JOB SEARCH SYSTEM IN ANDROID ENVIRONMENT- APPLICATION OF INTELLIGENT AGENTS

Salathiel Bogle[1] and Suresh Sankaranarayanan[2, 3]

[1]Mona Institute of Applied Science, University of West Indies, Kingston, Jamaica
salbogleprogmer@gmail.com
[2]Computing & Information Systems, Institut Teknologi Brunei, Brunei
[3]Department of Computing, University of West Indies, Kingston, Jamaica
pessuresh@hotmail.com

ABSTRACT

The Job selection process in today's global economy can be a daunting task for prospective employees no matter their experience level. It involves a detailed search of newspapers, job websites, human agents, etc, to identify an employment opportunity that is perceived compatible to abilities, anticipated remuneration and social needs. Search sites such as Seek, Academickeys.com, Careerbuilder.com, Job-hunt.org, Monster.com, etc allow prospective employees to register online and search and apply for employment. However most do very little to profile employers against employees or even attempt to confirm the validity of the data submitted by prospective employees. Also no information exists on feedback of the employer too on various criteria submitted by employees. Taking all these into consideration we here have proposed an intelligent agent (instead of the human agent) to perform the same search operations by interacting with the employer and job search coordinator agents. The proposed solution would involve the creation of an applicant, job search and employer agents that would use fuzzy preference rules to make a proper decision in getting a list of jobs based on the user's search criteria and also feed the rating of the employer based on feedback submitted by the past & current employees which is unique and first of its kind. All results applicable are organized based on a dynamic calculation of expected utility from highest to lowest and displayed as the job search listing. The system would use ANDROID 2.2, JADE-LEAP and the Google API to provide a robust, user friendly solution.

KEY WORDS:

M-commerce, Agents, JADE-LEAP, Android 2.2, Job Search, Expected Utility

1. INTRODUCTION

In today's global economy, the challenges associated with finding a suitable job is amplified by the technicalities associated with the Job search process which is seen by experience. Normally when we want to apply for a job, we search the newspapers; listen to radio and television broadcasts that may advertise vacancies and also job seekers register themselves with job site portals such as Academickeys.com, Monster.com, and Careerbuilder.com and so on. Many

DOI : 10.5121/ijist.2012.2301

employers do not register themselves with these mediums to provide full details of the job specifications but instead post important details on their own website only. Also with the growing number of online job search engines, segmenting the online labor market into "information islands", make it almost impossible for job seekers to get an overview of all relevant positions [1]. Therefore we do not always get to know all the vacancies, the nature and status of the employer to decide if this is the sort of job that is being sought for. Also at times we get flattered by the company's profile but don't get information about the rating of the company by the existing or past employee in terms of salary and so. Taking all these into consideration we propose to develop an intelligent agent (instead of a human agent) to perform the same search operations by interacting with the employer and job search coordinator agents. We propose to use an agent based utility concept to provide suitability profiling based on configurable factors such as distance from work, days and shift requirements, work environment, safety and hazard considerations, remuneration, skill-set, etc. The proposed system would be based on the ANDROID, JADE, LEAP technologies to provide mobile and web based accessibility. These agents would function based on fuzzy preference rules, to make a proper decision in getting a list of jobs corresponding to the user desired specification.

The paper is organized in sections as follows. Section 2 provides details on Online Job search system. Section 3 talks on Agent Based Systems, Ontology Agent Based Utility and Job search theory with motivation towards developing an Agent based Job Search system. Section 4 gives details on the Intelligent Job Search System with fuzzy preferences. Section 5 gives the implementation details on JADE-LEAP and Android 2.2 with Google Maps API. Section 6 is conclusion and future work.

2. ONLINE JOB SEARCH AND APPLICATION SYSTEMS

Job search is not a new area as several significant works have been done in several key areas to modernize, improve security and increase the success and usage of these systems. Some of the works that have inspired the conception of this research include:

- '*Improving Job Search by network of professionals and companies*' research in which job clusters were created to provide relationship between categories of professionals and company needs and is based on a network of job offers, discovering interesting relationships between them and clustering these to represent companies or professional. The output is a visualization of the network of professions and companies [2]
- The '*Semantic Web-based*' recruitment research used the data exchange between employers, applicants and job portals; and is based on a set of vocabularies in ontology which provide shared terms to describe occupations, industrial sectors and job skills. Monster.com uses a similar semantic web-based technology [1]
- '*Agent-based Application for Supporting Job Matchmaking for Teleworkers*' is a multi-agent system that performs job matchmaking in teleworking community focusing on the time consuming task of searching for appropriate working partners [3]

- Risk Aversion and Expected Utility theories which calibrate the relationship between risk attitudes over small and large stakes when the expected utility hypothesis is [4]
- '*Open Source Java Framework for Biometric Web Authentication Based on BIOAPI*' which provides interoperability between different software applications and devices by using the BioAPI specification which allows software applications to communicate with a broad range of biometric technologies [5].

