

-Keynote Address-

Telepresence Robots: Challenges and Opportunities

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Abstract:

Boy 'lived as a robot' for two months- was headlines in BBC in Spring 2012. Grady Hofmann, then 8 year old boy in UK had to undergo a bone marrow transplant, and he would be in an isolation room afterwards. Being away from family, school and everything for two months was an unthinkable task. Then came "QB", a telepresence robot that offered Grady a way to be in touch with his two brothers and family while in isolation room by embodying into "QB" at home. He drove the robot around home, went to dinner table, played with the two older brothers before bedtime, and visited school and met friends. He wasn't quite missing his family for the two months while in isolation room at hospital.

A telepresence robot like what Grady used has full-duplex video and audio connectivity between robot and the user over the Internet. The robot is manually driven by the user looking at the video feedback offered to him by the robot's cameras. The teleconferencing tools such as Skype, Facetalk, and Google Talk, are used heavily without "being there", or "moving around" experience, which is offered by telepresence robots, yet with an inferior audio-video fidelity to a high end large-screen video conferencing installation that is custom configured to bring vivid images and sounds from afar, costing thousands of dollars in equipping each room.

Quite often in offices many fruitful conversations take place, and decisions are made quite informally in water-cooler conversations outside the conference room. Thus, the corporate sector needs something beyond teleconferencing, might well be robotic telepresence, which allows people to move virtually through distant buildings by remotely controlling a wheeled robot equipped with cameras, microphone, speaker, and a screen displaying live video of the face of its user who is controlling the robot from afar.

Telepresence robotics technology is emerging and is still in its infant stage, thus, sometimes face difficulties to clearly demonstrate its merit over other means of teleconferencing. Most of the telepresence robots commercially available today are teleconferencing on wheels, or in its simplest form an iPad on wheels. Some doctors use advance telepresence robots to conduct bedside consultation from afar, security officers use them to patrol workspaces at night, Globe-trotting parents have already started using telepresence robots to stay in touch with their children at home. Recently, Brazil's Olympic Organizing Committee decided to put telepresence robots in operating rooms for the 2016 games in Rio de Janeiro allowing doctors who are unable to accompany their athletes to the games to advise Brazilian surgeons during operations.

Telepresence robots are gaining popularity and the market is growing faster. RoboDynamics in Santh Monica CA has sold more than 100 of its \$10,000 "TiLR" robots since 2008. Anybots in Santa Clare, CA has sold more than 70 of its \$9700 robot "QB" by early 2013.

Double Robotics in Sunnyvale started selling its \$2500 robot "Double" which is an iPad on two balancing wheels, and have received 1.2million worth of orders. Many other start-ups such as Montarobot, VGo Technologies, are already in the business while a few telepresence robots are sold at very high prices such as \$32,000 PeopleBot by Adept Technologies, and \$16,000 Beam by Sutable Technologies.

Telepresence robots help nurture contacts, and to improve one's influence. Bosses can keep employees on their toes by embodying themselves in a robot to cast a monitoring eye around the office while being away. Telepresence helps to bring distant employees into work quite inexpensively.

The true potential of telepresence robots will have to be decided based on the technological inventions in overcoming the major difficulties the robots are facing at present. Only a few telepresence robots today have the self-charging capability when the battery power is low, None of these robots have arms to open doors and enter rooms. These robots can move only on smooth floors, are unable to handle stairs, and struggle on uneven surfaces. None of them have the ability to know its locations inside the building, or to navigate to the destination autonomously, thus, the user has to drive the robot manually while watching a low-fidelity, variably-delayed video feed coming through the Internet, causing it an almost impossible task to perform satisfactorily.

Research and development on solving these problems is in full swing at present. Therefore, the day might not be too far for telepresence robots to show their true potential through the development of more robust and autonomous capabilities.

