Fever Status Detection using Artificial Neuron Network

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Abstract: This research paper proposes a monitoring system and a prototype that has been developed for detecting if a when fever is present in senior citizens or any other specific groups of people requiring continuous care. With various issues affecting the health of senior citizens, it is imperative to continuously monitor their health status. The monitoring system is beneficial as it will make it feasible to enable the real time detection of fever and thus allowing for the early treatment. Delaying treatment can lead to the underlining health issue going beyond the remediable condition. Thus, quick detection is vital. There are various issues that might causes illness in people. Some of the issues include virus outbreak, seasonal infections, disease, and old age. In this paper our focus is mainly on old age. This group of people is much more at risk of getting ill or frequently need more attention. In this project, the presence of fever or illness has been detected by using artificial intelligence (AI). The AI technique that is utilized in this project is artificial neural networks. The computation is done by first training the system and then secondly validating the trained system. After the training, the system is supplied with a new set of data, with a known state, to validate that the training was successful. To validate the system, it is provided with sample data to test its efficiency. If the system is well trained the validation data would label that data correctly. That label is known before the validation test, as the sample data had known labels. These known labels were not given to training but not validation system. The system is function properly if its label matched the sample data label. The conducted experiment demonstrated a successful detection with an efficiency rate of 82 percent.

1 INTRODUCTION

A status detection system is a computation system used to monitor data activity and then assign a one label on the occurring activity from given possible data labels. An example of a data labelling is biodata testing procedure which is intended to label the sample as either infection found or not infection detected. An automatic status detection system can be used to monitor senior citizens activity status to avail them quick support when needed. In most developed countries, senior citizens make up a large portion of the total population. Due to the advanced age, senior citizens require more care and support more than younger citizens. When taking care of senior citizen, we must monitor their physical and health status to be able to respond to their issues in the shortest possible time frame. It is feasible to identify an issue, before it becomes severe, and be able to respond to that issue. An example of one such issue is a senior citizen fells down and fails to get up on their own. A fell status system can notify a caregiver who is away from the house and then the caregiver can get back home to assist the fallen senior in good time. A delay in this situation could be fatal. Therefore, this work intent to conduct early detection of fever before the situation is out of controllable stage. This detection would make it to response to issue at a stage when the issues are still in remediable stages (Garçon et al., 2016).

There are four advantages why this system is very helpful; Firstly, this system can help decongest care giving facilities. Caregiver's facility would get congested, in a case where every person needing care, goes to live at the facility for physical monitoring and attention. Therefore, a system that can remotely monitor issues can benefit caregivers' facilities by attending to more clients since remote monitoring accommodates more clients than on-premises monitoring. The second advantage is that for some groups of people, for example senior citizen, such fever is so much common that they require frequent medical attention. Therefore, this monitoring system would allow for identifying the right moment when to

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receive direct human attention. Without such a monitoring system, such a needy person might delay or ignore to identify the moment when to seek direct human attention. Thus, a remote monitoring system that can identify the fever in its earliest possible time would allow treatment before the issue goes out of control. The third advantage is that a detection system can reduce the stress level on care givers. Caregivers usually make frequent checks on the person under their monitoring. In a case that a caregiver attends to other works, it because difficult to monitor their subject. Using an intelligent monitoring system, the caretaker could receive real-time data about the subject's health status. Therefore, caregiver would have less chances of missing status record data since the system would be sending status updates in real-time. Lastly, the importance of a monitoring system is the freedom and independence that the subject person gained from using the system. Since the caregiver will not have to constantly monitor them, this allows the subject to feel independent. They are relieved of the feeling of having someone constantly physically monitoring then. Some subjects would feel guilty when caregivers give them more attention as they feel they are inconveniencing the caregiver. With this system applied, the subject might feel they are not a burden to caregivers as the system assumes most of the caregivers' responsibilities (Paudel et al.,2018; Hussein et al., 2014; Das et al., 2015).

