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A survey on human activity recognition using CNN and LSTM

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Abstract--Human Activity Recognition (HAR) plays a massive role inside the everyday life of people due to its capability to investigate tremendous high-degree data approximately human interest from wearable or stationary devices. An extensive quantity of studies has been completed on HAR and numerous techniques primarily based on deep gaining knowledge of and device analyzing were exploited through the research community to categorize human sports. The

principle motive of this evaluation is to summarize contemporary works based on a big range of deep neural networks structure, mainly convolution neural networks (CNNs) for human hobby reputation. The reviewed systems are clustered into 4 classes relying on the use of input devices like multimodal sensing gadgets, smart phones, radar, and vision devices. This assessment describes the performances, strengths, weaknesses, and the used hyper parameters of CNN architectures for every reviewed device with an evaluate of available public statistics property in addition, a communicate with the cutting edge demanding situations to CNN based HAR systems is furnished. sooner or later, this assessment is concluded with a few functionality future guidelines that might be of outstanding assistance for the researchers who would really like to make contributions to this subject.

Keywords---Human Activity Recognition, Convolutional Neural Network, Multimodal Sensing Devices, Smartphone Data.

Introduction

Human Activity Recognition or HAR immediately, is a broad field of study related to the detection of a particular movement or movement of a person primarily based on sensory statistics. Actions are usually normal indoor activities, including walking, talking, standing, and sitting will be more focused activities that include those types of games that are accomplished in the kitchen or production area. Sensor facts can be recorded remotely, including video, radar, or other wireless devices. Alternatively, information can be recorded directly to a problem that includes handling a custom hardware or smart phones with accelerometers and gyroscopes. Sensory-based activity recognition requires an in-depth knowledge of human games ranging from many historically low-level neuromuscular reading readings, sensational activity-sensing statistics have been challenging and costly to accumulate, requires custom hardware. Now smart phones and other secret tracking devices used to track eligibility and eligibility are reasonably priced and available everywhere. Thus, sensory information from these gadgets is cheaper to collect, more common, and therefore a more readable model of a common thunderstorm problem. The problem is that you are waiting for the leisure time given the picture of sensory realities, usually figures from one or a little wider range of sensory types in general, this suffering is framed as a business of the fixed or periodic collection phase. It is a very difficult problem as there are no obvious or straightforward ways to narrate sensory records recorded in unique human games and each topic can moreover make it interesting in a wide variety, following changes within recorded sensory statistics. The reason is to file sensory facts and related functions for specific topics, adapt the translation from this information, and make the model more general in order to separate the interest of new unseen topics from their sensory information.

Literature Review

There are many references to the dignity books of human activity. Gavrilu (1999) divided the studies into two (with some external and external models) and 3-d strategies. In Aggarwal and Cai (1999), a new taxonomy was created that focuses on human movement tracking, single-view monitoring and multi-object viewing cameras, and modern human activities compared to air and previous taxonomy, Wang et al. (2003) have proposed a sequence of phase action. A contemporary overview Moeslund et al. (2006) focused primarily on location-based recognition tactics and proposed a four-tiered tariff that comprised human fashion, tracking, positioning, and dignity strategies.

The great difference between the definitions of new "action" and "entertainment" was suggested by the method of Turaga et al. (2008), in which trends of interest were classified according to their most interesting modern titles. Poppe (2010) identified popular preference strategies for large classes, describing them as "pinnacle-down" and "back side up." However, Aggarwal and Ryoo (2011) provided tree based taxation, in which popular recreational techniques of the people were divided into two main sub-classes, "single layer" methods and "high-level" tactics, each of which today has several layers according to modern categories.

Modeling 3-d information similarly is a brand new practice, and it changed into what was widely studied by Chen et al. (2013b) and He et al. (2013). as the human frame combines the limbs connected to the limbs, it is easy to model these parts using powerful capabilities, which can be obtained from powerful cameras, and create a fashionable 3-D image of the human frame, which is more instructive than modern 2d analysis sports accomplished in a picture plane.

