YEOJU TECHNICAL INSTITUTE IN TASHKENT
CENTRAL ASIAN JOURNAL OF STEM
http://stem.ytit.uz/

VEHICLES EMERGENCY RESPONSE SYSTEM ASSESSMENT BASED ON HIDDEN MARKOV MODEL

Q.A. Sharipov[2], A.K. Igamberdiev[1], N.A. Xalikova[1], M. Amonov[1],
A. Umarov[2], A. Rustamov[1,2], I. Mamayunusov
{akmal.rustamov@polito.it}
1. *Tashkent Institute of Irrigation and Agricultural Mechanization Engineers*
2. *YEOJU Technical Institute in Tashkent*

Abstract

The Hidden Markov Model (HMMs) provide a simple and efficient framework for modeling diffuse vector sequences that differ in terms of time. Whereas constant identification of the fundamental principles that underlie the HMM-based emergency response program, defining and simplifying the premises inherent in the direct application of those principles can lead to a low-precision and poorly operated environment visibility structure. Highly complex therefore is needed for the practical use of HMMs in contemporary structures. The purpose of this work is the implementation of the HMMs and holding experiments to find the optimal parameters models by the criterion of reducing the generalization error maximizing the probability of recognition samples and minimizing the probability recognition of false samples as applied to solving the problem of speech recognition. Such enhancements include availability of functions, better simulation of covariance, measurement of differential parameters, correction and standardization, mitigation for noise and a multiphases device mixture. The analysis concludes with a case study to demonstrate the mentioned techniques.

Keywords: Hidden Markov Model (HMMs), GPS, Autonomous Vehicles (AV), ERA-GLONASS.

ЯШИРИН МАРКОВ МОДЕЛИГА АСОСЛАНГАН АВТОМОБИЛЛАРДА ФАВҚУЛОДДА ВАЗИЯТЛАРДА ХАФСИЗЛИК ТИЗИМИ.

Қ.А. Шарипов[2], А.К. Игамбердиев[1], Н.А. Халикова[1], М. Амонов[1], А. Умаров[2], А. Рустамов[1,2]
I. Matayunusov {akmal.rustamov@polito.it}
1. *Тошкент ирригация ва қишлоқ хўжалигини механизациялаш муҳандислари институти*
2. *Тошкент шаҳридаги ЁДЖУ техника институти*

Аннотация

Яширин Марков модели (ЯММ) вақт жиҳатидан фарқ қиладиган диффуз векторли кетма -кетликни моделлаштириш учун содда ва самарали асосни таъминлайди. ЯММга асосланган фавқулодда вазиятларни бартараф этиш дастурининг асосини ташкил этувчи асосий тамойилларни доимий равишда аниқлаш, бу принтсипларни тўғридан-тўғри қўллашга хос бўлган биноларни аниқлаш ва соддалаштириш, атроф-муҳитнинг кўринишини аниқлиги паст ва ёмон бошқарилишига олиб келиши мумкин. Шундай қилиб, замонавий тузилмаларда ЯММлардан амалий фойдаланиш учун жуда мураккаб талаб қилинади. Бу ишнинг мақсади - ЯММ -ларни амалга ошириш ва намуналарни таниб олиш эҳтимолини максимал даражада ошириш ва сохта намуналарни тан олиш эҳтимолини минималлаштириш, умумлаштириш хатосини камайтириш мезонлари бўйича оптимал параметр моделларини топиш тажрибаларини ўтказиш. тан олиш. Бундай яхшиланишларга функтсиялар мавжудлиги, коварянсни яхшироқ симулятсия қилиш, дифферентсиал параметрларни ўлчаш, тузатиш ва стандартлаштириш, шовқинни камайтириш ва кўп фазали қурилма аралашмаси киради. Таҳлил юқорида кўрсатилган техникани намойиш этиш учун амалий иш билан якунланади.

Калит сўзлар: Яширин Марков модели (ЯММ), ГПС, автоном транспорт воситалари (АТВ), ЭРА-ГЛОНАСС.

