathematical and ComputerModelling , 48 (11), 1826–1839.
3 Chen, J., Patton, R. J., & Zhang, H. Y. (1996). Design of unknown input observers and robust fault detection filters. International Journal of Control , 63 (1), 85–105.
4 Chen, W., & Saif, M. (2006). Unknown input observer design for a class of nonlinear systems: an lmi approach. American Control Conference .
5 Choi, H. H. (2003). An lmi-based switching surface design method for a class of mismatched uncertain systems. IEEE Transactions on Automatic Control , 48 (9), 1634–1638.
6 Darouach, M., Zasadzinski, M., Xu, S. J., & al, e. (1994). Full-order observers for linear systems with unknown inputs. IEEE Transactions on Automatic Control , 39 (3), 606–609.
7 De Persis, C. a. (2001). A geometric approach to nonlinear fault detection and isolation. IEEE Transactions on Automatic Control , 46 (6), 853-865.
8 Dimassi, H., & Loria, A. (2011). Adaptive unknown-input observers-based synchronization of chaotic systems for telecommunication. IEEE Transactions on Circuits and Systems I: , 58 (4), 800–812.
9 Edwards, C., & Spurgeon, S. (1998). Sliding mode control: theory and applications.
10 Edwards, C., Spurgeon, S. K., & Patton, J. R. (2000). Sliding mode observers for fault detection and isolation. Automatica , 36 (4), 541–553.
11 Fallahi, K., & Leung, H. (2010). A chaos secure communication scheme based on multiplication modulation. Communications in Nonlinear Science and Numerical Simulation , 15 (2), 368–383.
12 Imsland, L., Johansen, A. T., Grip, F. H., & Fossen, I. T. (2007). On non-linear unknown input observers–applied to lateral vehicle velocity estimation on banked roads. International Journal of Control , 80 (11), 1741–1750.
13 Khalil, H. K. (2002). Nonlinear Systems.
14 Kocarev, L., Halle, K. S., Eckert, K., Chua, L. O., & Parlitz, U. (1992). Experimental demonstration of secure communications via chaotic synchronization. International Journal of Bifurcation and Chaos , 2 (03), 709–713.
15 Patton, R. J. (1997). Observer-based fault detection and isolation: robustness and applications. Control Engineering Practice , 5 (5), 671-682.
16 Pecora, L. M., & Carroll, T. L. (1990). Synchronization in chaotic systems. Physical review letters , 64 (8), 821.
17 Poznyak, A. S., Shtessel, Y. B., & Gallegos, C. J. (2003). Min-max sliding-mode control for multimodel linear time varying systems. IEEE Transactions on Automatic Control , 48 (12), 2141–2150.
18 Sharma, B. B., & Kar, I. N. (2009). Chaotic synchronization and secure communication using contraction theory. Pattern Recognition and Machine Intelligence Springer , 549–554.
19 Sharma, B. B., & Kar, I. N. (2011). Observer-based synchronization scheme for a class of chaotic systems using contraction theory. Nonlinear Dynamics , 63 (3), 429–445.

20 Slotine, J. J., Hedrick, J. K., & Misawa, E. A. (1987). On sliding observers for nonlinear systems. Journal of Dynamic Systems, Measurement, and Control , 109 (3), 245–252.

21 Spurgeon, K. S. (2008). Sliding mode observers: a survey. International Journal of Systems Science , 39 (8), 751–764.

22 Spurgeon, S. K., & Davies, R. (1993). A nonlinear control strategy for robust sliding mode performance in the presence of unmatched uncertainty. International Journal of Control , 57 (5), 1107–1123.

23 Stefano Boccaletti, J. K. (2002). The synchronization of chaotic systems. Physics reports , 366 (1), 1–101.

24 Tan, C., & Edwards, C. P. (2002). Sliding mode observers for detection and reconstruction of sensor faults. Automatica, , 38 (10), 1815–1821.

