A Novel Approach for Women Security with Information Fusion for Multi-Sensory Data

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Abstract- Current era is of autonomous applications. Such applications utilize various sensory resources to get input. As per the objectives of applications the information received from multiple sensors should go through processing, delivering and surveying. The method that can be opt to gather the sensory information and some conclusive parameters derivations from the information which can be helpful to take intelligent decisions for the autonomous applications these are the major hurdles. Computational time, accuracy, flexibility, real time monitoring etc. such parameters are very important to consider in process of system or application development. Sometimes only considering single sensor to draw any conclusion is not effective. Computing information received from various heterogeneous sensors gives more effective conclusive parameters. This survey paper briefly elaborates literature survey, gaps identified in present work, algorithms and architecture. Proposed system involves unsupervised algorithm which can be used on real time data and that can combine information received from multiple homogeneous or heterogeneous sources. By drawing some conclusive parameters the intelligent decision making can be done. According to requirement of application the exact intelligent decision making by reduction of unreliability and disordered sensory data in real time is the main center of interest. Furthermore Women Security problem is presented to illustrate as an application to prove our concepts and algorithm for sensor fusion. Women's safety is a very important issue due to increase in violations against women now a days. To help handle this issue we propose a women's safety system which is GPS enabled with dual security feature. This device comprises of a system that guarantees dual cautions in case where a woman facing harassment or she thinks she is in a difficult situation.

Index terms- Machine learning, information fusion, sensors, autonomous applications, sensor fusion, performance parameters, unsupervised learning, decision making, GPS, Women safety.

I. INTRODUCTION

Information Fusion is a technology which takes input from heterogeneous or homogeneous sources and then incorporates the received data. Using this data it creates preferred outcomes. Information Fusion or Sensor Fusion system is utilized in different areas such as Artificial Intelligence, Cognitive Computing, Neural Network, Machine Learning, and Soft Computing [2]. Some of the applications of information fusion are military, automations in home, medical, space etc. To collect data from heterogeneous sources, aggregate data to one uniform resource, take out the required information, create some conclusions based on the data and intelligent decision making these are some issues in this process. While concluding some exceptional care must be taken to fuse data and producing deductions for intelligent decision making.

India is developing country and it can only get success if women are part of their process. Its 2020 and still women are struggling for their rights and safety Women security is significant issue as violations against women are day by day increasing. To help settle this issue we propose a GPS based women well-being system that has double security highlight with manual and automatic way. This framework can be turned on by a lady in the event that she even figures she would be in a difficult situation. When automatic mode is activated woman needs to touch the fingerprint sensor then even if the woman is not in situation to turn on the system it waits for 1 minute after previous sensor touch then it automatically switch on the buzzer and sends panic message to 10 registered emergency contacts, nearby police station with location.

The further chapters in this paper are organized as section II Motivation, section III we describe the State of Art which includes fundamental concepts, survey of papers for domain knowledge and application case study, existing algorithms and techniques for Information fusion. In section IV we give Gaps analysis of related work. Section V is research objectives. Section VI is methodology and section VII is conclusion.

II. STATE OF ART

Fundamental Concept of Information Fusion

Information fusion is very interesting technology that actually does fusion. Instead of many uncertain decisions it gives authentic, impartial, vigorous decision by generating one entity combining many parameters together. In this process raw data in taken as an input. Users create some information in the form of pictures, database, sensors which is input source. Technique in which data only received from sensory

resources is known as sensor fusion and basically it is a subset of information fusion as shown in fig. 2. The primary target of data fusion is to improve precision in results and according to application take intelligent decision. For intelligent decision making unprocessed data as input is used by information fusion to convert it into knowledge. Neural network, soft computing, artificial intelligence and machine learning these are the different fields where Information fusion can be utilized [2]