ОЦЕНКА СИСТЕМЫ АВАРИЙНЫХ СИТУАЦИЙ ТРАНСПОРТНЫХ СРЕДСТВ НА ОСНОВЕ СКРЫТЫХ МОДЕЛЕЙ МАРКОВА

Қ.А. Шарипов[2], А.К. Игамбердиев[1], Н.А. Халикова[1], М. Амонов[1],
А. Умаров[2], А. Рустамов[1,2]
I. Matayunusov {akmal.rustamov@polito.it}

1. *Ташкентский институт инженеров ирригации и механизации сельского хозяйства*
2. *Технический институт ЁДЖУ в городе Ташкент*

Аннотация

Скрытая марковская модель (СММ) обеспечивает простую и эффективную основу для моделирования диффузных векторных последовательностей, которые различаются по времени. В то время как постоянное определение фундаментальных принципов, лежащих в основе программы аварийного реагирования на основе СММ, определение и упрощение предпосылок, присущих прямому применению этих принципов, может привести к низкой точности и плохо управляемой структуре видимости окружающей среды. Поэтому для практического использования СММ в современных конструкциях требуется очень сложная конструкция. Целью данной работы является реализация СММ и проведение экспериментов по поиску оптимальных параметров моделей по критерию уменьшения ошибки обобщения, максимизации вероятности распознавания выборок и минимизации вероятности распознавания ложных выборок применительно к решению задачи речи. признание. Такие улучшения включают доступность функций, улучшенное моделирование ковариации, измерение дифференциальных параметров, коррекцию и стандартизацию, уменьшение шума и смесь многофазных устройств. Анализ завершается тематическим исследованием, демонстрирующим упомянутые методы.

Ключевые слова: Скрытая марковская модель (СММ), GPS, автономные транспортные средства (АТС), ЭРА-ГЛОНАСС.

1. Introduction

"ERA-GLONASS" is the Russian state emergency response system for accidents. The system was put into commercial operation on January 1, 2015. This is the world's first mandatory and free emergency call system. The analogue of the ERA-GLONASS system is the pan-European eCall system, with which the ERA-GLONASS system provides technological compatibility. According to statistics, the majority of accident victims do not die at the very moment of the accident, but after. help comes too late. It is assumed that the introduction of the system will lead to a reduction in response time in accidents and other emergencies, which will reduce mortality and injuries on the roads and increase the safety of freight and passenger traffic. The ERA-GLONASS module is built into each car. This is a stripped-down cell phone with one SOS button and sensors. Like any smartphone, it has its own SIM card, antenna, 3G modem, microphone, speaker and GPS / GLONASS navigation module. Sending and calls are realized through the mobile operators “MTS”, “Beeline” or “Megafon” through the most accessible of them in the area. It is stated that the module can use any available cellular network. The ERA-GLONASS system includes the infrastructure of the virtual operator MVNO, which will be connected to all operators to ensure the highest achievable reliability of emergency call transmission.

The message that the device sends is short and weighs about 140 bytes, so the system will be able to send it even with poor call quality. On average, it takes about 10 seconds to connect to a mobile network and transfer data to a call center. In conditions of poor communication, ERA-GLONASS will make 10 attempts to transfer data, and then independently send a message via SMS. The first and most important misconception is that ERA-GLONASS is part of the GLONASS global navigation satellite system. This is not so the ERA-GLONASS system uses GLONASS and American GPS to determine the location of the emergency vehicle, this allows we to increase the accuracy of determination in places where satellite coverage of one of the systems is insufficient. Moreover, the location is performed only in the event of an accident or manual call SOS. The second misconception -

supposedly the system monitors all movements of the car. The operation of the system for continuous tracking (like a tracker) is not provided for by the project standards. Location data would have to be regularly sent over cellular networks and it is unlikely that they would be carried out for free.

2. Hidden Markov Model

The hidden Markov model is the model of the process in which the process is considered Markov, and it is not known what state S_i the system is in states are hidden, but each state S_i can produce an event O_j with some probability B_{ioj} that can be observed. In the field of signal recognition, it is often thought of as a product of multiplication, which act statistically. Thus, the goal of the analysis of such signals is to model the static properties of signal sources as accurately as possible. The basis of such a model is a simple study of the data and a possible degree of limitation of the deviations that arise. However, the model to be determined should not only repeat the production of certain data as accurately as possible, but also provide useful information about some significant units for signal segmentation. Hidden Markov models can handle both above aspects of modeling. In a two-stage stochastic process, information for segmentation can be obtained from the internal states of the model, while the generation of the data signal itself occurs in the second stage. This modeling technology gained great popularity as a result of successful application and further development in the field of automatic speech recognition. Studies of hidden Markov models have surpassed all competing approaches and are the dominant processing paradigm. Their ability to describe processes or signals has been successfully studied for a long time. The reason for this is that the technology for constructing artificial neural networks is rarely used for speech recognition and similar segmentation problems.