This study is composed of the following parts: The second chapter present fundamentals of artificial neural networks. The third chapter presents related works done by previous research works. Then the fourth chapter presents a proposed methodology of solving the problem. The fifth chapter gives the experimental results. Sixth chapter presents discussion of the results and prospects of the research. Seventh chapter is the last and gives the conclusion.

2 ESSENTIALS OF ARTIFICIAL NEURAL NETWORKS

An artificial neural network (ANN) is a data processing system that is inspired by how the human or animals' brain processes data (Nasser et al., 2019). The brain has several processing units, that are interconnected and using these interconnections, they can map input data to specified output data. Each one of the units in these interconnections is known as a neuron. The human brain has over 100 billion neurons, which are interconnected in several ways. It operates in such a way that it gets data from sensors, and then passes that data to its processing mechanism. The processing mechanism then manipulate this collected data to generate output information. In a similar approach ANN imitates the brains' data processing structure. Like the brain, the ANN has three components: input layer, hidden layer, and output layer (Nasser et al., 2019; Chatzimichail et al.,2013; Ajerla et al., 2016).

An ANN has multiple layers, and each layer processes data as a component of a processing layer group. The data gets processed at every single layer. The data gets processed as many times as there are layers. If the network has only one layer, then the processing would only occur in one step. In case of a multilayer ANN, the processing is performed from one layer to the next layer and then next layer until all layers have had a turn in processing the data. This means the data is processed repeatedly based on number of hidden layers in that network. In a network the number of neurons or number of layers are designed based on the problem that is been solved. However, the number of neurons should be decided appropriately. Simply increasing the number of neurons without some corresponding importance in features used in the problems would not automatically improve the performance of the network. Below is Figure 1, which shows the three layers of an ANN.

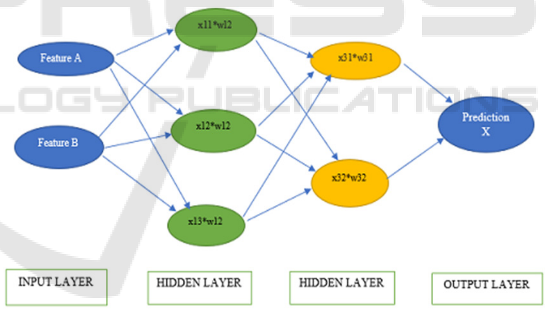

Figure 1: The three main layers in ANN topology.

The hidden layer is usually the most complex of the three layers of a network. The mapping of input to output is achieved after the ANN has undergone some training sessions. After the training, the network can then be used to solve the problem it was trained to solve. It solves the problem after it has mastered the link between every input and to corresponding outputs. ANN are used in solving a variety of problems. Common problems solved by using ANN include handwriting recognition, disease diagnosis, process control, financial viability predictions, stock market predictions, complex systems modeling, error compensation in industrial processes, fire control, security surveillance, etc. (Nasser et al.,2019; Ajerla et al., 2019; Janku et al., 2018; Mehr et al., 2016).

3 RELATED WORK

Within the existing literature, the detection problem has been solved in different ways by various researchers. A list of research of particular interest have been incorporated in presenting this research.

Chatzimichail et al. (2013), have discussed the detection ways to determine the presence of Asma in children under the age of five. The is done based on recognized symptoms as features of presence of Asma disease. The experiment was conducted by collecting a sample from 112 records which have 48 features. To solve the issue the researchers decided to reduce the number of features to nine from 48. This was done because the removed features had little impact on the results of the experiment. For analysis purposes, the experiment was performed twice. First with the full number of features at 48 and then secondly only with the nine to illustrate the need to have some features removed. During pre-processing, data was divided in ten equal sets. Ten cycles of training were performed using these ten datasets. For every cycle, one data set is used as testing data where the remaining nine sets are used as training data. The total results obtained are then summated to obtain an overage of the training accuracy. The experiment results showed that removing the features that had a smaller impact on results of experiment made the ANN much more effective by raising accuracy from 83.87% to 96.77%.