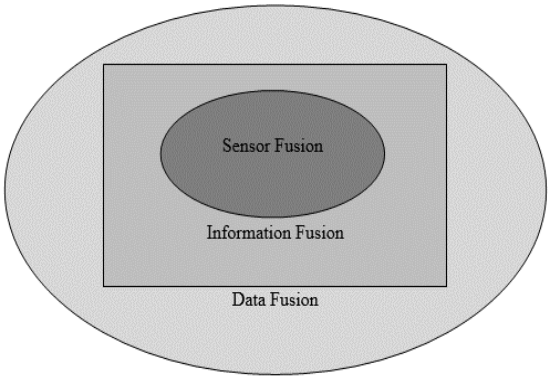

Fig.2: Multisensory/sensor fusion data, data fusion and information fusion

Survey of Papers for Domain Knowledge and Application Case Studies

[1] After the "AI Winter" of the 80s and 90s, enthusiasm for the utilization of information driven Artificial Intelligence (AI) strategies has been consistently expanding in various building fields, including speech and image analysis [1]. As informational indexes develop, utilizing machines to take in important examples from organized information can be very ground-breaking. The volume of information is too enormous for complete investigation, and the scope of potential connections and connections between dissimilar information sources are unreasonably extraordinary for any expert to test all speculations and determine all the worth covered in the information. AI (ML) is perfect to open doors for covered exploiting the opportunities in big Data.

[2] In this reference author provided Dynamic decision making approach to handle unpredictable emergency events. And their Reliability of decision results are based on current situations and historical data. With the help of data Calculates accurate decision matrix. Author mainly focused on Bayesian network, decision process, and intuitionistic fuzzy sets as key concepts. [2].

[3]This reference provides approach to recognize human activities in ubiquitous computing and Human Computer Interaction (HCI). They get data using appropriate sensors. Mainly focus on feature extraction and Uses Statistical features, Deep learning, multi sensor fusion, human activity monitoring, machine learning. It helps to reduce computation time and enhance accuracy [3].

[4]This reference provides security device for women. It uses Arduino controller and sensors such as temperature, flex sensor, MEMS accelerometer, Pulse rate sensor, sound sensor, a buzzer, LCD, GSM and GPS to Senses body parameters and then perform tasks as per application objectives such as – body temperature detection, voice detection, flex motion detection, sudden fall detection, pulse rate detection of victim, activation of buzzer, send panic message to registered contacts [4].

[5]The system in this reference demonstrate the fuzzy choquet integral an amazing nonlinear collection of function. Information about the improved ChIMP and the way it has been improved. Empowering of eXplainable AI is done by the ChIMP and it is its added benefit. A novel NN architecture with a gradient descent-based optimization solution that mimics the Choquet integral for information aggregation. Accuracy is less [5].

[6]This reference mainly focuses on detailed insights about deep learning, convolutional neural network algorithm and Naïve Bayes for data fusion. Methodology in this paper is used in detection of break analysis of video frame. The CNN algorithm needs lots of training data to make training converge and over fitting [6].

[7]System proposed in this reference involves exploration of Artificial intelligence procedures to give comprehensive execution assessment of Information fusion system. This mainly focuses on Statistical analysis to exploit interactions between elements to improve IFS design and its performance [7].

[8]Portable device proposed in this reference use to provide security for women by using Pressure switch, GSM800, GPS, and Microcontroller Arduino. When pressure switch activated by user it performs tasks like - send panic message, share location and call to registered numbers, if not answered redirect to police [8].

[9]Watch to provide women security. Use of GPS and GSM, sensors has been done to send location and to send message. This paper gives idea about the application that how the system can be design to help women in such crucial time span. Tasks mainly focused are detect heartbeat, automatic call to registered number, detect nearby police station and make ring [9].

[10]This reference provides information regarding various tools for Women Security and also it gives general idea about

system that can help women in dangerous situations. Auto receiving call, GPS, GSM, Spy camera detection, intrusion detection, call 100 or emergency numbers, generate shock in self-defense, alarms are the some highlighted features of these tools. It can be implemented with android app or Arduino based approach [10]

