FACULTY OF INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING

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CrowdPickUp: Task Pick-up in the Wild

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ABSTRACT

This thesis investigates the feasibility and performance of different types of crowdsourcing tasks picked-up in the wild i.e., situated, location-based and general through the implementation and evaluation of the CrowdPickUp crowdsourcing platform.

We describe in detail the implementation process of CrowdPickUp, which we then used in a study where workers could earn coins on the basis of task completion and use their earned coins to buy different available items of their own choice using CrowdPickUp's web shop integrated within our system. During the study, we recorded the average completion time and accuracy of different crowdsourcing tasks. The key findings show that our platform was able to generate high quality contributions in a composite environment.

Finally, we conclude the thesis by discussing the importance and usefulness of different crowdsourcing tasks designed for our crowdsourcing system and our possible future work within the area of crowdsourcing task-pickup system.

Keywords: Crowdsourcing, Situated Crowdsourcing, Location-based task pickup, QR Scanning, ground truth.

Ahmed F. (2016) CrowdPickUp: Task Pick-up in the Wild. Oulun yliopisto, koulutusohjelma Tietotekniikan. Diplomityö, 38 s.

TIIVISTELMÄ

Tämä diplomityö tutkii joukkouttamisen suorituskykyä ja mahdollisuuksia erityyppisten tehtävien avulla. Tehtävät jaetaan työntekijöille luonnollisissa olosuhteissa paikkasidonnaisesti työssä kehitetyn CrowdPickUp-alustan avulla.

Työ kuvailee yksityiskohtaisesti kehitetyn alustan sovelluskehitysprosessin. Tämän jälkeen valmista alustaa käytettiin käyttäjäkokeissa, joissa työntekijät pystyivät ansaitsemaan virtuaalivaluuttaa, jolla pystyi ostamaan erilaisia palkintoja. Kokeen aikana tutkimme ja tallensimme monenlaista tietoa, kuten esimerkiksi suoritetun työn tarkkuutta ja keskimääräistä tehokkuutta. Työn päälöydökset osoittavat, että alustamme kykeni tuottamaan korkealaatuista työtä luonnollisissa olosuhteissa ja ilman tutkijoiden jatkuvaa läsnäoloa.

Lopuksi diplomityö keskustelee löydösten ja kehitystyön tärkeyttä sekä soveltuvuutta erilaisten tehtävien suorittamisalustaksi. Lisäksi esittelemme ideoita, joilla työtä voi kehittää eteenpäin entistä hyödyllisemmäksi tutkimusinstrumentiksi.

Avainsanat: joukkouttaminen, paikkasidonnainen joukkouttaminen, paikkasidonnaiset tehtävät, QR koodit

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FOREWORD

This thesis work has been carried out at the Center for Ubiquitous Computing, University of Oulu, Finland under the supervision of Dr. Jorge Goncalves. I would like to express my sincere gratitude to Dr. Jorge Goncalves for giving me this opportunity to work on this thesis. Under his supervision, and with his help and support I have been able to achieve this milestone. The learning outcome while working on this project was awesome and I had a chance to use today's innovative technologies to study and implement this research.

Finally, I would like to thank my family, friends and all others who support me and guide me in every phase of life.

Oulu, 25.11.2016

Furqan Ahmed

ABBREVIATIONS

PSOAS	Pohjois-Suomen opiskelija-asuntosäätiö
GPS	Global Positioning System
API	Application Programming Interface
LBA	Location Based Assignments
VANETs	Vehicular Ad hoc Networks
WiFi	Wireless Fidelity
RDBMS	Relational Database Management System
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secured
JSPs	Java Server Pages
JDBC	Java Database Connectivity
SSL	Secure Socket Layer
QR	Quick Response Code

1. INTRODUCTION

Crowdsourcing is a popular topic in both academia and industry, and as a result many researchers have adopted this methodology. The emergence of online crowdsourcing platforms e.g., Mechanical Turk and CrowdFlower have allowed workers to get paid by solving number of different tasks. In these platforms many tasks are difficult to be completed and solved by the computers e.g., extracting out specified text from an image and recognizing object in an image etc. The motivating factor for the workers to solve the tasks in these platforms are either intrinsic or extrinsic motivators [7].