Aggarwal and Xia (2014) have now categorized modern techniques for recognizing human recreational activity from 3-d stereo systems and motion pictures systems that are key to the advanced 3D real-world techniques. In this suspension, the Microspresent dayt Kinect has played a major role in the movement holding the bones of the body that is today called the use of deep sensors. Although much of the research is focused on the hobbies of personal entertainment from video tracking, the recognition of personal entertainment from static images is still an open and difficult task. Although today's research of personal recreation awareness are linked to facial recognition and or measurement methodologies Guo and Lai (2014) compile a list of all human attraction techniques, starting with photography, then classify them into bigger categories based on their modern relevance and fashion potential all the way to modernism. Jaimes and The Department (2007) proposed a multidisciplinary personal computer interaction that specializes in heart-to-heart communication techniques from posture, facial expressions, and speech.

Pantic and Rothkrantz (2003) examined social media tactics that influence nonverbal multimodal signals like facial expressions and voice. Pantic et al. (2006) studied 49a2d564f1275e1c4e633abc331547db several advanced human behavior strategies that incorporate social factors and protect many of the open computer problems and how they can be successfully installed on a personal computer. Zeng et al. (2009) presented a review of modern techniques

49a2d564f1275e1c4e633abc331547db that use visual and audio methods to detect automated conditions and provide a list of modern data sets in order to quote a personal touch.

Bousmalis et al. (2013a) suggested that a new multimodal analysis (i.e., visual and auditory signals) be developed to create dignity strategies and data sets for automatic contracts and discrepancies. Such communication abilities can also be useful in understanding social behavior, which is essential for social participation. Finally, a full current examination of human behavioral ontologies for novel fact perception and information representation was provided by Rodríguez et al. (2014).

Methodology

This section represents the HMM model, Convolutional Neural Network and Longshort Term Memory (LSTM) For Human Activity Recognition. These Methods Can Be Beneficial And Powerful In The Popularity Of Consumer Spending Time.

Hidden Markov Model (HMM)

Hidden Markov Model (HMM) Markov's hidden model plays a first-class role in the famous breeding machine used for touch recognition, speech and sample recognition. This document describes the methods for calculating popularity and categorizes records by time [8]. A set of statistics acquired from sensors can be used to assess sports. Wearable sensors and image processing techniques can be used to collect data. An Accelerometer sports on a personal framework, for example, can collect data while overcoming a few restrictions, such as flexibility and privacy [9]. HMM based primarily on entertainment reputation can be defined as, Description of gestures, A series of school records, HMM is being tracked and evaluated through informed (immature) records. It keeps track of things like walking and sleeping. It captures test and training information via wearable sensors. From the tri-axial accelerometer and gyroscope sensors, it collects and sends information for processing. In the release of the work, it has pre-calculated statistics from the output of the function and detects sports from the processed records such as upwards, lying, sitting etc. in line with the interest identified in the working version. HMM investigates and discovers many provinces depending on various human activities. Sports analysis can be achieved using short-term patterns. The effectiveness of the improved version is assessed by looking at the quality [5] the main method is type of standing is widely used in the analysis of human games. HMM therefore reflects the self-regulatory dignity of human recreation and discovery prior to the HMM module, Preprocessing is achieved with trained data sets. The Gaussian composite version is used to make a historical release.

Convolution Neural Network

Convolutional Convolution Neural Network Convolutional Neural Community Models, or CNNs Quickly, are not the kind of deep neural community developed to be used for image information, e.g. such as noticing handwriting ensure that they work best on solid computer problems while being instructed on a scale of tasks

that include locally identifying and performing gadgets in images and interpreting graphic content on a regular basis. It may be fashion based on two basic elements: Convolutional Layers, Combining layers. Convolutional layers use a kernel that can be read in tiny chunks at a time and steps throughout the entire input direction to test enter, as well as a 2d image or 1D signal. The input from each survey is displayed on the filter map and represents your own internal interpretation data. Combining layers take a guess from a work map and break it down into more important elements, as well as using a measurement signal method or a magnification technique. Layers of convolution and integration can be performed indefinitely, resulting in several layers of summarizing input warnings. Those networks often provide one or more completely connected layers that translate what has been read and map this image into the category value.