A Fuzzy-Mathematical Model To Recover Motion With Monocular Vision

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Abstract:

The research was focused on studying the applicability of fuzzy mathematical modelling to predict the motion path of an object, relying on perception obtained via a single camera, known as monocular vision in the domain of computer vision. The strategy is analysing a sequence of images captured in regular time intervals, more specifically, studying the variation of the apparent size of an object and the relative position change of it on the reference frame. A fuzzy-mathematical model, the major emphasis of the research, recovers the motion path as an equation, for example, if the object moves on a straight line, then in form of $y = m.x + c$, according to a pre-defined two-dimensional coordinate system. Therefore, the ultimate task assigned to the fuzzy mathematical model is, determining the actual numerical values of the parameters of the motion path, m and c .

In order to find m and c , it was obvious to study the correlation among the features embedded to the two input graphs mentioned, (especially the apparent size variation as the primary input) and the parameters of motion path equation i.e. gradient (m) and intersection (c). One of the most important discovery was finding the relationship between the gradient (m) of the object's motion path and the apparent size variation. It was observed that the gradient value has some relationship with the skewness of the curve of the apparent size variation graph, and most probably independent from other factors such as the intersection (c). Finding the relationship with the Intersect (c) of the motion path equation and the graph features was another key milestone. Another interesting finding, the relationship between the intersect(c), gradient(m) and the initial apparent size(s) was derived. It was observed that, c is varying with m following a linear manner approximately, while c 's variation with initial apparent size is non-linear, but maintains a fuzzy relationship.

We postulate monocular vision is adequate to obtain the perception rather than binocular or stereo-vision, the widely used technique in computer vision related research. Although stereo vision is appropriate to have the depth information of objects with its additional dimension in 3-D visual perception, it is recognized as an expensive technique in terms of processing and many other aspects. Nevertheless, it was realized that with a non-conventional approach, even with monocular vision, the objective of estimating the motion path of dynamic objects can be achieved. Monocular vision is the only alternative to get rid of the unavoidable excess burden of aligning and calibrating, if preferred stereo vision instead. This advantage was successfully gained due to the application of an innovative concept - a fuzzy-mathematical model to simulate the motion behaviour, since it requires the form of inputs those can be prepared with 2-D visual perception.

Necessary feature extraction is being achieved via a real time image processing module which relies on an optical flow technique as the key technique to recognize dynamic objects. Lukas-Kanade, a Sparse Optical Flow algorithm. The particular optical flow algorithm was selected among many Sparse and Dense Optical Flow algorithms, purely on experimental basis.

It was reported a 91.98% average accuracy from the fuzzy-mathematical model in simulation environments, where the inputs were generated by a simulator program in order to study the precision of the fuzzy-mathematical model as a standalone application. An average accuracy of 59.9% was experienced at the real time version, an artifact to test the postulated concept in real time dynamic environment, which comprised of three major modules: a real-time image processing module, the fuzzy mathematical model and a mobile robot.

MaSIO – a Solution to Information Overflow in Agriculture

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Abstract:

Information overflow has been a hindrance to search for information even by computing experts and subject matter experts. The situation is worst with the persons who have limited computing knowledge and unfamiliarity in the relevant subject. We argue that technological advancements in computing could provide solutions for the said issue. Our research has been inspired by the power of Multi-agent Systems (MAS) technology to model complex systems encompassing large number of distributed and interconnected entities that might change over the time. We have developed a Multi-agent System, MaSIO, to address the above issue.

The system is designed through the MaSMT framework. MaSMT is a java based multi-agent system development framework, especially designed for development of English to Sinhala machine translation system. MaSMT provides two types of agents, namely ordinary agents and manager agents. A manager agent consists of number of ordinary agents within its control. MaSMT manager agents can directly communicate with other manager agents and each and every ordinary agent in the swarm is assigned to a particular manager agent. An ordinary agent in a swarm can directly communicate only with the agents in its own swarm and its manager agent. The framework primarily implements object-object communication, XML-based data passing and MySQL database connectivity to use agents' ontology. MaSIO system has been implemented as a Java-based generic solution. System consists of two dispatcher agents (GUI agent and MaSMT manager agent) and number of client agents which are available in the MaSMT framework. The GUI agent provides graphical user interface of the system. This interface gives users to login, edit his/her user profile and change some system setting to internet access. MaSMT manager agent is also dispatcher agent that handles all the context reading process. The MaSMT manager also store the number of visit of the site and number of successful visit. Hit ratio is calculated through number of successful visit

$$\text{Hit Ratio} = \frac{\text{Successful visit}}{\text{Total number of visit}} \times 100$$