25 Theesar, S. J., & Balasubramaniam, P. (2014). Secure communication via synchronization of lure systems using sampled-data controller. Circuits, Systems, and Signal Processing , 33 (1), 37–52.

26 Vadim, U. I. (1977). Survey paper variable structure systems with sliding modes. IEEE Transactions on Automatic control , 22 (2).

27 Venkatasubramanian, V. e. (2003). A review of process fault detection and diagnosis: Part I: Quantitative model-based methods. Computers & chemical engineering , 27 (3), 293-311.

28 Walcott, B., & Zak, S. H. (1987). State observation of nonlinear uncertain dynamical systems. IEEE Transactions on Automatic Control , 32 (2), 166–170.

29 Yan, X. G., & Edwards, C. (2007). Nonlinear robust fault reconstruction and estimation using a sliding mode observer. Automatica , 43 (9), 1605–1614.

Dr. A. Rengarajan [1], S. Rajasekaran [2] and P. Kumaran [3]

An Efficient Lightweight Proactive Source Routing Protocol for Handling Overhead, Packet Delivery, Throughput in MANETS

Abstract: In this paper we proposed an Effective Proactive Routing Protocol (EPSR). EPSR can maintain more network topology information than conventional protocol like Distance Vector (DV) based protocols, Link State (LS)-based routing optimized link state routing and reactive source routing as in LPSR. The paramount function of Mobile Ad Hoc networks is to determine the route between source nodes to destination and forwards the traffic from source node to neighbor node to reach destination when the transmission range exceeds. This can be done proactively using the proactive routing protocol for frequent update of topological information and to avoid the stale that is history of routing information. We propose a brand new routing protocol called efficient proactive routing protocol galvanized by DSDV and OLSR protocols which rely on collective task of routing. The proposed protocol implemented using few techniques called route update, loop detection and multipath route discover algorithm. Using these techniques we have analyzed it can give better performance with help of the parameters includes overhead, throughput, and packet delivery ratio and end- to-end delay.

Keywords: Mobile Ad Hoc Network, DSDV, OLSR, Route Update, Loop Detection

1 Introduction

A Mobile Adhoc network is a wireless communication network, where nodes that are not within direct transmission range of each other will required other nodes to forward data. It can operate without existing infrastructure, supports

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mobile user and falls under the general scope of Multihop wireless networking. Such a networking paradigm was originated from the needs in battle field communication, emergence operation, search and rescue, and disaster relief operations.

2 Literature Survey

Zehua Wang *et al* [1] propose a lightweight proactive source routing (PSR) protocol. PSR can maintain more network topology information than distance vector (DV) routing to facilitate source routing, although it has much smaller overhead than traditional DV-based protocols. PSR is only a fraction of the overhead of these baseline protocols, and PSR yields similar or better data transportation performance than these baseline protocols. In this proposed system they used three different methods to implement the overhead controlled routing protocol. The period of the update cycle is an important parameter in PSR. Furthermore, we go an extra mile to reduce its routing overhead. First, we interleave full dump and differential updates to strike the balance between efficient and robust network operation. Second, we package affected links into forests to avoid duplicating nodes in the data structure. Finally, to further reduce the size of differential update messages, each node tries to minimize the alteration of the routing tree that it maintains as the network changes its structure.

Z.Wang et al [2] propose CORMAN is a network layer solution to the opportunistic data transfer in mobile ad hoc networks. Its node coordination mechanism is largely in line with that of Ex-OR and it is an extension to Ex-OR in order to accommodate node mobility. CORMAN generalizes the opportunistic data forwarding in Ex-OR to suit mobile wireless networks. That is, when a batch of packets are forwarded along the route towards the destination node, if an intermediate node is aware of a new route to the destination, it is able to use this new route to forward the packets that it has already received. That is, a pipeline of data transportation could be achieved by better spatial channel reuse. The design of CORMAN can be further improved to address this explicitly. This may involve timing node back off more precisely and tightly, or even devising a completely different coordination scheme. The potential of cooperative communication in multi-hop wireless networks is yet to be unleashed at higher layers, and CORMAN is only an example.