Table no. 1 Literature Survey of Domain Papers and Application papers

Sr. No.	Title	Authors & Publication	Limitations	Proposed work
[1]	A Very Brief Introduction to Machine Learning With Applications to Communication Systems	Osvaldo Simeone 2018 IEEE Transaction	1. It cannot be recognize as a broad solution 2. Learning tasks are completed at distributed machines that need to organize by means of correspondence e.g., by moving the outcomes of calculations.	Where to put the learning tasks (machine learning algorithms)
[2]	A Dynamic Weight Determination Approach Based on the Intuitionistic Fuzzy Bayesian Network and Its Application to Emergency Decision Making	Zhinan Hao, Zeshui Xu, Senior Member, IEEE, Hua Zhao, Hamido Fujita 2017 IEEE Transaction	The quality of accumulated outcomes totally depends on reliability and accuracy of weights	Use fuzzy logic to make decision
[3]	Deep Learning Fusion Conceptual Frameworks for Complex Human Activity Recognition Using Mobile and Wearable Sensors	Nweke Henry Friday Ghulam Mujtaba Mohammed Ali Al-garadi Uzoma Rita Alo 2018 IEEE Transaction	Difficult to feature extraction and complex human activity recognition	Ubiquitous computing to recognize activity using wearable sensors
[4]	A Novel Approach to Provide Protection for Women by using Smart Security Device	Kalpana seelam K.Prasanti Asst.Prof. 2018 IEEE Transaction	As it depends on pulse rate chances of false notifications possible	1. Safe and secure electronic system for women. 2. Device senses some parameters when women is in threat 3. Victim location is sent to the registered mobile number
[5]	Enabling Explainable Fusion in Deep Learning with Fuzzy Integral Neural Networks	Muhammad Aminul Islam, Derek T. Anderson, Anthony J. Pinar, Timothy C. Havens, Grant Scott, and James M. Keller, 2019 IEEE Transaction	Need to improve accuracy	A novel NN architecture with a gradient descent-based optimization solution that mimics the Choquet integral for information aggregation.

Table no. 2 Literature Survey of Domain papers and Application papers

Sr. No.	Title	Authors& Publication	Limitations	Proposed work
[6]	NB-CNN Deep Learning-Based Crack Detection Using Convolutional Neural Network and Na¨ıve Bayes Data Fusion	Fu-Chen Chen and Mohammad R. Jahanshahi 2017 IEEE Transaction	To make training converge and over fitting the Convolution neural network algorithm needs lots of training data.	1. Improve overall performance and improvement of the system
[7]	Identifying interactions for information fusion system design using machine learning techniques	Ali K. Raz, Paul Wood, LinasMockus, James Llinas, and Daniel A. DeLaurentis. 2018 IEEE Conference	It consumes memory and take much time to respond	1. the independent design and evaluation of IFS constituent elements 2. Statistical analysis to exploit interactions between elements to improve IFS design and its performance.
[8]	Smart Intelligent System for Women and Child Security	Prof. Sunil K Punjabi Prof. Suvarna Chaure Prof. Ujwala Ravale Prof. Deepti Reddy 2018 IEEE Conference	1. This system is huge in size to carry	1. Immediate responses in any harassment 2. Call will redirect to police and will send the message 3. less response time to help victim
[9]	Smart watch for womens security IOT concept watch me	Helen , M. FathimaFathila, R. Rijwana, Kalaiselvi 2017 IEEE Conference	Heart rate may increase due to some non-emergency situations	1. Overcome the functionality of smart watch because it is not possible to have mobile all the time in hand 2. sensors present in system will helpful in some scenarios
[10]	All in one Intelligent Safety System for Women Security	1. AbhijitParadkar 2. Deepak Sharma 2015 IEEE Conference	1. Maximum time to operate. 2. Data loss	1. System can provide useful evidences against crime 2. Provides tool for intrusion detection

Survey of Algorithms

Several techniques and algorithms are available for example dempster shafer evidence theory, Bayesian belief network, center limit theorem fuzzy logic, neural network, kalman filter to combine data or information [2]. Fusion process mainly involves one important objective that is exact generation of conclusive parameters and according to application take intelligent decision. The suitable algorithms to proposed algorithm are Bayesian network, neural network and fuzzy logic.

1. *Fuzzy Logic*

The fuzzy logic was put forth by Dr. Lolfi zadeh. The Boolean logic works on true or false i.e 1 or 0. Working of computer depends on this Boolean logic. The computations and reasoning done between 0 and 1 in fuzzy logic. Humans consider various possibilities between YES and NO while making decisions which computer cannot. The way humans considers all the possibilities between digital values YES and NO while making decisions is followed by the fuzzy logic. Accurate reasoning may not be possible by fuzzy logic but it gives acceptable reasoning. Fuzzy logic manages unreliability, imperfect, unclear, distorted or incorrect inputs.

2. *Neural Network*

Supervised learning mechanism supported neural networks were put forth in 1960. To build a system in neural network it requires lot of training examples so that the system can able to learn also to enhance the accuracy it creates deductions or derive rules from examples which are considered for training. There is no involvement of human is required in neural network.