Other forms of crowdsourcing, have also gained prominence over the last few years. For instance, mobile crowdsourcing has also gained researchers interest due to mobile phones becoming an important means of communication, sharing information from remote locations and increase in the ubiquity due to the presence of location sensing in the mobile devices [3]. The process of people contribution in sharing information from remote locations will increase due to the presence of location sensing and internet connectivity in mobile phones. Mobile phones are ubiquitous is and now a day most devices not only provide a way of communication but also provide different sensors e.g., accelerometer, light and GPS etc. leveraging the possibility of extracting contextual information. Another form of crowdsourcing that has been gaining traction is situated crowdsourcing. Researchers have investigated the potential for situated crowdsourcing in order to overcome some crucial challenges and limitations faced in online crowdsourcing [6].

In this thesis, we proposed a crowdsourcing task-pickup system named CrowdPickUp in which there are three types of tasks categories 1) Situated Crowdsourcing tasks in which participants needs to submit the tasks that are related to their current vicinity or require local knowledge. 2) Location-based Crowdsourcing Tasks in which user needs to be physically present on a specified location to share the crowdsourced information, and 3) General Tasks, which includes several typical crowdsourcing tasks, such analyzing and visualizing texts and objects.

1.1. Objectives and Scope of this thesis

CrowdPickUp crowdsourcing task-pickup system is a cross platform web based application that runs on every browser. This system has several components i.e., 1) Tasks panel (situated, location-based, general, survey), 2) User dashboard to view the count of different tasks completed, 3) Web shop which allows participants to purchase rewards through earned virtual coins, and 4) Help menu. The objective of this thesis is to analyze the performance of workers that register to the platform by giving them different crowdsourcing tasks and recording their average time to complete the tasks and accuracy.

1.2. Structure of the thesis

The structure of the thesis is as follows. Chapter 2 introduces the related work that has been conducted in the past, which is related to the study including discussion on different situated and mobile crowdsourcing platforms. In Chapter 3 we elaborate the proposed approach and implementation of our crowdsourcing task-pickup system and showcase the architecture of our system. This is then followed by the study design in Chapter 4, in which we describe in detail all the different types of crowdsourcing tasks we have designed for the system. In Chapter 5 we present the general statistics of our system based on user submissions, including time taken to complete the tasks, contribution accuracy and the survey results. Finally, Chapter 6 concludes our thesis by discussing our results and proposing future work that can be carried out using our system.

2. RELATED WORK

2.1. Situated Crowdsourcing

There have been several studies on situated crowdsourcing. One example is Bazaar [7], a Situated Crowdsourcing Market that uses kiosks to enable researchers to deploy simple crowdsourcing tasks placed in different locations for the workers to participate. The study consisted of three main components i.e., a grid of kiosks contains Android tablet which is set to kiosk mode and an active internet connection to connect to the server, a server on which a middleware was deployed to communicate between android device and MySQL database. The middleware was developed on Slim micro framework which is a lightweight PHP framework to develop web applications and APIs. The third component is a Researcher/Administration Hub to allow researchers to manage tasks and to oversee the whole system. Similarly, [5] researchers study the used public displays as a crowdsourcing mechanism. The study tested eight different motivational settings and analyzed user behaviors and crowdsourcing performance on public displays. The results of the study show that the use of public displays for crowdsourcing mechanism is feasible and through motivational design and validation checks, performance can be improved [16].