Cheng Li PSR *et al* [3] said builds a Breadth First Spanning Tree (BFST) in every node of the network. As a proactive routing protocol, we must reduce the overhead of PSR. Ideally, we need to provide each node with abundant routing information using a communication overhead similar to or smaller than that of a proactive DV protocol. High data transportation performance reducing the communication overhead should not penalize the network's capability in data communication. In PSR, nodes maintain and exchange BFSTs periodically. The full dump message containing the entire spanning tree is of the size O ($|N|$), which is in fact much less frequently broadcast than a compact differential updates. While achieving these objectives, PSR yields the same transportation capability as the more expensive protocols like OLSR and DSDV.

Padmavathi.K *et al* [4] purpose of this paper is to provide a better quality of the package delivery rate and the throughput, that is in need of powerful routing protocol standards, which can guarantee delivering of the packages to destinations, and the throughput on a network. We study some parameters of OLSR that forces the inaccuracies in the energy level information of neighboring nodes and show the comparison between ideal and realistic version of OLSR. It operates in a table-driven and proactive manner, i.e., topology information is exchanged between the nodes on periodic basis. Its main objective is to minimize the control traffic by selecting a small number of nodes, known as Multi Point Relays (MPR) for flooding topological information. In route calculation, these MPR nodes are used to form an optimal route from a given node to any destination in the network. This routing protocol is particularly suited for a large and dense network. OLSR generally proposes four types of periodic control messages, namely: Hello messages, Topology Control (TC) messages, Multiple Interface Declaration (MID) messages, Host and Network Association (HNA) messages.

Dhanalakshmi Natarajan *at al* [5] said an optimized link state routing (OLSR) protocol is a proactive routing protocol. An advanced OLSR (AOLSR) protocol is proposed based on a modified Dijkstra's algorithm which enables routing in multiple paths of dense and sparse network topologies. The routing is based on the energy of nodes and links (implied from the lifetime) and the mobility of the nodes. It is a hybrid ad hoc routing protocol because it combines the proactive and reactive features. Two cost functions are introduced to build link-disjoint or node-disjoint paths. Secondary functions, namely path recovery and loop discovery process are involved to manage the topology changes of the network. AOLSR protocol is analyzed and compared with the existing MANET routing protocols namely, dynamic source routing (DSR) and OLSR. Its performance is observed to be satisfactory in terms of average end-to-end delay, packet delivery ratio (PDR), average time in first-in-first-out (FIFO) queue, and throughput.

Gulfishan Firdose Ahmed *at al* [6] said this paper examines routing protocol for mobile ad hoc networks the Destination Sequenced Distance Vector (DSDV) and On Demand protocol that evaluates both protocols based on the packet delivery fraction and average delay while varying number of sources and pause time. In this paper we consider the new approach an Improved-DSDV Protocol is proposed for Ad Hoc networks. Improved -DSDV overcomes the problem of stale routes, and thereby improves the performance of regular DSDV. In our improved DSDV routing protocol, nodes can cooperate together to obtain an objective opinion about other trustworthiness. In this state problem of DSDV routing information will maintain at each node locally in the network. All routing decisions are taken completely distribution fashion. So the local information may be old and invalid, local information updates periodically.

Rahem Abri *at al* [7] proposes a new improvement on DSDV; we introduce a new metric called hop change metric in order to represent the changes in the network topology due to mobility. We determine a threshold value based on this metric in order to decide the full update time dynamically and cost effectively. The proposed approach (La-DSDV) is compared with the original DSDV. The results show that our threshold-based approach improves the packet delivery ratio and the packet drop rate significantly with a reasonable increase in the overhead and the end-to-end delay. A new lightweight threshold-based scheme is proposed in order to improve the low packet delivery ratio of the original DSDV under high mobility. The results show that our approach based on this metric improves the packet delivery ratio and the packet drop rate with a reasonable increase in the overhead and the end-to-end delay. It decides the update time without communicating with other nodes in the network. Since the communication between nodes of battery depletion, it is an important metrics for the nodes that run on battery power in MANETs.