Hidden Markov Models (SMM) describe a two-stage stochastic process. The first stage consists of a discrete stochastic process that is static, causative, and simple. The state space is considered as finite. Thus, the process probabilistically describes the state of transition to discreteness, the finite state space. This can be visualized as a finite state machine with differences between any pairs of states that are labeled with the probability of transition. The behavior of the process at a given time *t* depends only on the immediate state of the preceding element and can be characterized as follows:

$$P(S_t|S_1, S_2, S_3, \dots \dots S_{t-1}) = \mathrm{P}\ (S_t|S_{t-1})$$

At the second stage, for each moment of time *t*, O_t is additionally generated by output or output. The distribution of associative probability depends only on the current state of *St*, and not on any previous states or output.

$$P(O_t|O_1, O_2, O_3, \dots \dots O_{t-1}, S_1, S_2, S_3, \dots \dots S_{t-1}) = \mathrm{P}\ (O_t|S_{t-1})$$

This sequence of output data is the only thing that can be observed in the behavior of the model. On the other hand, the sequence state adopted during data generation cannot be investigated. This is the so-called “stealth” from which the definition of hidden Markov models is derived. If we look at the model externally, observe its behavior - quite often there are references to the sequence of output states O_i, O_2 ... O_t, as the reason for observing the sequence. Further, the individual elements of this sequence will be called the result of observation.

In the literature, patterns of recognizing the behavior of HMMs are always considered at a certain time interval T. To initialize the model at the beginning of this period, additional probabilities are used to describe the probability of the distribution of states during t = 1. Equivalent criterion of the final state, as a rule, is absent. Thus, the actions of the model come to the final state as soon as an arbitrary state is reached at time T. However, the first-order hidden Markov models, which are usually denoted by A, described as:

• establishment of a finite set of states {s | 1 <s <N},

• state of transition probabilities, matrix A

$$A = (a_{ij}|a_{ij} = \mathrm{P}\ (S_t = j|S_{t-1} = i)$$

• the state vector π

$$\pi = (\pi_i | \pi_i = \mathrm{P}\ (S_1 = i)$$

• state of a specific probability distribution

$$A = (a_j(O_t) | a_i(O_t) = \mathrm{P}\ (O_t = j | S_t = i)$$

3. Results and Analysis

In This example shows how to implement hard clustering on simulated data from a mixture of Gaussian distributions. Gaussian mixture models can be used for clustering data, by realizing that the multivariate normal components of the fitted model can represent clusters. Fit a two-component Gaussian mixture model (GMM). Here, knowing the correct number of components to use. In practice, with real data, this decision would require comparing models with different numbers of components. Also, request to display the final iteration of the expectation-maximization fitting routine. Plot the estimated probability density contours for the two-component mixture distribution. The two bivariate normal components overlap, but their peaks are distinct. This suggests that the data could reasonably be divided into two clusters. For cluster to provide meaningful results when clustering new data, X0 should come from the same population as X, the original data used to create the mixture distribution. When computing the posterior probabilities for X0, cluster and posterior use the estimated mixing probabilities. Each cluster corresponds to one of the bivariate normal components in the mixture distribution. cluster assigns data to clusters based on a cluster membership score. Each cluster membership scores are the estimated posterior probability that the data point came from the corresponding component. Cluster assigns each point to the mixture component corresponding to the highest posterior probability. This data set includes labels. Determine how well gmBest clusters the data by comparing each prediction to the true labels.

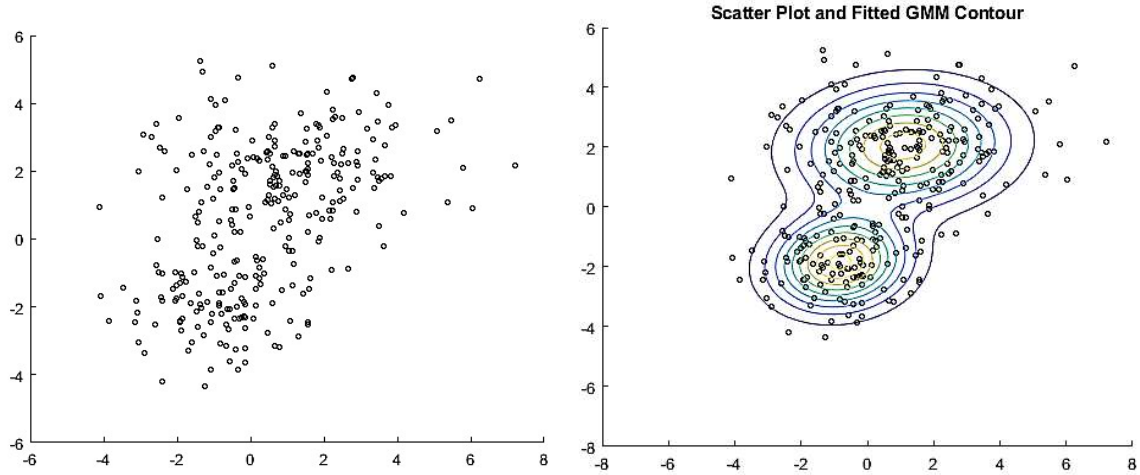

Figure 1. Markov chain Classes reproducibility plot a digraph (left), Markov chain with node colors representing the expected first hitting times (right)