Although these and other research have contributed to the implementation of several web based and android applications including monster.com, seek.com, academickeys.com, careerbuilder.com, LinkUp, HireADroid, etc., there is no work that support an agent based architecture running on JADE and Android that is capable of providing utility based ordering of jobs, dynamic employer rating over period, fuzzy job selection rules which is unique in our system too [6]. So taking these into consideration we have developed the Intelligent Agent-based Mobile Job Search system. But before going into system developed we need to review details on Intelligent Agents, Job search Theory, Agent based utility.

3. INTELLIGENT AGENT TECHNOLOGY

Over the years there has been much controversy about the definition of an artificial intelligent agent [7]. There exists a weaker notion of agents and a stronger more controversial notion. [8] define an agent as "anything that can be viewed as perceiving its environment through sensors and acting upon that environment through effectors". [9] agrees with this definition but adds additional clarity by stating that "intelligent agents continuously perform three functions: perception of dynamic conditions in the environment; action to affect conditions in the environment; and reasoning to interpret perceptions, solve problems, draw inferences and determine actions". Agents should autonomously carry out activities by being independent or self-directed and should not depend on external input only from human operator or other agents to act manifesting social abilities when interacting with other agents (and possibly humans) via some kind of agent-communication language [7-10].

Today artificial intelligent agents are integrated into many computer-based systems including expert systems, job search engines, web searches, info-bots and so on. These autonomous agents can perform time consuming, mundane and sometimes even life endangering tasks reliably, instead of the human agent [11]. [10] describes a stronger notion of agency in which agents process characteristics such as knowledge, belief, intention and obligation. Other attributes applies to stronger agent notion. These include mobility where agents move around an electronic network, veracity where agents will not knowingly communicate false information and benevolence where the assumption is that an agent will try to do what it is asked and will not have conflicting goals [12].

3.1 Job Search Theory

In a dynamic labor market, the process by which people find new jobs has importance to policymakers and scholars also. Policymakers have made attempts to design training and other programs to help match an individual's skills with the requirements of potential employers

[13][14]. Job-search theory attempts to propose strategies for making optimal employment decisions by considering factors that determine individual's demands and their prospect for finding an acceptable job offer [13][14]

Job search models are measured in both discrete and continuous time and a simple model can be used to represent the basic search behavior of an unemployed worker where the intent is to maximize expected utility [14]. This research focuses on Discrete Time Job search. In Discrete Time Job search the individual is interested in choosing a policy (i.e. a sequence of decision rules) that determines whether or not to accept any particular job offer. The eventuality of the job offer is referred to as the outcome and is dependent on preferences of the searcher such as skills, pay, location of the employment opportunity, and the willingness of the employer to employ the searcher. The review of job search theory provides the basis for a discussion on agent-based utility relevant to the job search process.

3.2 Agent-based Utility

In economics, utility functions are used to model preferences of agents. These functions serve as a device for us to assign a single number to any bundle (Handout on Utility Function Transformation 2002). Proponents of Subjective Expected Utility (SEU) theory have offered many axiomatisations of their models. One approach develops utility and subjective probability as distinct concepts and provide explicit axioms which justify the combination of these into an expected utility ranking of the strategies (options, actions, prospects) before a decision maker [4]. In 1979 weighted utility theory was proposed by [15], and then refined by [15]. [16]. [15] replaced the independence axiom with weak independence and convexity axioms which led to a weighted linear representation. Expected utility '**u**' is a linear function on the simplex:

$$\{\mathbf{p} \mid \mathbf{p} = (p_1, p_2, \ldots, p_n); \sum p_i = 1; \forall\, I, p_i \geq 0\}$$