If hit ratio is more than 70% and total number of visits more than 25 then the particular site is added to the particular domain (to public access) otherwise it stores in the user specific domain. If hit ratio is less than 40% and total number of visit more than 25 then the particular site is removed from public access domain and or particular user specific domain. MaSMT agent collect information from the web sources and communicates with other agents to remove duplicate contexts. If duplicates do not exist then agent send the context to the GUI agent through the context manager agent. In addition to the above each web search agent updates its hit ratio. The GUI agent reserves this information through the global message space and creates the output web page to show the information. The MaSIO system has been tested through the agriculture domain and successful results were achieved.

Modeling of Hidden Layer Architecture in Feed-forward Artificial Neural Networks

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Abstract:

Artificial neural networks have showed their effectiveness in many real world problems such as signal processing, pattern recognition, and classification problems. Although they provide highly generalized solutions, there are several unanswered problems in using artificial neural networks. Determining the most efficient architecture of artificial neural networks is identified as one of the major problems. The performance of neural network strongly depends on the size of the network. By increasing the number of layers, generalization ability can be improved. However, this solution may not be computationally optimized. On the other hand, both too many and too few hidden neurons show bad generalization. Therefore, determining the most suitable architecture for the given task is very important in artificial neural networks. As such, a large number of researchers have been carried out to model the hidden layer architecture by using various techniques. These techniques can be categorized as pruning, constructive and evolutionary techniques. A pruning algorithm starts with an oversized network and removes nodes until the optimal architecture occurs. A Constructive algorithm tends to the solution on the other way. It builds the appropriate neural network during the training process by adding hidden layers, nodes and connection weights to a minimal architecture. However, these approaches have various limitations and they have not addressed the existing problem of hidden layer architecture properly.

A new pruning algorithm, based on backpropagation training to model hidden layer architecture has been introduced by this paper. The new algorithm tends to the optimal solution into two phases. First, it determines the number of hidden layers in the most efficient network and then eliminates unimportant nodes from each hidden layer. The removable nodes are identified through the delta values of hidden neurons. The intension of using delta value is that, they are used to compute the error term of the next training cycle and hence, they can be used in minimizing the error. Thus, the correlation coefficient between the summation of delta values of each layer and the error of the training cycle is used to identify the less saliency neurons. In addition, zero delta value implies that there is no change of the connection weight of the particular neuron during the training process. Therefore error can be reduced by eliminating hidden neurons with either small positive values or large negative values, if the correlation is either positive or negative respectively.

The proposed method has been tested with some benchmark problems in artificial neural networks and machine learning. The experimental results show that the new algorithm is able to reduce the sizes of neural networks which can be trained by using lesser number of training cycles. Moreover, new architectures show better generalization relative to the backpropagation algorithm.

WMAC: Web-Based Multi-Agent Solution for Agriculture Community

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Abstract:

Multi-agent System Technology (MAS) is one of the modern software development technology which can be used to solve real world problems. Most of MAS applications are developed as standalone applications and run on the client PCs. At present, limited numbers of MAS have been developed as web applications. Web based MAS can run on any computer as well as on mobile phones. Therefore, web based solutions are more useful than the standalone applications.