Long-Short Term Memory (LSTM)

Long Short-Term Memory (LSTM) LSTM social fashion is a type of continuous neural network that is capable of researching and forgetting the long sequence of input data should be used with records built from a long sequence of statistics, up to 200 to 400 steps of time they may well fit into this problem. The version can support more than one sequence of input data, which includes the entire accelerometer axis and gyroscope calculations. The version learns to extract elements from visual tracking and how to map the inner skills to different types of tasks. The advantage of using LSTMs in the series class is that they can test from the information of the raw time collection quickly, and they do not need domain information to incorporate developer features. The version can analyze the internal image of the realities of the time series and better yet find complete comparable performance on models such as the database version with engine features.

Conclusion

The purpose of this study is to provide an overview of the methodologies often used to classify medical images. These methodologies can be used to recognize the work of older persons and the monitoring of their activities through the models of HMM, CNN, LSTM, wearable and non-wearable sensors. There are other obstacles to the modern system such as privacy in addition to effective monitoring and accuracy. In the design process, it is proposed that additional sensory data gathered from unique physical functions be used to evaluate the various models and their efficiency.

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References

- S. A. Taghanaki, K. Abhishek, J. P. Cohen, J. Cohen-Adad, and G. Hamarneh, "Deep semantic segmentation of natural and medical images: A review," *Artif. Intell. Rev.*, pp. 1-42, 2020.
- Pubali De , Amitava Chatterjee, and Anjan Rakshit , " Recognition of Human Behavior for Assisted living using Dictionary Learning Approach", *IEEE SENSORS JOURNAL*, VOL. 18, NO. 6, MARCH 15, 2018.
- Uriel Martinez-Hernandez, Imran Mahmood, and Abbas A. Dehghani-Sanij, "Simultaneous Bayesian Recognition of Locomotion and Gait Phases With Wearable Sensors", *IEEE SENSORS JOURNAL*, VOL. 18, NO. 3, FEBRUARY 1, 2018.
- Akram Bayat, Marc Pomplun, Duc A. Tran, "A Study on Human Activity Recognition Using Accelerometer Data from Smartphones", *ELSEVIER* 2014.
- Bo Tang, Jin Xu, Haibo Heand Hong Man, " ADL: Active Dictionary Learning for Sparse Representation", *IEEE* 2017.
- Eunju Kim, Sumi Helal, and Diane Cook, " Human Activity Recognition and Pattern Discovery", *IEEE* 2010.
- Y. Zhang, and K. M. Ramachandran. Human Activity Recognition with Streaming Smartphone Data. 2019 Global Conference for Advancement in Technology (GCAT). *IEEE*, 2019.
- Agarwal, P.; Alam, M. A lightweight deep learning model for human activity recognition on edge devices. *Procedia Comput. Sci.* 2020, 167, 2364-2373.
- Xia, K.; Huang, J.; Wang, H. LSTM-CNN Architecture for Human Activity Recognition. *IEEE Access* 2020, 8, 56855-56866.
- Hassan, M.M.; Uddin, Z.M.; Mohamed, A.; Almogren, A. A robust human activity recognition system using smartphone sensors and deep learning. *Future Gener. Comput. Syst.* 2018, 81, 307-313.
- Lee, S.-M.; Yoon, S.M.; Cho, H. Human activity recognition from accelerometer data using convolutional neural network. In *Proceedings of the IEEE*