In another study [6], researchers systematically investigated workers' behavior and response to economic incentives in a situated crowdsourcing market. The study shows that in order to recruit workers and to obtain situated crowdsourcing contributions a market-based model is a sustainable approach. The study also suggested that price mechanism is an efficient tool through which the supply of labor can be adjusted in a situated crowdsourcing market. Another study [17] carried out in health care domain involved developing a system to reduce the stress level and increase the restoration opportunities of the hospital staff, which as a result improved the physical environment of a hospital emergency department. The study outlined a pragmatic participatory method, which uses social software implemented on situated interactive displays.

Yet another example is the use of a dialog system based on situated crowdsourcing [16], which addresses the issue that arise when collecting data from user queries in a moving car. The study compares the queries collected using the crowdsourcing methods to those collected using a real situated dialog system and based on the similarity in semantic content, naturalness of language expression and bias of the collected data. In another study, researchers used a situated crowdsourcing mechanism that estimates queue length in real time [15]. The system relies on public interactive kiosks to collect the human estimation about their queue waiting time without interfering into billing or customer systems in order to determine whether people who just joined the queue would differ in their estimates from people who were in the front of the queue.

Situated Crowdsourcing can also be very useful for our urban environments. Previous work has proposed a future view of crowdsourcing-enabled urban environments which can enable a flexible situated collaboration pattern and through crowdsourcing a way to contribute to the wealth and quality of life of urban environment can be promoted [18]. The study also presents several case studies on how these environments can have a high impact from the individual and societal

point of view, along with the challenges that could be faced in order to implement these environments to make them come in to reality. In another example, researchers used a crowdsourcing approach to support community-centric use and management of vacant houses. The project is on-going in Kashiwa City in Japan and argue for an open, inclusive and community-centric distributed platform to cater some important needs in the community [20].

Previous work has also highlighted the importance of civilian-initiated activities during disaster situations and use crowdsourcing to manage the voluntary activities during these emergencies [19]. The study demonstrates two tools that surround both situated and mobile crowdsourcing concepts. According to the study, both situated and ubiquitous crowdsourcing are helpful and appropriate in managing these disastrous situations, but there are also questions regarding the coordination of the volunteers and their activities during these emergencies.

Several studies have surveyed the crowdsourcing system including the mobile crowdsourcing platforms as well as situation crowdsourcing platforms. The study [27] presented a survey of mobile and situated crowdsourcing systems by addressing questions on how the users contribute to the system when new ones are developed and evaluated. The study analyzes 40 mobile and situated crowdsourcing platforms that are being used in real world and proposed a genetic model and new genes of mobile and situated crowdsourcing systems by examining the user contribution. They discuss how the proposed model can also be used to create new crowdsourcing systems.

2.2. Mobile Crowdsourcing

2.2.1. Completing Crowdsourcing Tasks on the Go

Mobile crowdsourcing has gained a lot of attention from the researchers due to their ubiquity and as a result it is possible to design tasks that the users can complete anytime and anywhere. Crowds are engaged with mobile and hand-held devices and can become a source of data by capturing and sharing high amounts of data e.g., capturing real world events etc. [1].

mClerk [4] is an example of a mobile crowdsourcing platform that allow users to receive the tasks on their mobile phones through SMS, making it accessible to anyone having low-end mobile phones to high-end smartphones. mClerk is very effective for digitizing local-language documents in the form of text and small images. Similarly, MobileWorks [11] provides employment to the users of developing countries which is a mobile web based application that provides Optical Character Recognition (OCR) tasks to its users that can be completed using mobile web browser. The application divides the documents into different pieces and sends it to different workers to address the limited screen resolution available on low-end phones. mCrowd [8] is another platform based in mobile crowdsourcing that enables mobile users to post and work on sensor-related crowdsourcing tasks.

Twitch crowdsourcing [9] is another mobile crowdsourcing platform that allows its users to make contributions while unlocking their phones each time. The platform takes advantage of the common habit of turning to the mobile phone in spare moments. It spans goals such as authoring a census of local human activity, rating stock photos, and extracting structured data from Wikipedia pages. Using

Twitch mobile crowdsourcing platform 82 users made 11,240 crowdsourcing contributions and its median activity took just 1.6 seconds.