This paper presents design architecture of the web based multi-agent system WMAC which was designed as an improved version of the existing standalone Multi-agent system, AgriCom. The WMAC system is used to communicate with the people engaged in agriculture industry namely farmer, buyer, seller and instructor. System uses a common MYSQL database as the ontology of the each agent. Web container (pages) of the WMAC has been developed through the PHP and WMAC engine has been developed through AJAX technologies. WMAC works in two modes namely manual mode and automatic mode. In the manual mode system works as agriculture web site and user can change the existing data as per the user wish. In the automated mode system works as a multi agent system. Hence, users do not need to be with computer every time because the WMAC engine plays a role of user in real agricultural community. WMAC Engine is the important part of this system. This has been developed using the AJAX and is the controlling module of the WMAC which is capable of controlling of all the features/ tasks that are in the WMAC. WMAC Engine communicates with the Web container and also Database. With the certain time intervals, the WMAC Engine checks the Database and updates the Web container. As well user can dive particular tasks to do while he logged in and also he can stop that any time. WMAC Engine is the backbone of the WMAC. This makes a communication between web server and the WMAC database. The system has been tested with 22 users and successful results were obtained. As a further work of the project, it is very useful to develop WMAC as a mobile edition.

Multi Agent System for Artificial Neural Network Training

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Abstract:

Artificial neural networks (ANN) are highly used in the areas of pattern recognition, feature extraction, function approximation, scientific classification, control systems, noise reduction and prediction. 'Feed-forward and back-propagation' is the most commonly used artificial neural network category. Many researchers face difficulties when selecting a proper ANN architecture and training parameters. The manual ANN training process is not the best practical solution because it is a much time consuming task. Also most of the people conduct the manual process in an ad-hoc manner without having proper knowledge on artificial neural networks. At the end of this research a multi-agent system: MASAnnt (Multi Agent System for Artificial Neural Network Training) was developed to automate the neural network training for feed-forward and back-propagation neural network. Interaction among agents enables emergence of quality training sessions which cannot be achieved by ad-hoc training sessions conducted by humans. It is straight forward to recognize training parameters such as number of hidden layers, number of neurons in each hidden layer, momentum, learning rate, Emax (Error goal) and activate function of an ANN as a set of agents. Inherent features of agents including coordination, communication and negotiation are able to mimic the ANN optimizing and training process by manipulating these parameters. This system was developed on top of JADE agent development framework. Our experiments show that the more rational results can be obtained from the system with both simple data sets like XOR as well as with real life data sets. As the real life data set we used the well-known "Iris Data Set" which is available at the Machine Learning Repository in University of California, Irvine. Developed system was able to provide less error rates in the latter part of the training cycles than the beginning. Based on evaluation results we can conclude that the neural network training tasks are successfully accomplished by the agent based approach by analysing the results of the evaluation.

Conflict Reduction Analysis of Bulk Agent Approach in Multi Agent Systems

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Abstract:

Our universe can be considered as the largest multi agent system with no visible conflicts. Particles in different dimensions interact, based on different gravitational rules, which defines the universal extra dimensions called Bulk. The same concept can be modelled, as the Bulk Agent Approach in multi agent systems to overcome potential conflicts, which also empowers the direction of the emergent success of the overall system. On the other hand, it is a design challenge in multi agent systems, on how to avoid unnecessary conflicting chaos, which could consume large computational resources and valuable time.

Lack of resources or social knowledge could lead to either resource conflicts or knowledge conflicts. As a solution, Argumentation Based Negotiation (ABN) with the support of conflict evading and re-planning has been presented in the literature as one of the best approach in conflict resolution techniques. However, conflict evading and re-planning would not be useful in an environment where resources are not abundant. Therefore, we present our novel approach as a solution for the burning limitations of conflict evading and re-planning.

Philosophical explanations and Brane Cosmology, which explains on how gravity governs on brane particles, based on the concept of universal extra dimensions, are the main inspirations for our research. Any multi agent environment can be considered as a multi dimensional universe, where the universal norms originate in a higher dimension. These universal norms provide the guidelines for emergent success of the whole system. However, universal norms can change dynamically based on the social and environmental changes in the lower dimensions. Therefore, in our architecture we define higher dimensions by an agent type called Bulk Agents whereas agents in the lower dimensions are called Brane Agents. The Bulk Agent monitors behaviors of the Brane Agents and provides the direction or the guideline for the success of the overall system. These directions were shared among brane agents as Volatile Ontology so that the overall agent society is well capable of avoiding potential conflicts which otherwise would increase the failure rate of the system.