3. Kalman Filter

Kalman Filter initially put forth by the Kalman in 1960. At that point it turned out to be exceptionally famous fusion strategy. To combine low-level redundant data Kalman filter is utilized. For getting precise outcome between Estimated Value and Data Kalman filter is mainly considered. User satisfaction is important so till their approval iteration process of Kalman filter goes on.

4. Bayesian Theory

Bayesian theory totally depends on probability theory. We can addresses the difficulties of insufficient data fusion and can discover the solution for the equivalent by utilizing information fusion or sensor fusion enabled Bayesian theory. Data uncertainty issue is conveyed by probabilistic techniques and it totally depends on the probability distribution or density functions.

III. GAP ANALYSIS OF RELATED WORK

Gap analysis- Research Papers

Solution provided in reference [1] cannot be considered as universal solution and systems, learning tasks are carried out at distributed machines that need to coordinate via communication e.g. by transferring the results of intermediate computations. Proposed system in reference [2] might have potential information loss in transformation process and it may lead to delays in emergency decision making. Solution given in reference [3] is difficult to feature extraction and recognize complex human activity recognition. In reference [5] solution uses NN architecture with gradient based optimization solution that mimics Choquet integral for information aggregation but has less accuracy. As in [6] The CNN algorithm is used it needs lot of training data to make training converge and over fitting. As per analysis reference [7] has limitations as system consumes memory and takes much time to respond.

Women Security system given in reference [4] works automatically on increase in pulse rate but there might be possibility of false notifications. Solution provided in reference [8] contains some complex designing issues and immediate response is not possible with this approach. System proposed in [9] totally depends on heart rate. Increase in heart rate gives notifications but heart rate may increase due to some non-emergency situations also so this can give false notification. Solution given in [10] takes maximum time to operate and there are chances of data loss.

Gap analysis- Women Security Application

Table no. 3 Gap analysis - Women security application

Parameters / Papers	Accuracy	Request Time	Response Time	Cost	Complexity	Performance	Reliability	Availability	Secure Ratio
Deep Learning Fusion Conceptual Frameworks for Complex Human Activity Recognition Using Mobile and Wearable Sensors	Moderate	Moderate	Moderate	High	High	High	Yes	Yes	High
A Novel Approach to Provide Protection for Women by using Smart Security Device	Moderate	Moderate	Moderate	High	Less	Moderate	Yes	No	Moderate
Smart	Less	Less	Less	High	Less	Less	Yes	Yes	Less

Intelligent System for Women and Child security									
Smart watch for women Security based on IOT concept 'Watch Me'	Less	Less	High	Moderate	Less	Less	No	No	Less
Research and development of a mobile based women safety application with real-time database and data-stream network	Moderate	Less	High	Less	Moderate	Moderate	No	No	Less
HearMe A Smart Mobile App for Mitigating Women Harassment	Less	Less	High	Less	Moderate	Less	No	Yes	Less
Smart Security Solution for Women based on IOT	Moderate	Less	High	Moderate	Less	Less	No	No	Less
Design and Implementation of Safety Armband using ARM7	Moderate	High	Moderate	High	High	Moderate	Yes	Yes	High
All in one Intelligent Safety System for Women Security	Less	Less	Moderate	Moderate	Moderate	Less	Yes	Yes	Less
A Mobile Application for Women's Safety WoSApp	Less	Less	High	Less	Less	Less	Yes	No	Less
Proposed System	**High**	**High**	**Less**	**Less**	**Less**	**High**	**Yes**	**Yes**	**High**

Gap analysis- Algorithms

Table no. 4 Gap analysis – Algorithms

Standard Techniques / Parameters	Bayesian Belief Network	Dempster Shafer Evidence Theory	Kalman Filter	Neural Network	Fuzzy Logic	**Proposed System**
Accuracy	Yes	Less	Yes	Yes	Moderate	**Yes**
Reliability	Yes	Yes	No	Yes	Less	**Yes**
Flexibility	No	Yes	No	Less	Less	**Yes**
Can reduce uncertainty	Yes	Yes	Yes	Yes	Yes	**Yes**
Can reduce imperfection, incompleteness, inconsistency	No	Yes	Yes	Yes	Moderate	**Yes**
Decision making	Yes	Yes	Yes	Yes	Moderate	**Yes**
Multi-sensor data fusion	Yes	Yes	Yes	Yes	Yes	**Yes**
Computation Time	Less	Less	Moderate	Less	Moderate	**Less**
Big data processing	No	No	No	Yes	No	**Yes**
Energy saving	Yes	Reduce Energy Consumption	Less	Yes	Less	**Yes**
Real time monitoring	Yes	Yes	Yes	Yes	Yes	**Yes**
Heterogeneity of devices	Yes	Yes	Yes	Yes	Yes	**Yes**
Supervised or Unsupervised	Supervised	Supervised	Supervised	Supervised Unsupervised	Supervised	**Unsupervised**