Ajerla et al. (2016), considers an application for providing various service to senior citizens using artificial intelligence detection. The system offers services that include fire detection, gas leak detection and unaccompanied monitoring. The task was to improve the performance of an algorithm if the sensor was place on the waist rather than on the head or wrist. This was because head or wrist is more accurate but is less comfortable for the subject compared to the wrist. The rest has more vector movements that the head of waist of which these movements are the input of the ANN. 525 data sets where collected. Because they were of different sizes, some of the data was disused and some of the data was normalized but adding zeros where they had no entry to make all the dataset have same size. The final data used was 120. The 120 sets were divided into 90 as training data set and 30 as testing set. An ANN of three hidden layers. The ANN is trained to detect the occurrence or no-occurrence of a fall. The experiment concludes that the detection of fall from the waist and head in previous experiment was at 95% while in this experiment it was at 75%. The 75% detection accuracy for the sensor on the wrist was considered an improvement as the waist position is more convenient than the head. A similar research is conducted by Yoo et al. (2016). Both these systems are used as a real-time motoring system for falling and hence caregivers are updated immediately on occurrence of falling.

Janku et al. (2018), presents a research about a new method of fire detecting technique using neural networks It focuses on the issue with current systems that they have difficult in differentiating controlled fires from dangerous fires. Controlled fires are fires that are specifically started and are not a danger to life or property. For instance, a fire from a welding machine when using a welding thing in a warehouse. For the experiment, the research required to use three different types of sensors. A sensor for smoke, a sensor for colour and a sensor for movement direction. The three sensors would collect data from the environment and then send it to the centre of the ANN. The networks are of two kinds, the shallow nets and deep leaning machine. The two of them differ in the sense that the shallow nets are consist of only three layers, while the deep learning machines has more than three layers. The basic layers are input layer, hidden layer, and output layer. In the deep learning machines the hidden lawyer is not one but several layers. The data from each of the three sensors was used in this experiment. The researcher also stated current systems use one sensor compared to the three that this experiment is utilizing. Furthermore, this work intended to remove a scenario of having a high error values in the detection system. The cited previous research works are said to have a lot of false negatives and false positives. The study experiment provides interesting results that proves a better method to detect fires. The new method has provided results fire detection with accuracy of 93%. This system operated online hence a real-time motoring system for fire and hence care takers are updated immediately on the occurrence of fire.

In implementing our experiment, we shall take the following direction. In training data, we shall set the size of training data at 80% instead of 60% used by Kajan et al., (2014) and 75% by Yoo et al., (2016). This makes the system more specific and less generic a good preference in this problem. We shall also limit the parameters we select to those that have the highest impact among the list of probable parameters.

4 RESEARCH METHODOLOGY

Senior citizens face several health issues. Neural networks can be utilized to protect them from such issues that they face in their daily lives (Shahid et al.,2007; Amato et al., 2007; Mehr et al., 2016). The application of ANN could improve and enhance lifespan for the seniors. To develop a monitoring and alert notification system, we shall design a prototype for detecting fever in senior citizens and other citizen in risk category. We shall use pseudonymized and anonymized data to train and test this application.

4.1 Method and Procedure

To help identify whether a medication alarm should be alerted, the following three tasks must be performed. (1) The features of the sample data are evaluated for relevancy. We use only those features which have high relevancy to the identification of medical condition. Using the square-mean error of each features' error, the features with small square-mean error changes are removed. The regression method is the method we shall apply to identify these less significant features. (2) After this feature removal operation, a feedforward-propagation ANN is trained on this dataset to help identifies the status of the medical condition. The dataset is divided into five equal sub-datasets. In iterations, each of these five sub-datasets is used as a test set while the rest is used as a training set. This iteration is used to avoid cross-validation and to make sure that every sub-dataset is used at least once as a testing set. (3) After the training sessions, the test dataset is feed into the system for testing procedure. If the tests results are of some specified accuracy level, then the design is successful. The designed systems can then be used for a subject dataset to predict status of medical condition. This is the final step of the experiment. In summary, we used three different datasets in this network. First is training dataset, second is testing data set and last is the subject dataset. The third dataset is the candidate dataset that is under investigation for the status of medical condition.