CrowdMAC [10] is a crowdsourcing platform for mobile access in which mobile users who have sufficient capacity in their data plan, create a market place for mobile internet access by sharing their access to other nearby mobile users for a small fee. MoneyBee [12] is a unique mobile crowdsourcing platform that use mobile phone operator service instead of conventional internet crowdsourcing approach which has a large subscriber base and the ability to pay task workers using prepaid airtime.

Other studies have look at incentive mechanisms in mobile crowdsourcing. For examples, previous work focused on the problem of contributor-task matching in mobile crowdsourcing by identifying existing users who poses social media domain expertise, and incentivize them to perform some tasks [21]. In the end, the study proposed a framework to extract the contributor's expertise based in their social media activities and determine incentives for them. The framework evaluated on Flickr data for the entire city of Barcelona that shows high level of task quality and wide geographical coverage. In another study, researchers demonstrated an incentive mechanism design for mobile phone sensing by considering two system models: 1) platform-centric model where the crowdsourcing platform rewards the participant users and user-centric model in which the users have more control on the incentives they received [22]. In the study for the platform-centric model the incentive mechanism was developed using Stackelberg Equilibrium and for the user-centric model an auction-based incentive mechanism was developed which is efficient, individual rational, profitable and truthful. Through extensive evaluation for the performance, the theoretical properties of the incentive mechanisms were validated.

2.2.2. Location-based Crowdsourcing

Location-based crowdsourcing tasks are also possible using Internet and GPS enabled mobile phones e.g., going to the specific location and send reports about the environment of the location, sending reports of any instant accident, sending instant notification about traffic or weather situation, etc. Askus [2] is a mobile crowdsourcing platform for supporting collective actions and information capture. In Askus, the user is allowed to contact any person on a certain geographical location and send him/her request to carry out small tasks using their mobile phones. Google uses mobile crowdsourcing for live traffic situation, Google Map running on user's phone send the bits back to Google Servers and analyze how fast or slow the user is currently driving [3].

TRAC [13], tackle the problem of simulating the smartphone users to join mobile crowdsourcing application with smartphones. It takes into consideration the dimension of location information when assigning sensing tasks to smartphones in which as a result the theoretical and computational complexity increases. gMission [14] is another location-based crowdsourcing platform which features a collection of novel techniques including geographic sensing, worker detection and task recommendation. The platform makes it possible to implement a new crowdsourcing mode i.e., spatial crowdsourcing in which a requester can ask for resources related a specific location and the worker who is willing to take the task travel to that specific location and get the data. Previous work, proposed a framework and studies the preferences and concerns of using Location-based assignments (LBA) and

geotagging in news making through crowdsourcing [23]. Tasks were given to the users and then they were interviewed and asked to complete a questionnaire to get their preferences of receiving tasks and their usage of geotags. This study proposed a framework for participation preferences, which supports future work in Location-based crowdsourcing and to develop new processes and systems.

Other work investigates sensors in smartphones to construct a radio map for a floor plan and designs LiFS, an indoor localization system based on WiFi infrastructure and mobile phones [26]. The study crowdsourced the calibration of finger prints and results in achieving comparable location accuracy as compared to previous approaches. Zee is another crowdsourcing platform for indoor localization, which makes the calibration zero-effect by crowdsourcing the training data without any user's effort by using smartphone sensors [25]. Zee is designed to run in the background of the phone without explicit user participation. Another interesting research uses a social media platform i.e., Twitter in the context of location-based crowdsourced queries and investigates how feasible is to answer the location-based queries over Twitter and more specifically how effective it is to employ location-based services to find appropriate people to answer the given location-based query [24]. The study provides insights on the feasibility of the above stated approach and highlight some challenges in social search engines.