A prospect $(x_1, p_1; \ldots; x_n, p_n)$ is a contract that yields outcome x_i with probability p_i based on the linear function above. To simplify notation, we omit null outcomes and use (x, p) to denote the prospect (x, p; 0, 1-p) that yields x with probability p and 0 with probability 1-p. The (riskless) prospect that yields x with certainty is denoted by (x). Thus expectation to choose prospects is based on

$$U(x_1, p_1; \ldots ; x_n, p_n) = p_1\, u(x_1) + \ldots + p_n\, u(x_n).$$

That is, the overall utility of a prospect, denoted by U, is the expected utility of its outcomes [17]

4. INTELLIGENT AGENT BASED JOB SEARCH SYSTEM

Although online job search sites have greatly improved the job acquisition process there are still challenges in providing a qualitative approach to job search, providing a job best suited for an employee. The literature reviewed confirms that the technologies exist to create a system that improves the job search process using well founded techniques such as utility theorem applied to autonomous agents, increased accessibility through the use of mobile technology. This section provides a design for the construction of such a system as shown in Fig 1 that integrates critical components to enable it to work effectively. A data enabled mobile network integrated with a

local area network (LAN) is the required platform. This enables efficient agent communication between the mobile device and the multi-agent environment. All agents in the architecture were designed to follow the FIPA2000 architecture for Agent Communication Language (ACL) message passing in multi-agent systems and provide the protocol for managing agent interaction and coordination (FIPA ACL Message Structure Specification 2002). The main objective of the system developed[6] as shown in Fig.1 addresses the following challenges:

- *Intelligent agent (instead of human agent) to perform the job search operations by interacting with employer and job search coordinator agents (Bogle & Suresh, 2011; Bogle & Suresh, 2011).*
- *Agent based utility concept to provide suitability profiling based on configurable factors such as distance from work, days and shift requirements, work environment, safety and hazard considerations, remuneration, skillset, etc.*
- *Employ fuzzy preference rules, to make proper decision in getting a list of jobs corresponding to the user desired specification.*
- *Enable past and current employees to profile employers based on configurable metrics*

Let us now discuss the design roles and responsibilities of these components in the architecture. The Intelligent agent based Job Search design consists of the following intelligent agents. Let us now briefly consider these agents:

- **Applicant Agent (AA) -** The applicant agent performs the activities of a human agent for job search and is a key entity in the process. The Applicant Agent primary responsibilities are:

  i. *Submit search requests in xml data structures based on dynamic user preferences.*
  ii. *Allow configuration of job search importance preference matrix for applicant.*
  iii. *Submit employer rating data.*
  iv. *Allow configuration of salary markup and markdown thresholds.*
  v. *Present search details in a user friendly format.*
  vi. *Pre-populate relevant job application fields on user screen from registration data.*

The following variables are possible to be configured and represent a metric of expected utility of a specific job presented to the applicant (Bogle and Sankaranarayanan 2011). The relevance of utility is not confined only to the variables presented below, as the system uses a configurable architecture.

- Industry
- Occupation
- Education
- Job Type (Full-time, part-time, contract, etc.)
- Career Level (amount of experience obtained versus what is required for the job)
- Salary and Allowances (salary and all additional benefits)

- **Job Search Agent (JSA)** – This agent is the brain behind the job search process and is equivalent in role to online job search sites, local newspaper and printed media, etc. as it interacts with employer agents to acquire job listings and also uses fuzzy preference rules and utility based theorem to select appropriate jobs in accordance with input parameters and settings meta-data provided by the AA. This agent's primary responsibilities include:

    i. *Dynamically and intelligently adjust search criteria based on fuzzy preference rules when no match is found from the dynamic SQL sent by the Applicant Agent.*
    ii. *Perform calculation of expected utility for each job result using the employer importance preference for the specific job as the weighting and the applicant importance preference as the probability matrix.*
    iii. *Sort in an efficient manner the results by expected utility in descending order (highest to lowest) and passing the organized results to the applicant agent for presentation to the user.*
    iv. *Perform formal housekeeping for all closed and expired jobs in the form of automated archiving.*

- **Employer Agent (EA) –**The employer agent models some actions and responsibilities performed by the employer. The main activities are:

    i. *Posting of job vacancies listed by employers*
    ii. *Allow configuration of job importance criteria weightings.*
    iii. *Interact with Job Search Agent to ensure only valid jobs appear in the listings*

    .

4.1 Job Search Algorithm

The following algorithm was developed based on the system architecture as shown in Fig.1. Applicant starts a Job Search session from the mobile phone and can be registered users and securely login or unregistered users can search for jobs but must be registered and logged-in to apply for any job.