4.2 Experiment Data and Used Tools

The artificial neural network was developed in Python programming language. Python has supporting libraries for ANN implementation. In this experiment the libraries that we used include keras, matplotlib, pandas and TensorFlow. The computer used had the following specifications: Processor: Intel(R) Core (TM) i7-4510U, CPU: 2.00GHz, 2 cores, RAM Memory: 4 GB DDR3 1600 MHz, OS: Windows 64 bits.

The data we used consists of one thousand medical records. The records have 8 fields, each representing a unique data feature of the record. We divided the records into two groups. One group is to be used as training dataset and the other as a validation dataset. The records ratio is 8 to 2; where training set is (80%) and validation set is (20%). The experiment used data from different sources that corelated to feature detection as advised by medical specialists. The data's features selected are not selected at random. These are features that have been identified to be direct or indirectly linked to the presence or absence of fevers (Chatzimichail et al.,2013). The ANN model has TensorFlow backend. it has three layers, the first layer has 12 neurons, second layer has 8 and last layer has two neurons. The training dataset is online database available from https://data.world/anaozp/diabetes. This dataset has been used to train and test the ANN.

5 RESULTS

Based on the collected data we trained the neural networks and attained an accuracy of 79.8%. Several experiment trials were conducted. The accuracy of 79.8% is acceptable to successfully determine presence or absence of fever.

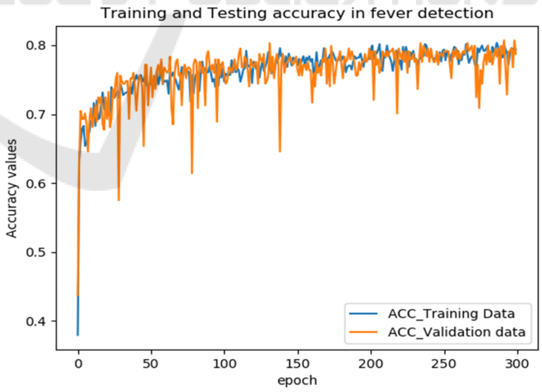

Figure 2: Accuracy evolution of the training and testing sessions.

Figure 2 shows the results for the training and testing sessions that were conducted. It shows the level of accuracy from this specific training and testing in the machine learning experiment. As can be seen from the figure, the training took 300 epochs with training accuracy results ranging from 0 % to 82 %. However, the feasible testing range was shorter, starting from

65 % ending at 82 %. Within the first 20 epochs, the training accuracy rises sharply from 0 to 70 %. From the 20th epoch, it steadily grows until it reaches 78 % by the 250th epochs. It then marginally grows and then stabilizes around 80% till the end of the experimental period. As proven in the figure, there are less data spikes in system training than in system testing. The training-testing deviation starts at 67 % on the 10th epoch. Spikes grow until around the 120th epoch. They then gradually reduce to a 10% difference by the 250th epoch. This spike reduction indicates acceptable training performance. The training and testing accuracy start to stabilize at about the 150th epochs with 78.1% and 79.8% accuracy, respectively. Accuracy starts from its lowest point and goes upwards as the epochs increases. It stops increasing at about 78.1% to 79.8% and stabilizes there. Therefore, this experiment is a success as the test performance indicates acceptable performance on actual subjects' data.

The training and testing loss start to stabilize at around after the 120th epochs with 0.140 and 0.145 loss, respectively. The loss starts from the highest point and starts declining. It continues a steady decline until it reaches around 0.141 of the loss where it then stabilizes.