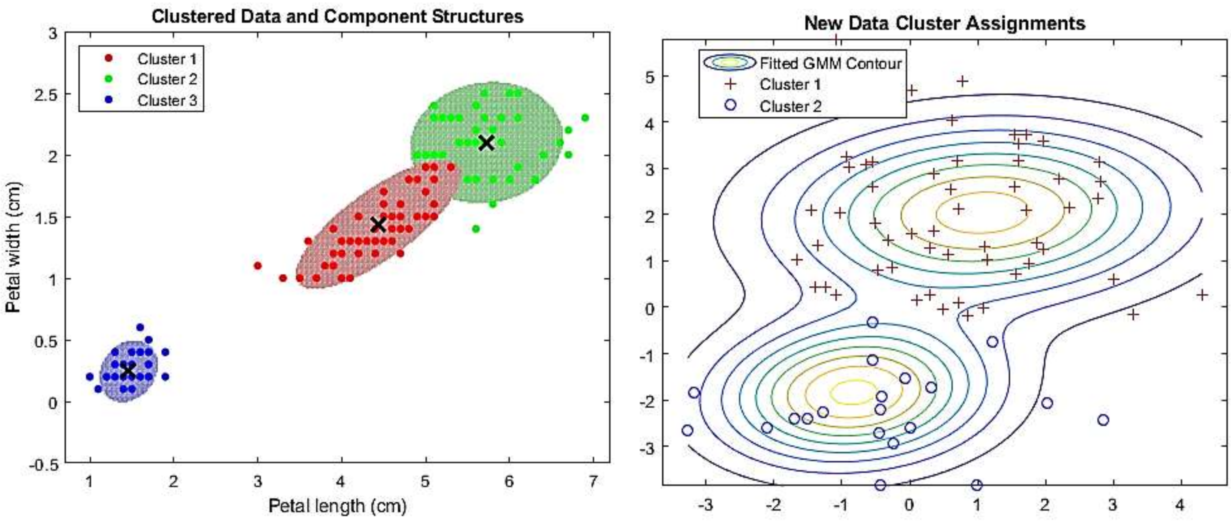

Figure 2 The eigenvalues of the Markov chain on the complex plane.

In the Fig. 2 the pink disc in the plot shows the spectral gap the difference between the two largest eigenvalue modul. The spectral gap determines the mixing time of the Markov chain. Large gaps indicate faster mixing, whereas thin gaps indicate slower mixing. In this case, the gap is large, indicating a fast-mixing chain. When we are slowing mixing process of chain another 23-state Markov chain from a random transition matrix containing 475 infeasible transitions. With fewer feasible transitions, this chain should take longer to mix. Plot a digraph of the Markov chain and identify classes by using node colors and markers.

3. Conclusion

This paper review first describes the core architecture of a navigational unit system based on an HMM emergency response evaluation and then outlines the different advanced features needed for state-of-the-art results. Hidden Markov Models was implemented as applied to the task of recognizing separate data. Practical results are obtained for parametric vectors based on cepstral coefficients and linear prediction coefficients, and corresponding estimates of system performance for various model parameters. Further studies are planned in several directions: development and implementation of transformation algorithms will ensure signal independence of the system, increasing in the size of the training sample will lead to a significant increase in the time of training and testing; as a result, the use of modern parallelism technologies, in particular, computations on graphic processors, may be required.