3. PROPOSED APPROACH AND IMPLEMENTATION

This chapter describes the implementation of CrowdPickUp, a crowdsourcing task pickup platform, which enables workers to complete three different types of tasks (Situated, Location-based and General). The components of CrowdPickUp platform will be discussed in detail in the next section.

3.1. Implementation Process

The implementation process consisted of three phases: 1) Task implementation, Database backend development, and system backend and UI development. First, the tasks were designed and finalized for each task category (Situated, Location-based and General). In the second phase, the database architecture was designed and implemented as per the tasks and system requirements. During the final stage of the implementation process the user interface and the application backend was developed, in which multiple server-side and client side frameworks were used to build the platform, which will be discussed in the later sections.

3.2. System Architecture

CrowdPickUp system is hosted on Amazon Elastic Compute Cloud (Amazon EC2) which provides resizable capacity in the cloud. As can be seen in Figure 1, our Amazon EC2 instance runs on centos (Community ENTerprise Operating System) which is a free rebuild of source packages developed by Red Hat Enterprise Linux. CrowdPickUp was developed using Java Platform, Enterprise Edition (Java EE) which is a widely-used enterprise platform to build enterprise applications. MySQL was used for database development for adding, accessing and managing application content, which is an open-source Relational database management system (RDBMS) and is commonly used in many enterprise applications for its simplicity of use, scalability and memory management. The communication between the client browsers and the web server is private and secured with HTTPS, which has been described in section 3.7 below. Figure 1 and Figure 2 shows the graphical illustration of CrowdPickUp system architecture and communication.