- International Conference on Big Data and Smart Computing (BigComp), Jeju, Korea, 13–16 February 2017; pp. 131–134.
- K. Nakano, and B. Chakraborty. Effect of dynamic feature for human activity recognition using smartphone sensors. 2017 IEEE 8th International Conference on Awareness Science and Technology (iCAST), IEEE, 2017.
- Christian Debes, Andreas Merentitis, Sergey Sukhanov, Maria Niessen, Nicolaos Frangiadakis, and Alexander Bauer, "Monitoring Activities of Daily Living in Smart Homes", IEEE 2016.
- Meisam razaviyayn hung-wei tseng zhi-quan luo, "Dictionary learning for sparse representation: complexity and algorithms", IEEE international conference 2014.
- Shagun Shaily, Veenu Mangat, "The Hidden Markov Model and its Application to Human Activity Recognition", IEEE 2015.
- Palwasha Afsar, Paulo Cortez, Henrique Santos, "Automatic Human Action Recognition from Video using Hidden Markov Model", IEEE 2015.
- Rong liu, ting chen, lu huang, "Research on human activity recognition based on active learning", IEEE 2010.
- Yan Wang, Shuang Cang², Hongnian Yu¹, "A noncontactsensor surveillance system towards assisting independent living for older people", Research gate, December 2017.
- Liming Chen, Member, IEEE, Jesse Hoey, Chris D. Nugent, Member, IEEE, Diane J. Cook, and Zhiwen Yu, "SensorBased Activity Recognition", IEEE, VOL. 42, NO. 6, NOVEMBER 2012.
- Oscar D. Lara and Miguel A. Labrador, "A Survey on Human Activity Recognition using Wearable Sensors", IEEE communications surveys & tutorials, 2013.
- F. Friedrich, M. Smeja, and J. Fahrenberg. Detection of posture and motion by accelerometry: a validation study in ambulatory monitoring, *Computers in human behavior* 15.5 (1999): 571-583.
- W. Wu, et al. Classification accuracies of physical activities using smartphone motion sensors. *Journal of medical Internet research* 14.5 (2012).
- D. Anguita, et al. Human activity recognition on smartphones using a multiclass hardware-friendly support vector machine. *International workshop on ambient assisted living*. Springer, Berlin, Heidelberg, 2012.
- C. Ronao, and S. Cho. Human activity recognition with smartphone sensors using deep learning neural networks. *Expert systems with applications* 59 (2016): 235-244.
- Sarah Fallmann and Johannes Kropf. (2016) "Human activity recognition of continuous data using Hidden Markov Models and the aspect of including discrete data." *Intl IEEE Conferences* 121-126.
- M. Humayun Kabir, M. Robiul Hoque, Keshav Thapa, and Sung-Hyun Yang. (2016) "Two-Layer Hidden Markov Model for Human Activity Recognition in Home Environments." *International Journal of Distributed Sensor Networks*, Volume: 12 issue: 1.
- Lin Fan, and Zhongmin Wang. (2014) "Human activity recognition model based on decision tree." *International Conference on Advance Cloud and Big Data*, pp. 64-68.
- Piyush Kumar Pareek et al, 'Survey on Challenges in Devops ', *International Journal of Innovative Research in Computer Science & Technology (IJIRCST)*, ISSN: 2347-5552, Volume-4, Issue-5, September-2016.