Our analysis is experimented based on an application called Multi Agent Marketplace. Our experiments were analyzed based on statistical figures which have shown that the conflicts can be avoided or resolved with minimal computational time and resources by introducing Bulk Agents, which represents the extra dimensions in multi agent systems. This paper presents the results of our analysis on identifying the level of effectiveness of the Bulk Agent approach in conflict resolution in Multi Agent Systems.

Keywords-multi agent systems; bulk agent; conflict resolution; brane agent; cosmology

A Comprehensive Approach for Mobile Shopping

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Abstract

One of the major concerns in mobile applications is the processing power and memory. In the meantime when an application uses a lot of processing and memory it tends to reduce the battery life of the device. This is a primary concern for developing advanced algorithmic functions to be able to run in handheld mobile devices. In order to cater to the requirements of the people, the mobile applications are needed in such a way where it consume only a minimum amount of resources in the device, but capable of using the high tech hardware power runs on the server side environment which is also known as the Thin-Client Model for application development. This approach is heavily usable if the amount of processing becomes higher. In the meantime, mobile enabled retail shopping is also an area which requires such an approach, where the number of retail shops which contribute to achieve a final solution is large. The main problem in the area of retail shopping is the lack of ability of finding the correct product from the correct merchant against various parameters like price of the product, availability during odd hours specially when the user is not in a familiar place and the distance to the location. In an ideal solution, the application should receive pricing/other relevant information from large number of retail shops and process them to create the shopping list to the end user which also requires large amount of memory and processing power. Mobile Shopper or “mShopper” is an application which provides a solution to the problems in the area of retail shopping by adhering to the above mentioned concept. It runs the user interfaces in the mobile device consuming low processing power, but delegates the tedious processing elements including retrieving bulk data, multi agent processing and result formatting to a remote server. The application provides an easy mechanism to do the day to day shopping which uses mobile technology to manage the shopping activities in a distributed, and service oriented environment with the support of multi agent technology. The agent processors work in the server side, process the available option, comes to a conclusion and then the final result will be sent back to the mobile device. Because of the this approach, it's easy to implement the application for heterogeneous mobile platforms available today which is also changing dramatically in the market. The main focus of the application is to provide easy mobile interaction to the customers in their day to day shopping experience. This application takes the burden of decision making in retail shopping away from the end user. Also the mShopper helps the end users to keep a track of items bought. The system manages the complexity of the internal overhead including identifying retail shop locations by finding the distance to the place from where the user is, filtering shopping lists, product searching, etc. and provides a convenient User Interface to use simple Input / Output in order to feel a wonderful shopping experience. The application uses dynamic modeling of web services to receive the product information on the run time, location based services to identify the shop location, multi agent technology to identify, create and manage the shopping list and distribute the task among the group. Altogether the “m-Shopper” identifies these trends as the technology for the coming years and provides solutions to reduce the complexity in day to day life. Even though the application is used for mobile retail shopping it can be used as a sample application to model many other mobile related, decision making systems.

Bone Crack Detector based on X-Ray using Fuzzy Logic and Neural Network

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Abstract:

Doctors inspect large number of X-ray images daily to detect the fractures or broken bone, bone tumors, degenerative bone conditions, Osteomyelitis, etc. Manual inspection of X-ray images is a monotonous and time consuming activity. This paper presents a computer-assisted decision support system to detect the crack of the bone in X-Ray image using Fuzzy Logic and Neural Network. X-Ray images are inserted to the system via a scanner with transparency adaptor or by using an X-Ray illuminator. The system compromise of three modules; Image Processing and feature extraction, Fuzzy Logic based identification and Neural Network based verification. Once the X-ray images are fed into the system it will go through the image processing module for preprocessing, background elimination, crack detection, separate the crack line from smooth lines and finally the actual crack detection. The output of the image processing module, forwards to the input of fuzzy logic detection module. And the output of the fuzzyfication forwards to the input of the neural network for further verification. Finally Neural network detects the crack of the X-Ray images from non-crack X-Ray images.

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