Seon Yeong Han *at al* [8] proposes an adaptive Hello messaging scheme to suppress unnecessary Hello messages without reduced detestability of broken links. Simulation results show that the proposed scheme reduces energy consumption and network overhead without any explicit difference in throughput. An adaptive Hello interval toreduce battery drains through practical suppression of unnecessary Hello messaging. Based on the event interval of a node, the Hello interval can be enlarged without reduced detects ability of a broken link, which decreases network overhead and hidden energy consumption.

Poonkuzhali Ramadoss *at al* [9] said, in this study a new QoS routing protocol is proposed which provides better path selection by avoiding congestion, balancing the load and energy. It minimizes the communication overhead without reducing the network performance. The protocol provides source routing using DFS spanning tree routing in MANET. Thus PSRP is designed which provides nodes with the cost of network structure information for source routing at a communication overhead similar or even less than a distance vector routing protocol. In PSRP nodes maintain and exchange DFSTs periodically. The full dump message which contains the entire spanning tree is of the size O (|n|) which is less frequently broad cast than a compact differential updates. PSRP yields the same transportation capability as the more expensive protocol like OLSR and DSDV.

3 Problem Identification

In PSR, each node maintains a breadth-first search spanning tree of the network rooted at it. This information is periodically exchanged among neighboring nodes for updated network topology information. This allows it to support both source routing and conventional IP forwarding, in which we try to reduce the routing overhead of PSR as much [3]. PSR has only a fraction of overhead of OLSR, DSDV, and DSR but still offers a similar or better data transportation capability compared with these protocols [4], [6]. Many lightweight protocols use “Table Driven” approach. PSR make use of Path Finding Algorithm for routing update and Link Vector Algorithm for reducing the overhead of LS routing algorithm.

Overhead is reduced only fraction when compared to other baseline protocol using TCP. PDR is less than the DSR when using UDP/TCP for data transmission. The overhead is less when compared to other underlying protocol but the data transportation is very low i.e. the packet delivery ratio is less.

3.1 Disadvantages

- Due to overhead there is comparatively less Packet delivery ratio than DSR during data transmission.
- Overhearing the packet during data exchange leads to energy consumption which increases the overhead. Transmission link breakage more thus reduces the PDR and increases the overhead.
- Route discovery and maintenance takes more time to update the information hence delay is more.
- The existing protocols are also vulnerable to the denial-of-service (DoS) attacks, such as RREQ based broadcasting.

- Large amount of bandwidth required to estimate the optimal routes.
- Limited number of control traffic messages

4 Proposed an Effective Proactive Routing Protocol (EPSR)

LPSR having Overhead during the topology changes in the network this can be further reduced using hybrid routing protocol. Proactive reduces the topology updates overhead whereas reactive increases the packet delivery ratio (PDR) thereby the performance and delay can be avoided. Hello Message technique can reduce the delay and overhead by assigning intervals. Using Hybrid Routing Protocol (AOLSR&DSDV) the neighbor node maintenance is easier which further reduces the overhead and increases PDR. An advanced OLSR (AOLSR) protocol, based on a modified version of Dijkstra's algorithm can be proposed. The hello message internal will be added to the hello message packet which identifies the signal strength of neighbor nodes thereby link breakage can be avoided [5], [6], [7]. The hybrid routing protocol focuses on reducing the overhead further and thereby increases the Packet Delivery Ratio (PDR) and throughput. The Tree Based Algorithm will optimize the information to be forwarded to other neighbor nodes.