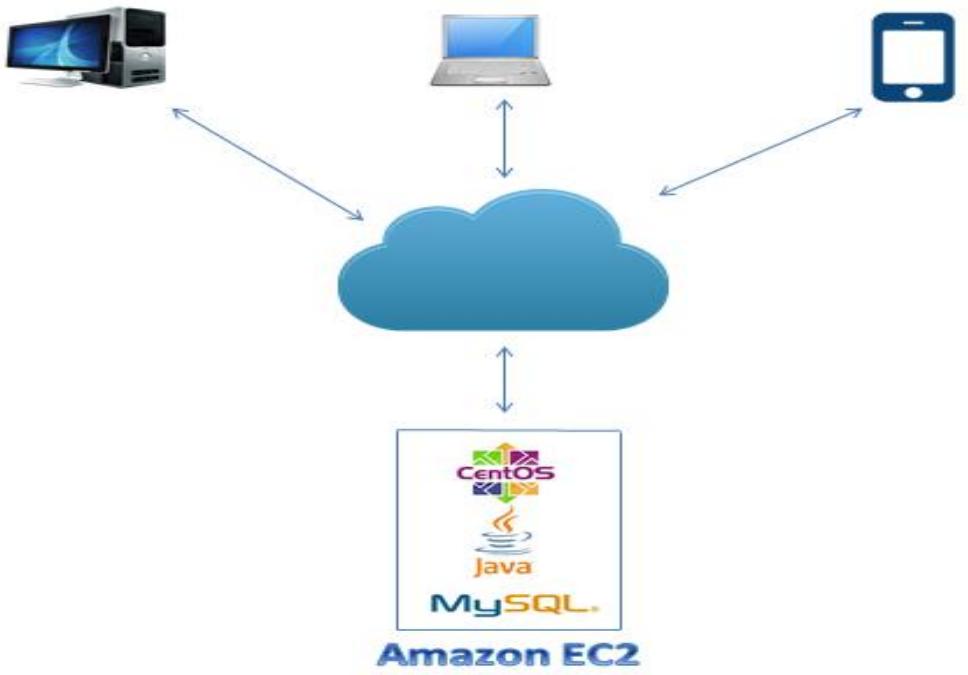

Figure 1: CrowdPickUp System Architecture Diagram

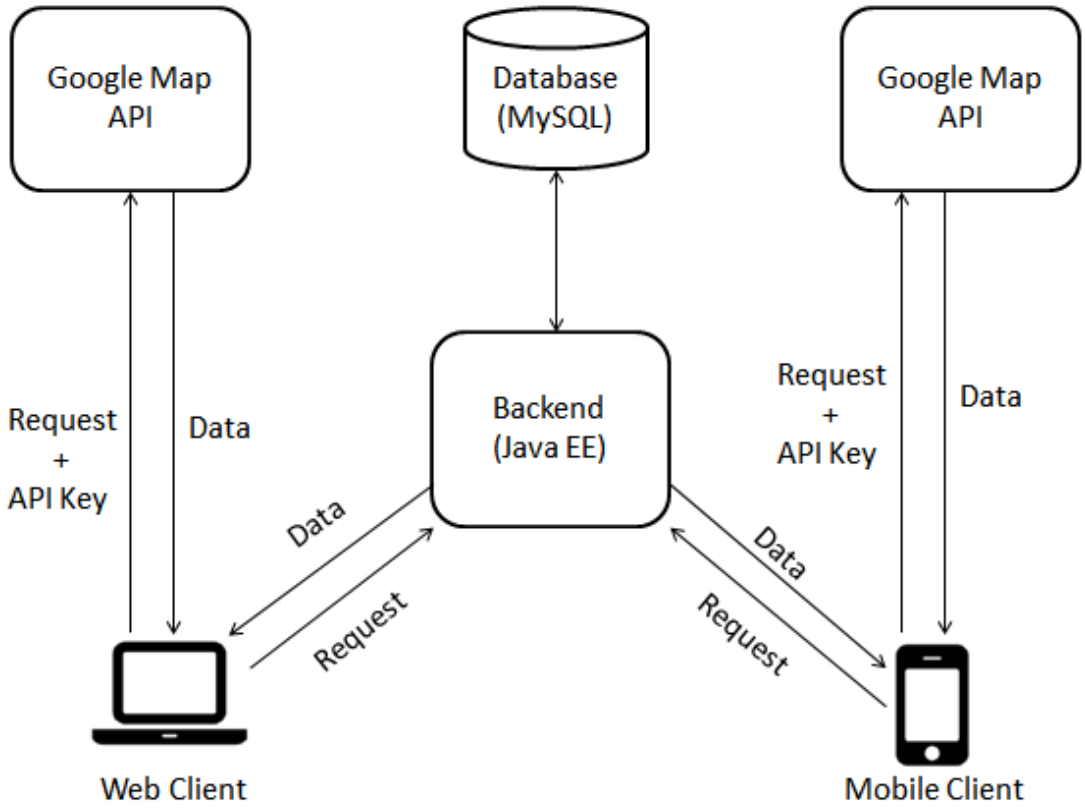

Figure 2: CrowdPickUp System Communication Diagram.

3.3. User Interface Development

The user interface was developed using Java Server Pages (JSPs) to generate dynamic web pages using simple HTML and CSS code. CrowdPickUp is developed to work with every browser from mobile browsers to PC browsers. To achieve responsiveness, we integrated Bootstrap with our system. Due to the usage of ready-made code blocks provided by Bootstrap, CrowdPickUp's user interface was developed rapidly.

3.4. CrowdPickUp Backend Development

CrowdPickUp's backend development is comprised of JavaEE stack. Spring web MVC framework was used to provide model-view-controller architecture to the application and to develop a loosely coupled and flexible system. Spring MVC gives a modularity to the application code in the form of input logic, business logic and User Interface Logic. One of the key component of the system is user authorization and authentication management. We used Spring Security framework, which is a JavaEE framework that provides authentication/authorization and access control management to our enterprise application. Hibernate Object/Relational Mapping (ORM) framework which is based on Java Database Connectivity (JDBC) was used, which allows fast development of our application and also allows our business code to access objects rather than database tables.