- Applicant configures search settings. These settings can be modified at any point in time.
- Google maps plugin is used to select location (city, country)
- Applicant select additional search parameters such as salary, industry, education, allowances, rating period, etc.
- Criteria and settings from the user interface are pushed by the applicant agent to the job search agent using customizable job search ontology.
- The job search agent builds dynamic queries from constraints and settings and execute on the database with fuzzy preference rules as below:

- *If job is available for salary below the minimum salary range within threshold with exact or closest matching of facilities in the same or different location or parish*
- *If job is available for the salary range specified with exact or closest matching facilities in the same or different location or parish*
- *If job is not available within the salary range, find a job above the maximum salary within threshold with exact or closest matching facilities in same or different location or parish*
- *Search agent also finds a job in the same industry with the facilities for any salary in same or different location or parish*

- Retrieve employer rating per employer with cache optimizations to reduce execution of unnecessary database queries.
- Calculate the expected utility per job in listing and sort listing in descending order.
- Asynchronously alert applicant agent of the job listings.

The details on the implementation of the agents based on the architecture presented using JADE-LEAP in Android 2.2 has been presented in Section 4 as screenshots

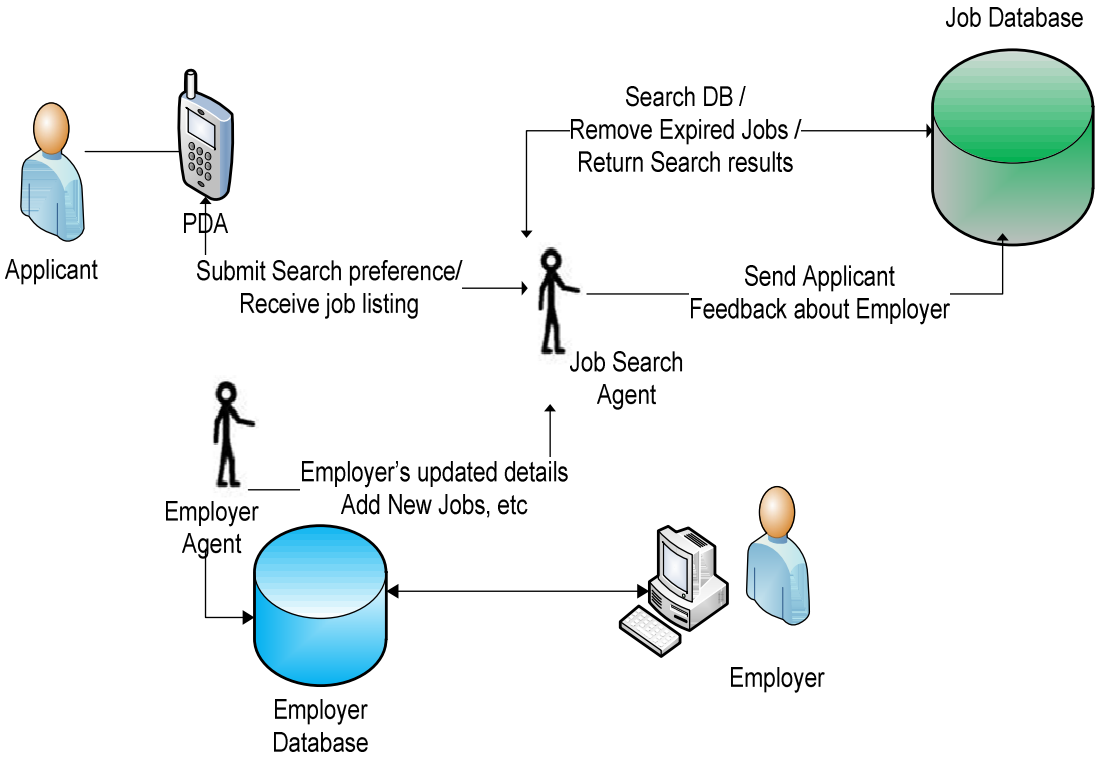

Fig. 1 Job Search Flow Architecture

.