- Dr.Piyush Kumar Pareek et al, 'Education Data Mining –Perspectives of Engineering Students ', International Journal of Innovative Research in Computer Science & Technology (IJRCST), ISSN: 2347-5552, Volume-4, Issue-5, September-2016.
- Dr.Piyush Kumar Pareek et al, 'A survey on approaches for predicting performance of students',International Journal of Engineering Research and Science, ISSN No.2395-6992 Paper Id:IJOER-Jun-2016-25.
- Dr.Piyush Kumar Pareek et al, 'A survey on Long term product planning and requirements prioritization to customer value creation', International Journal of Engineering Research and Science, ISSN No.2395-6992 Paper Id: IJOER-Jun-2016-27.
- Dr.Balakrishna R, Piyush Kumar Pareek et al, 'Study on Six Sigma approach to improve the quality of process outputs in business processes in Small & Medium Level Software Firms' Springer AISC Series/ SCOUPS INDEXED JOURNAL, Paper Id : IT -221-ICPCIT2015 , June 2015.
- Dr.Balakrishna R, Piyush Kumar Pareek et al, 'Data Mining for Healthy Tomorrow with the implementation of Software Project Management technique', Springer AISC Series/ SCOUPS INDEXED JOURNAL, Paper Id : IT -187-ICPCIT2015, June 2015.
- Piyush Kumar Pareek & Dr. A. N. Nandakumar, 'To Implement Lean software development frame- work for minimizing waste in terms of non-value added activities', Research Publishing, Jain University ICISTSI-15 , Innovative Partners for Publishing Solutions, Singapore (May 2015).
- Piyush Kumar Pareek & Dr.A.N.Nandakumar, 'Identifying Wastes in software, International Journal of Engineering Studies and Technical Approach'. January Issue 2015.
- Piyush Kumar Pareek & Dr.A.N.Nandakumar, 'Failure Mode Effective Analysis of Requirements Phase in small software Firms', Paper ID: ICSTM/YMCA/2015/292, International Conference on Science, Technology and Management (ICSTM-2015). International Journal of Advance Research in Science and Engineering (IJARSE, ISSN- 2319-8354, Impact Factor- 1.142) [www.ijarse.com], Special Issue Jan2015.
- Mr. Piyush Kumar Pareek, Dr. A. N. Nandakumar, 'Lean software development Survey on Agile and Lean usage in small and medium level firms in Bangalore', International Journal of Advanced Research in Computer Science and Software Engineering , Volume 4, Issue 12, December 2014 , ISSN: 2277 128X .pp 1-7 Impact Factor : 2.08.
- Mr.Piyush Kumar Pareek, Dr. A. N. Nandakumar, 'Lean software development Survey on Benefits and challenges in Agile and Lean usage in small and medium level firms in Bangalore' , International Journal of Advanced Research in Computer Science and Software Engineering , Volume 4, Issue 12, December 2014 , ISSN: 2277 128X .pp 1-11 Impact Factor : 2.08.
- Piyush Kumar Pareek , Dr.Praveen Gowda , et al 'Ergonomics in a Foundry in Bangalore to improve productivity',International Journal of Engineering and Social Science , ISSN: 2249- 9482 ,Volume 2,Issue 5 (May 2012) , pp 1-6.
- Piyush Kumar Pareek, Dr. Vasanth Kumar S A , et al 'Reduction of Cycle Time By Implementation of a Lean Model Carried Out In a Manufacturing Industry', International Journal of Engineering and Social Science , ISSN: 2249-9482,Volume 2,Issue 5 (May 2012) , pp 114-123.

- Piyush Kumar Pareek , Dr.Praveen Gowda, et al 'FMEA Implementation in a Foundry in Ban- galore to Improve Quality and Reliability',*International Journal of Mechanical Engineering and Robotics Research*, ISSN :2278-0149,Volume 1,Issue 2(June 2012),pp 81-87.
- Piyush Kumar Pareek, Dr.Vasanth Kumar S A , et al 'Implementation of a Lean Model for Carrying out Value Stream Mapping in a Manufacturing Industry', *International Journal of Mechanical Engineering and Robotics Research*, ISSN :2278-0149,Volume 1,Issue 2(June 2012),pp 88-95.
- Piyush Kumar Pareek, Dr. A. N. Nandakumar, et al 'Methodology and Functioning of Project Management Techniques in Agile Software Development Process', *International Journal of Research in IT, Management and Engineering*, ISSN: 2249-1619, Volume2, Issue12 (December2012), pp 76-85.
- N. A. Prasad and C. D. Guruprakash, "An ephemeral investigation on energy proficiency mechanisms in WSN," 2017 3rd International Conference on Applied and Theoretical Computing and Communication Technology (iCATccT), Tumkur, 2017, pp. 180-185.
- A. P. N and C. D. Guruprakash, "A Relay Node Scheme for Energy Redeemable and Network Lifespan Enhancement," 2018 4th International Conference on Applied and Theoretical Computing and Communication Technology (iCATccT), Mangalore, India, 2018, pp. 266-274.
- Achyutha Prasad, N., Guruprakash, C.D., 2019. A relay node scheme of energy redeemable and network lifespan enhancement for wireless sensor networks and its analysis with standard channel models. *International Journal of Innovative Technology and Exploring Engineering* 8, 605–612.
- Achyutha Prasad, N., Guruprakash, C.D., 2019. A relay mote wheeze for energy saving and network longevity enhancement in WSN. *International Journal of Recent Technology and Engineering* 8, 8220–8227. doi:10.35940/ijrte.C6707.098319.
- Achyutha Prasad, N., Guruprakash, C.D., 2019. A two hop relay battery aware mote scheme for energy redeemable and network lifespan improvement in WSN. *International Journal of Engineering and Advanced Technology* 9, 4785–4791. doi:10.35940/ijeat.A2204.109119.
- Rekha VS, Siddaraju., "An Ephemeral Analysis on Network Lifetime Improvement Techniques for Wireless Sensor Networks", *International Journal of Innovative Technology and Exploring Engineering*, vol. 8, issue 9, 2278-3075, pp. 810–814, 2019.
- Prasad N. Achyutha, Sushovan Chaudhury, Subhas Chandra Bose, Rajnish Kler, Jyoti Surve, Karthikeyan Kaliyaperumal, "User Classification and Stock Market-Based Recommendation Engine Based on Machine Learning and Twitter Analysis", *Mathematical Problems in Engineering*, vol. 2022, Article ID 4644855, 9 pages, 2022. <https://doi.org/10.1155/2022/4644855>.
- Achyutha, P. N., Hebbale, S., & Vani, V. (2022). Real time COVID-19 facemask detection using deep learning. *International Journal of Health Sciences*, 6(S4), 1446–1462. <https://doi.org/10.53730/ijhs.v6nS4.6231>.
- Kalshetty, J. N., Achyutha Prasad, N., Mirani, D., Kumar, H., & Dhingra, H. (2022). Heart health prediction using web application. *International Journal of Health Sciences*, 6(S2), 5571–5578. <https://doi.org/10.53730/ijhs.v6nS2.6479>.