Bibliography

1. A. Rustamov, N. Gogoi, A. Minetto, F. Dovis “GNSS Anti-Spoofing Defense Based on Cooperative Positioning” // Journal paper: 33rd International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+ 2020), Impact factor for October 2020 – 2,54. DOI: 10.33012/2020.17565
2. A. Rustamov, N. Gogoi, A. Minetto, F. Dovis “Assessment of the Vulnerability to Spoofing Attacks of GNSS Receivers Integrated in Consumer Devices” // Journal paper: 2020 International Conference on Localization and GNSS (ICL-GNSS), Impact factor for June 2020 – 2,54. DOI: 10.1109/ICL-GNSS49876.2020.9115489
3. A. Rustamov, N. Gogoi, Wenjian Qin, F. Dovis “Assessment of Anthropogenic Disturbances on GNSS-based Navigation” // Journal paper: UPINLBS 2019: The Sixth International Ubiquitous Positioning, Indoor Navigation and Location-Based Services Beijing International Conference Center of foreign studies agency Beijing, China, November 13-14, 2019, Impact factor for June 2020 –1,54.

4. A. Rustamov, P. Chiabert, G. D'Antonio, F. Lombardi, S. Ruffa "The Role of Manufacturing Execution Systems in Supporting Lean Manufacturing" // Journal of IFIP International Conference on Product Lifecycle Management. (July 2016 IFIP Advances in Information and Communication Technology) DOI: 10.1007/978-3-319-54660-5_19. Impact factor for 2014 – 1,54
5. A. Rustamov, A. Sharipov, N. Kholikova, A Umarov "Development of recommendations for use of EROGLONASS navigation systems on autonomous agricultural vehicles (tractors) in Uzbekistan" // Journal of "Sustainable Agriculture". Mechanics: applied and fundamental. Mechanical engineering. Instrument engineering №1(1). 2019 ISSN 2181-8584 – C. 8-10. (13.00.00; №33).
6. A. Rustamov, A. Sharipov, N. Kholikova, A Umarov "Ўзбекистон ҳудудида қишлоқ хўжалиги автоном транспорт воситалари (тракторлари)да Эроглонасс навигация тизимларидан фойдаланиш бўйича тавсияларни ишлаб чиқиш" // Journal of Irrigation and Melioration ISSN 2181-8584, 2019 – C. 106-110. (13.00.00; №33).
7. A. Rustamov "Implementations emergency response system in case of accidents and emergency situations (ЭРА-ГЛОНАСС) for cars and trucks in Uzbekistan" // Journal of "Sustainable Agriculture". Mechanics: applied and fundamental. Mechanical engineering. Instrument engineering №1(1).2018 – C. 28-36. (13.00.00; №33).
8. A. Rustamov, A. Hoshimov, J. Inoyatkhodjaev "A Review and Classification of World Class Manufacturing Literatures" // Вестник Туринского политехнического Университета в городе Ташкенте Вестник ACTA – Ташкент, 1-3-2018 – C. 8-10.
9. A. Rustamov, A. Hoshimov, J. Inoyatkhodjaev "Introduction of an electronic control unit (ECU) for an automotive emergency response system in case of accidents and emergency situations (ЭРА-ГЛОНАСС) for cars and trucks in Uzbekistan" // Вестник Туринского политехнического Университета в городе Ташкенте Вестник ACTA – Ташкент, Выпуск 2/2018 – C. 3-10. (05.00.00; №25).

10. A. Rustamov “Determination of correlations of control punching area of ecall / ЭРА-ГЛОНАСС automated emergency response systems” // Вестник Туринского политехнического Университета в городе Ташкенте Выпуск 2/2018, ACTA TTPU 4 (2018) 108-109 – С. 108-109. (05.00.00; №25).
11. A. Rustamov, K. Sharipov “Implementation A Umarov assessments of Ero-Glonass navigation system in agricultural autonomous vehicles in the territory of Uzbekistan” // Вестник Туринского политехнического Университета в городе Ташкенте, ACTA TTPU 3 (2019) 28-31 – С. 106-110. (05.00.00; №25).
12. A. Rustamov, K. Sharipov “Ўзбекистонда автомобиль ва юк машиналари учун фавқулодда вазиятларда ЭРА-ГЛОНАСС системасининг ўрнатилиши ва уни автомобиль мехатрон тизими билан интеграция қилиш усулларини ишлаб чиқиш” // Электрон хисоблаш машиналари учун яратилган дастурнинграсмий рўйхатдан ўтказилганлиги тўғрисидаги гувоҳнома, №DGU 20201690. Сана.05.10.2020
13. A. Rustamov, K. Sharipov, J. Inoyatkhodjaev, A Umarov “Определение проблем и корреляционная система аварийного реагирования (эра-глонасс) для легковых и грузовых автомобилей в Узбекистане” // 104–ой международной научно-технической конференции на тему «Опыт создания и эксплуатации автомобильного транспорта в условиях жаркого климата» 19-20 сентября 2018 года – С. 8-10. (05.00.00; №25).