5. IMPLEMENTATION USING JADE-LEAP

The system was implemented using java development kit 1.6.0_21 (jdk1.6.0_21) as the base runtime environment using Eclipse Helios release build 20100617-1415 with android plug-in enabled as the development IDE. JADE 4.0.1 was used for the Agent Platform [18-19] to host all agents, control behavior and perform agent management. JADE-LEAP 4.0 was used to enable agents on mobile devices [20], and Jade Android 1.0 enabled JADE-LEAP agents on Android mobile devices. Android 2.1 platform 8 with Google APIs SDK was used for the creation of the Android application with Google Maps integration capabilities . Finally MySQL5.1 Database Server using MySQL Workbench 5.2CE was used to create all databases for employer, university, job search & application. The list of agents in the JADE environment is shown in Fig.2. The Applicant agent resides in a separate split container and labeled with the mobile handset's IMEI number. All other agents reside in the main container and are identified by their abbreviated names.

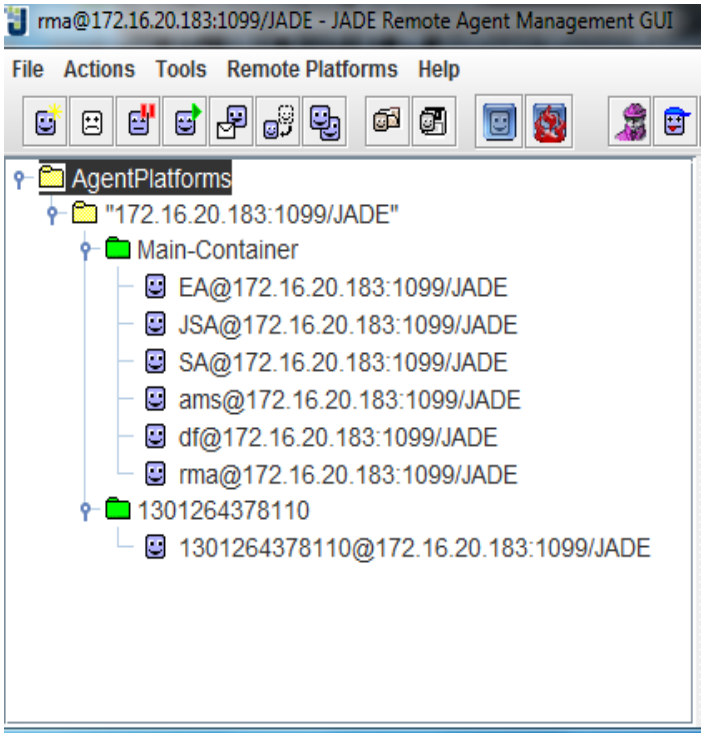

Fig.2. Agents in JADE Container

5.1. Job Search Implementation

There are several scenarios that are possible from the discussion above, however the following are considered with results presented:

1. Exact match in same or another location
2. Approximate match in same location with salary mark up and down.

3. Exact match in same or another location with best matched allowances and benefits
4. Any salary match.

In Fig. 3, the user configures the search preference system by fixing the industry as 75% important, occupation as 100% very important and job type as 0% unimportant and also salary mark up and mark down range as 27 and 33 respectively. This is the utility transformation form that is used to guide the priority of presentation of job to the users that makes it easier for the user to select the appropriate job and apply. Fig.4 shows the Google map to select the location and country where he wants to search the job.

Fig.3. Configure Search Preference Screen.

Fig.4 Google Maps- Location Selection

In Fig.5, the applicant agent now enters the search criteria which inlcudes the Country and city from Google Map. Also the other criteria like Salaray range as 20000 to 40000, Industry as Accounting, Education as Associate Degree, Job type as Full time, Career level as Expereince and Rating period as six months. Now that the search criteria is submitted, the Job search agent is started from the Andoird handset that queires the database to match the user criteria to retrieve the jobs and list to the user's handset based on search preferences system set. In here the search agent finds there exists no job that matches the criteria in Kingston, Jamaica and possess the intelligence to match in another location i.e St. Mary with same criteria. The agent now finds one job that matches his criteria and produces the result with salary range of 26,000 to 32000 with rating of 4 out of 5 as shown in Fig.6. Fig.7 shows the full details of job with complete salary package and so.

Fig.5. Search Agent Screen -1

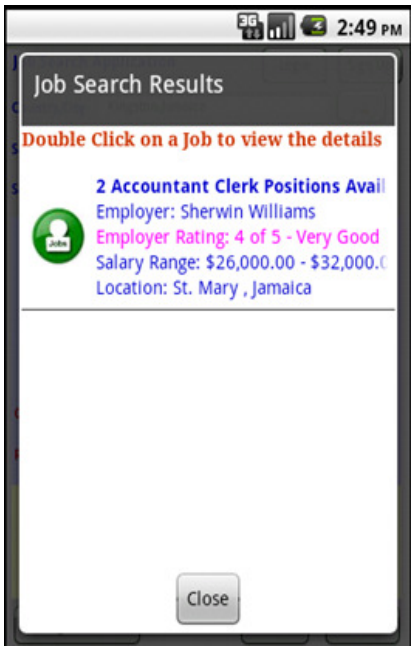

Fig.6. Job Search Agent Results-1

Fig. 7. Full Job Details.