- Suryasa, I. W., Rodríguez-Gámez, M., & Koldoris, T. (2022). Post-pandemic health and its sustainability: Educational situation. *International Journal of Health Sciences*, 6(1), i-v. <https://doi.org/10.53730/ijhs.v6n1.5949>
- R. V S and Siddaraju, "Defective Motes Uncovering and Retrieval for Optimized Network," 2022 6th International Conference on Computing Methodologies and Communication (ICCMC), 2022, pp. 303-313, doi: 10.1109/ICCMC53470.2022.9754109.
- N. G and G. C. D, "Unsupervised Machine Learning Based Group Head Selection and Data Collection Technique," 2022 6th International Conference on Computing Methodologies and Communication (ICCMC), 2022, pp. 1183-1190, doi: 10.1109/ICCMC53470.2022.9753995.
- Jipeng, T., Neelagar, M. B., & Rekha, V. S. (2021). Design of an embedded control scheme for control of remote appliances. *Journal of Advanced Research in Instrumentation and Control Engineering*, 7(3 & 4), 5-8.
- Prakash, N. C., Narasimhaiah, A. P., Nagaraj, J. B., Pareek, P. K., Sedam, R. V., & Govindhaiah, N. (2022). A survey on NLP based automatic extractive text summarization using spacy. *International Journal of Health Sciences*, 6(S8), 1514–1525. <https://doi.org/10.53730/ijhs.v6nS8.10526>
- Prakash, N. C. P., Narasimhaiah, A. P., Nagaraj, J. B., Pareek, P. K., Maruthikumar, N. B., & Manjunath, R. I. (2022). Implementation of NLP based automatic text summarization using spacy. *International Journal of Health Sciences*, 6(S5), 7508–7521. <https://doi.org/10.53730/ijhs.v6nS5.10574>
- Ramkrishna, S., Srinivas, C., Narasimhaiah, A. P., Muniraju, U., Maruthikumar, N. B., & Manjunath, R. I. (2022). A survey on blockchain security for cloud and IoT environment. *International Journal of Health Sciences*, 6(7), 28–43. <https://doi.org/10.53730/ijhs.v6n7.10692>
- Hebbale, S., Marndi, A., Achyutha, P. N., Manjula, G., Mohan, B. R., & Jagadeesh, B. N. (2022). Automated medical image classification using deep learning. *International Journal of Health Sciences*, 6(S5), 1650–1667. <https://doi.org/10.53730/ijhs.v6nS5.9153>
- Hebbale, S., Marndi, A., Manjunatha Kumar, B. H., Mohan, B. R. ., Achyutha, P. N., & Pareek, P. K. (2022). A survey on automated medical image classification using deep learning. *International Journal of Health Sciences*, 6(S1), 7850–7865. <https://doi.org/10.53730/ijhs.v6nS1.6791>