IV. METHODOLOGY

When system takes input from sensory resources which is in the form of raw data the major hurdle is to convert the received input into proper knowledge and information. It can help the decision maker to take intelligent decision in sufficient time span. The proposed system architecture depicted in fig. 5 shows the various phases through which the system can give the final decision taking sensory data as an input and using unsupervised learning approach.

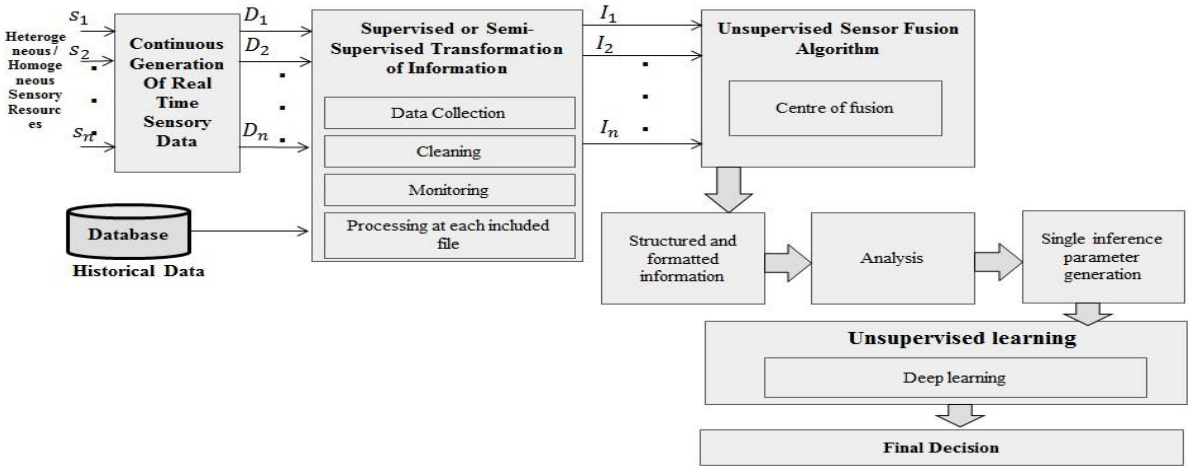

Fig.5: Proposed system architecture

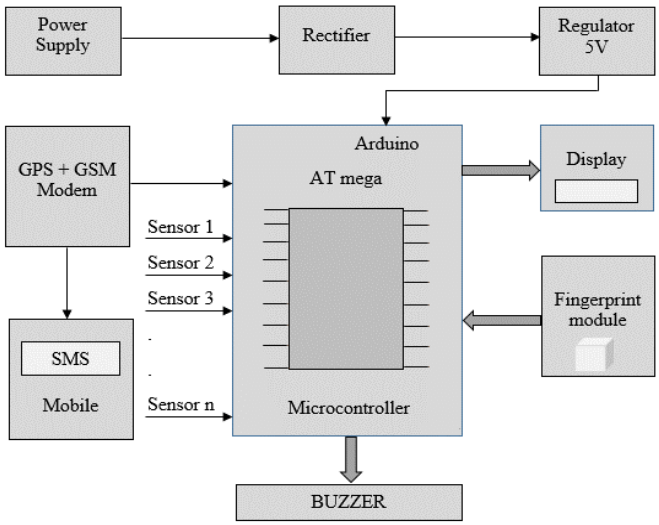

Fig.6: Application Block Diagram

V. CONCLUSION

This survey paper gives brief description of the term information fusion. In some of the domains like machine learning, artificial intelligence, neural network etc. this information fusion technology can be used to provide accurate solutions to various issues. Using machine learning with sensor fusion technique women security problem can be solved. Literature survey and methodology for these concepts is done briefly in this paper. This framework will end up being exceptionally helpful in sparing lives just as forestalling rapes against women.

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