Let us consider second scenario, shown in Fig.8 where the search Agent uses the salary mark-up and mark-down criteria applied to the salary range of 40000 to 50000 to provide a margin ratio in percentage for an increase and decrease of the upper and lower limits of the salary range specified in the search. With a markup of 27% and markdown of 33%, the system is expected to lower the lower bound by 33% and increase the upper bound by 27%. The search Agent searches for software job in Computer Industry for a salary range of 40000 to 50000 in location Kingston, Jamaica. The search agent finds Jobs in computer industry by adding salary mark up and marks

down and produces it to the user's Handset as shown in Fig.9. Fig.10 shows the Rating breakdown for 6 months rating of the Employer by previous employees.

Fig.8. Search Agent Screen-2

Fig.9. Job Search Agent Results-2 Fig.10. Rating details breakdown

Let us consider third scenario as shown in Fig.11 where the user searches for software Developer job in Computer industry for any salary range but with additional details like Medical, Housing, Relocation and Transportation allowance within the same location i.e. Kingston. The agent here

finds Application Engineer job that matches his criteria in Kingston with salary mark of 36000 to 40000 and also another Senior Software developer with salary of 45000 to 60000 with best matched facilities as shown in Fig. 12 and 13. The user selects the senior software developer job but finds one allowance i.e. Relocation as not available but with a higher salary range. Salary values of zero allow matches of all salaries

Fig.11 Search Agent screen-3.

Fig.12. Job Search Agent Results-3

Fig.13. Full Job Details

Let us consider fourth scenario as shown in Fig.14 where the user searches for Accounting job for any salary range but with additional details like Medical, Housing, Relocation, Return Airfare and Transportation allowance within the same location i.e. St. Mary. The agent here finds Accounting in St. Mary with salary mark of 26000 to 32000 as shown in Fig.15 ignoring the facilities as shown in Fig. 16.