4.1 Advantages

- It increases the protocols suitability for ad hoc network with the rapid changes of the source and destinations pairs.
- It protocol does not require that the link is reliable for the control messages since the message are sent periodically and the delivery does not have to be sequential.
- It protocol is well suited for the application which does not allow the long delays in the transmission of the data packets hence reduces overhead.
- Routes maintained only between nodes who need to communicate that reduces overhead of routing maintained.
- Route caching reduces route discovery overhead and a single route may yield many routes to the destination.

- The hello message internal will reduce the time consumption during the topology update and Tree based algorithm optimize the route and reduces the communication overhead.

5 System Architecture

EPSR having Overhead during the topology changes in the network this can be further reduced using hybrid routing protocol. Proactive reduces the topology updates overhead whereas reactive increases the packet delivery ratio (PDR) thereby the performance and delay can be avoided. The route discovery process is initiated by the source who broadcast a new RREQ in the network. The broadcasting is done via flooding. The duplicate RREQs will be discarded by checking the pair of source node address and its broadcast ID present in the RREQ. If a node receives RREQ for the first time, it updates its routing table. This reverse route may later be used to relay the Route Reply (RREP) back to the initiator. Hello Message technique can reduce the delay and overhead by assigning intervals. Using Hybrid Routing Protocol (AOLSR&DSDV) the neighbor node maintenance is easier which further reduces the overhead and increases PDR. An advanced OLSR (AOLSR) protocol, based on a modified version of Dijkstra's algorithm can be proposed. The hello message internal will be added to the hello message packet which identifies the signal strength of neighbor nodes thereby link breakage can be avoided. The hybrid routing protocol focuses on reducing the overhead further and thereby increases the Packet Delivery Ratio (PDR) and throughput. The Tree Based Algorithm will optimize the information to be forwarded to other neighbor nodes. In case of link failure, the node closer to the source of the break initiates RERR and propagates it to all the precursor nodes. When the source node receives the RERR, it will reinitiate the route discovery. The primary functions of AOLSR protocol are topology detection and path estimation [5]. The network topology is sensed to inform the nodes the topology information. It is an optimization of link-state routing. In a classic link-state algorithm, link-state information n is flooded throughout the network. OLSR uses this approach as Well, but the protocol runs in wireless multi-hop scenarios, the message flooding in OLSR is optimized to preserve bandwidth [4]. DSDV has two types of route update packets Full dump for all available routing information and Incremental for Only information changed since the last full dump [10], [11], [12].

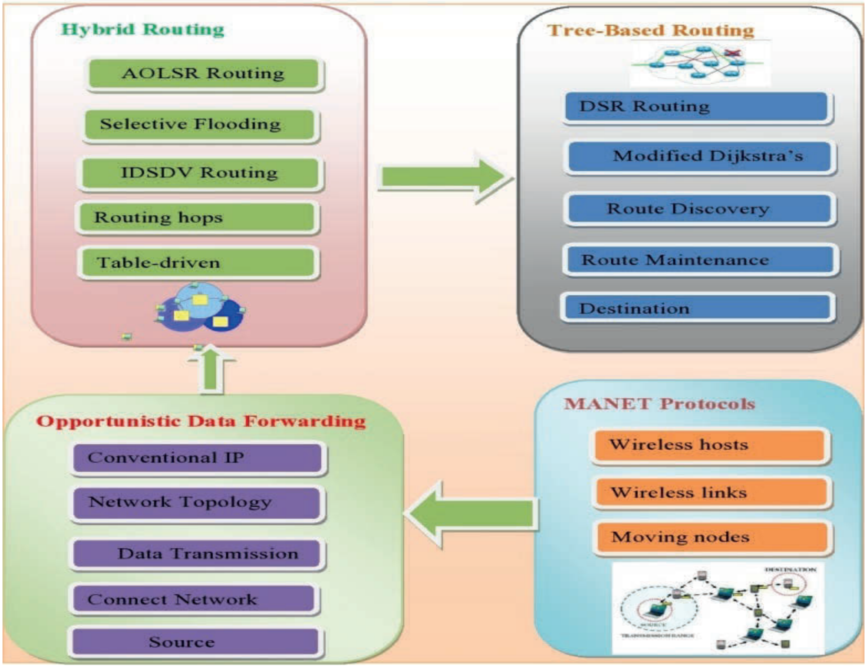

Fig. 1: System Architecture

5.1 Algorithm for Route Discovery

When a packet reaches a router:

- Time delay is measured with all the routes through which the destination can be reached and also connected with the present router, by sending ECHO packet.
- Based upon the fitness value (delay value), the fitter paths/routes are selected.
- The selected paths from same source-destination pair are then sorted and checked on the basis of their freshness.
- The packet is then forwarded based upon the current value of the route.
- Step (2) is repeated until the packet reaches the destination.

6 Module Specification

6.1 Modules1: Mobile Ad Hoc Networks Environment

- Formed by wireless hosts which may be mobile. No pre-existing infrastructure.
- Routes between nodes may potentially contain multiple hops
- – Nodes act as routers to forward packets for each other.
- – Node mobility may cause the routes change.

Routing protocols in MANETs can be categorized using an array of criteria. The most fundamental among these is the timing of routing information exchange. On one hand; a protocol may require that nodes in the network should maintain valid routes to all destinations periodically [13], [14]. In this case, the protocol is considered *proactive*, which is also known as *table driven*.

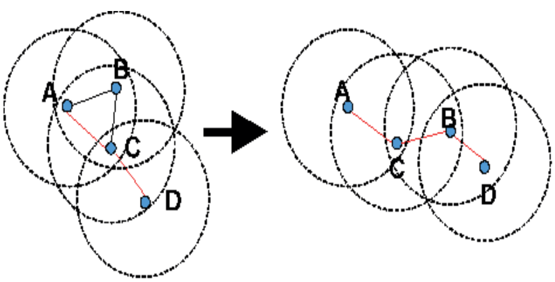

Fig. 2: Mobile Adhoc Network

6.2 Modules2: Opportunistic Data Forwarding Technique

Opportunistic network are a class of mobile ad hoc networks (MANETs) where contacts between mobile nodes occur unpredictably and a complete end-to-end path between source and destination rarely exists at one time **[17], [18], [19]**. There are two important functions provided by the transport layer.

- Ensuring reliable data transmission between source and destination.
- Ensuring that the network does not become congested with traffic.
- These functions are ineffective in opportunistic networks.
- Opportunistic networks require different approaches to those adopted in the more common intermittently connected networks.

6.3 Modules3: Implementing Modified Dijkstra's Algorithm

- The primary functions of AOLSR protocol are topology detection and path estimation. The network topology is sensed to inform the nodes the topology information.
- The path estimation utilizes the modified Dijkstra's algorithm to compute the various paths based on the information from topology detection. A link failure in one path should not affect other routes.
- The source path (route from source to destination including all the hops) is always preserved in the header of the data packets. The data flow diagram of AOLSR protocol.
- Topology detection and path estimation are responsible for the determination of the multiple paths from the source to the destination. Hello message interval will make sure that there is no local link repair.

Destination sequence distance vector (IDSDV)

- Table-driven
- Based on the distributed Bellman-Ford routing algorithm
- Each node maintains a routing table
  - ➢ Routing hops to each destination
  - ➢ Sequence number

Problem in DSDV is a lot of control traffic in the network and solution Using IDSDV is

- Two types of route update packets
  - ➢ Full dump (All available routing information)

Incremental (Only information changed since the last full dump)

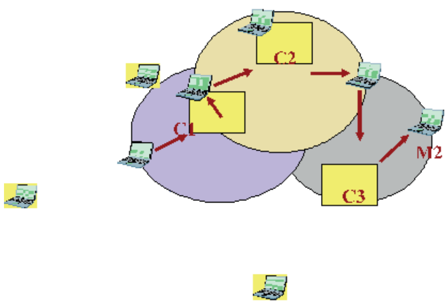

Fig. 3: Destination Sequence Distance Vector