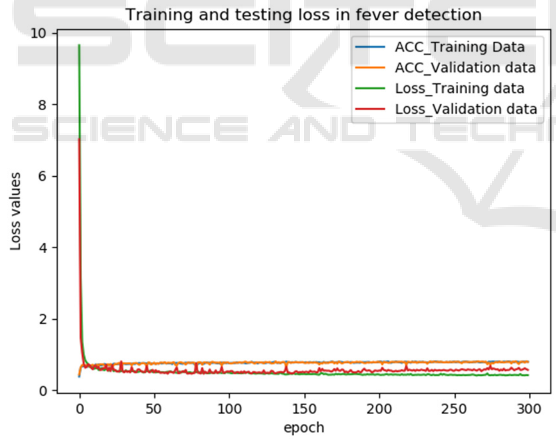

Figure 3: Loss and accuracy evolution of the Training and testing sessions.

In Figure 3, loss and accuracy metrics are shown. The accuracy metric increases while the loss metric decreases with the increase in the number of epochs.

6 DISCUSSION

The experiment's result illustrates the usability of this neural network in fever status detection as a vital component of assistive technologies. Instances of expected benefits of such a system includes. The system allows early detection of an illness without having a physically residing at a care facility. ANN has been applied to identify illness status for subject senior citizens. ANNs with a success rate at 81% did manage to label the medical status based on specific features. The subject citizen had sensors that are taking record of changes in selected body parameters (Ajerla et al., 2019; Yoo et al.,2018). The sensors can be attached or unattached to the body depending on preference. Rather than subject been located at a monitoring care facility, sensors send data to the facility making the monitoring process much more convenient. This makes subject more self-reliant and improves quality of life and reduces expensive for cost of care and attention. This can also make the monitoring process more robust and effective. Furthermore, the ATs can make automatic diagnosis and then alert relevant caregiver for further care and prescription. This would as a result reduce or even eliminates workload for personnel at care facilities.

With an increase in the population of senior citizens, the need for monitoring systems would increase. According to the World Health Organization, (2002), in 2025, there would be a total of about 1.2 billion people over the age of 60. By 2050 this number would increase to 2 billion with 80% of them living in developing countries. The population growth is faster for older persons than for the rest of the population (United Nations, 2007). In 1950 the total number of people over 60 years old was 8 percent. By 2007, this percentage had grown to 11 percent. By 2050, this number is projected to be at 22 percent. The increase in elderly population means more people would require assistive living care than before. Thus, detection systems are becoming vital and would require more investment both academic and financial. They could also become a usual home appliance for the elderly family member of the home.

In future research we hope to focus on a system, which includes a notification message and pill taking schedule. Apart from fever detection system, this application can be coupled with other application to form a complex system offering several services. We wish to integrate these into this fever detection as separate system components.

7 CONCLUSION

In this paper, we have discussed fever status detection using an artificial neural network. An experiment was setup to perform fever status detection using neural networks. The experiment has provided insights on the viability of a fever detection system. The system could be useful in reduction of cost in the elderly citizens care and medical services. Additionally, we outlined three key benefits for the use of assistive technologies systems in rapid detection of health status or condition of person under observation.

1) The remote and quick diagnosis would allow easier and continuous surveillance and enable early treatment of illness.

2) An automated system could minimise subject persons' dependence and reduce stress on both the care giver and the person receiving care. Less stress and less dependence for the concerned senior citizen could be a good remedy for improvement of health.

3) An automated system would reduce the cost for care and medical services. Employing machines would costs less than employing human monitoring assistants. Early diagnosis can also be achieved without automated technologies; however, such a method would require more costs than using the automated detection system.

The common solution to senior citizens monitoring is to have the citizen reside at a care facility. Such solution costs more for the senior citizen and is more workload for the care facility. Hence a fever detection system is a better option as it addresses both these issues. This detection services could be installed at a home, housing a senior citizen. This system could be able to support in the everyday lives' activities and care service delivery to senior citizens and other vulnerable citizens. With such a system in common usage, the lives of millions of senior citizens across the globe could be improved.

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