Fig.14 Search Agent screen-4

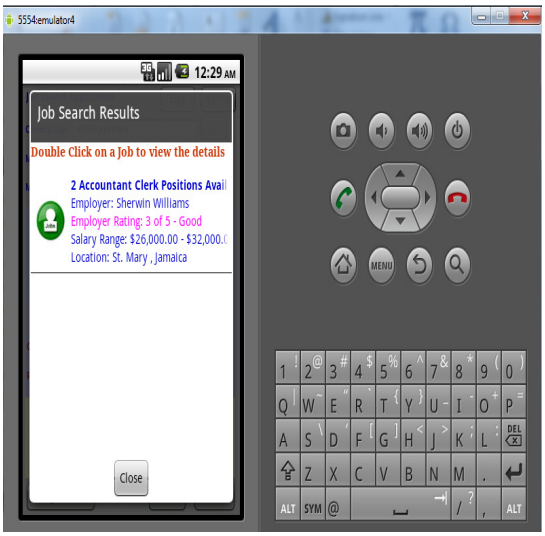

Fig.15. Job Search Agent Results-4

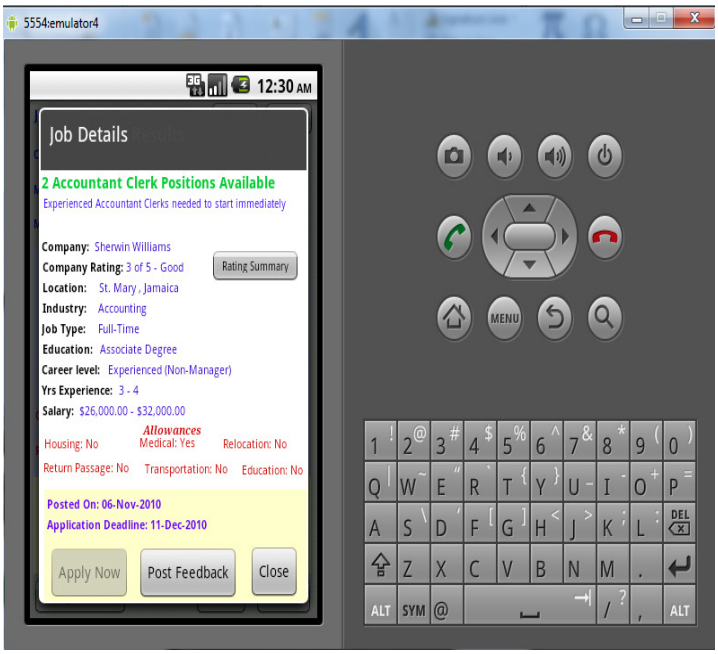

Fig.16. Full Job Details

In our system, it is possible for the user to submit feedback about the employer as an existing or past employee too as shown in Fig. 17. Fig.18 shows the feedback recorded in Central database which the employer has no control over it. This feedback will be recorded in database after verifying the user credentials with the employer to make sure no user who has registered with the system and not working with this past employer of the industry is not submitting the feedback.

Fig.17. Employer Job Feedback Form

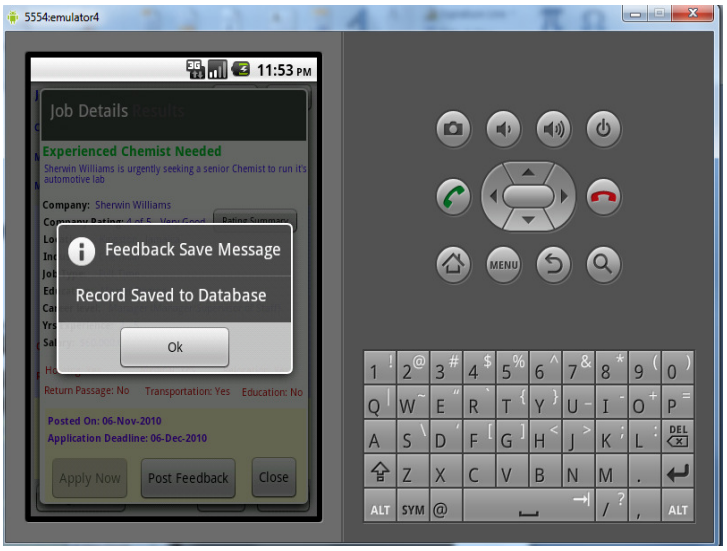

Fig.18. Feedback submitted

6. CONCLUSION & FUTURE WORK

Job Search is a very involved process that could require hours of interaction with different search sites, applications, human agents, etc. The developed system intelligently anticipates the needs of the user and makes intelligent decisions based on fuzzy preference rules and dynamically make location, salary markup and markdown, and allowances choices that are perceived beneficial to the user. This is evident in the results presented in the form of scenarios and supporting screenshots. The system could be extended to include a secure application process where the applicant's experience and education is verified possibly by including biometric data along with the job application details which has been published elsewhere. In addition the job search process could enhance the calculation of utility by including risk factors of success in choosing one job over another. This could enhance the probability of applying for the job that would be most suitable for an applicant on many levels.

References

1. Mochol, Malgorzata, Holger Wache, and Lyndon Nixon. "Improving the accuracy of job search with semantic techniques." Berlin, Germany, 2007
2. Frivolt, Gyorgy, and Maria Bielikov. *Improving Job Search by Network of Professions and Companies.* Bratislava, Slovakia: Institute of Informatics and Software Engineering, 2006
3. Sugawara, Kenji. "Agent-Based Application for Supporting Job Matchmaking for Teleworkers." *Second IEEE International Conference on Cognitive Informatics (ICCI'03).* 2003. pp. 137
4. Rabin, Matthew. *Risk Aversion and Expected-Utility Theory: A calibration Theory.* Berkeley California: Department of Economics, 1999
5. Agulla, Elisardo G, Enrique O Muras, Jose Castro, and Carmen G Mateo. *An Open Source Java Framework for Biometric Web Authentication Based on BioAPI.* Vigo, Spain: Department of Signal Theory and Communications, University of Vigo, 2007.
6. Bogle, Salathiel, and Suresh Sankaranarayanan. "Intelligent Agent based Job Search System in Android Environment." *2011 IEEE International Conference on Electro/Information Technology,* 2011
7. Franklin, Stan, and Art Graesser. " Is it an Agent, or just a Program?: A Taxonomy for Autonomous Agents." *Third International Workshop on Agent Theories Architectures and Languages.* Springer-Verlag, 1996.
8. Stuart, Russell J., and Peter Norvig. *Artificial Intelligence: A Modern Approach.* Englewood Cliffs, NJ: Prentice Hall, 1995
9. Hayes-Roth, B. "An Architecture for Adaptive Intelligent Systems." *Artificial Intelligence: Special Issue on Agents and Interactivity*, 1995: 72, 329-365.
10. Jennings, N. R., and M. Wooldridge. *Applications of Intelligent Agents.* London: University of London, 1998.
11. Poole et al. *Computational Intelligence.* New York: Oxford University, 1998
12. Spanoudakis, Nikolaos, and Pavlos Moraitis. "An Ambient Intelligence Application Integrating Agent and Service-Oriented Technologies." *In Proceedings of SGAI Conference.* Paris, France: Paris Descartes University, 2007. pp.393-398.
13. Addison, J. T., Centeno, M., & Portugal, P. (2004). Key Elasticities in Job Search Theory: International Evidence.IZA.

14. Zaretsky, Adam M., and Cletus C. Coughlin. "An introduction to the Theory and Estimation of a Job-Search Model." *Review* (Review), 1993: 53-56.
15. Chew, S. H. *Two representation theorems and their application to decision theory.* Vancouver: University of British Columbia, 1980
16. French, Simon, and Zhigang Xie. *A Perspective on Recent Developments in Utility Theory.* London, England: University of Leeds, 1993
17. Kahneman, Daniel, and Amos Tversky. "Prospect Theory: An Analysis of Decision under Risk." *Econometrica Vol. 47, No. 2*, 1979: pp. 263-292.
18. Bellifemine, Fabio, Giovanni Caire, and Dominic Greenwood. *Developing multi-agent systems with Jade.* John Wiley & Sons, Ltd, 2007.
19. "FIPA ACL Message Structure Specification." *Foundation for Intelligent Physical Agents.* 12 03, 2002. http://www.fipa.org (accessed 2011).
20. Moreno et al. "Using JADE-LEAP to implement agents in mobile devices." *http://jade.tilab.com/papers/Exp/02Moreno.pdf.* 2003. (accessed 2011).

Authors

Salathiel Bogle receive his Master's degree in Computer Science from University of West Indies, Jamaica in 2011. Prior to that he did Bachelor's Degree in Computer Science from University of Technology Jamaica. He is presently working in reputed Telecommunication industry in Jamaica i.e. Digicel as Project Manager. He has got two Research publications in IEEE proceedings and International Journal of Computer Science, engineering and IT from his Master's Dissertation. His research interests are mainly on intelligent agents, Mobile computing.

Dr. Suresh Sankaranarayanan holds a PhD degree (2006) in Electrical Engineering with specialization in Networking from the University of South Australia. Later he has worked as a Postdoctoral Research Fellow and then as a Lecturer in the University of Technology, Sydney and at the University of Sydney, respectively during 2006-08. He is the recipient of University of South Australia President Scholarship, towards pursuing the PhD degree programme and has also bagged the IEEE travel award in 2005. He was working as a Lecturer (Asst. Prof. Status) in the Department of Computing and lead the Intelligent Networking Research Group, in the University of West Indies, Kingston, Jamaica, during 2008-11.

He has also worked as a Professor, School of Computer Science and Engineering, Vellore Institute of Technology (VIT University), Chennai Campus, India, for a short period during 2011. He is now working as Associate Professor, Department of Computer & Information Systems, Institute of Technology, Brunei (ITB – A technological university). Currently he is also functioning as a Visiting Professor, Department of computing, Faculty of Pure & applied Science**,** University of West Indies, Mona Campus**,** Kingston-7, Jamaica, West Indies. He has supervised 28 research students leading to M.Sc, ME, M.Phil and M.S degrees. He has got to his credit, as on date, about 50 fully refereed research papers published in the Proceedings of major IEEE international conferences, as Book Chapters and in International Journals. He is also a Reviewer and Technical Committee member for a number of IEEE Conferences and Journals. He has conducted many tutorials, workshops and also given Guest Lectures in Networking in various Universities and Colleges. He also managed a collaborative research programme with Oakland University, Rochester, USA. His current research interests are mainly towards 'Mobile and Ubiquitous Computing - Wireless Sensor Networks, Mobile Commerce, Intelligent Agents' used in the Health, Commercial and Engineering sectors.