3.5. Secure Communication

In CrowdPickUp crowdsourcing task pick-up system, the communication between the web server and the client browser is secured and encrypted which means the communication is done using HTTPS communication protocol instead of common HTTP communication protocol. The purpose of this encrypted communication is to make sure the user sensitive data is private and integral. In order to achieve this functionality, we have installed a self-signed certificate on our tomcat application server to make the communication channel secure and private with HTTPS. A basic communication flow between CrowdPickUp System and client browsers are shown in Figure 3.

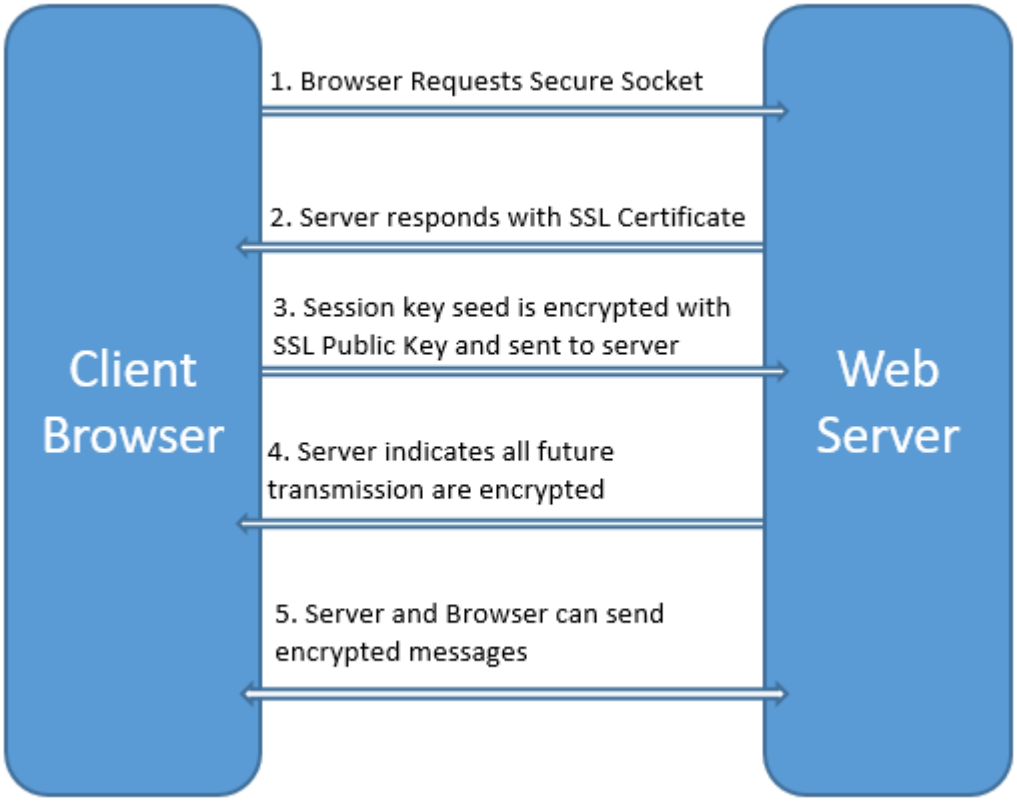

Figure 3: CrowdPickUp secure communication flow.

The diagram shows a Secured Socket Layer (SSL) communication between web server and the client browser. First, the client browser requests a secure socket from the web server and in response, the web server responds with the SSL certificate installed on the tomcat application server. In the second phase of communication, the web client browser encrypts the session key seed along with the SSL Public key and sends it to our web server. Finally, our web server and client browsers can send encrypted messages between each other.

3.6. User Management

CrowdPickUp is layered with a flexible and powerful authentication and access control framework in order to secure our crowdsourcing platform from unauthorized access and authentication. CrowdPickUp users need to register to the platform using the secure signup page as can be seen in Figure 5 and upon successful login (Figure 4) with the credentials the users are able to view and submit the tasks. The user's password credentials are highly secured with md5 hash string and stored in our secured database backend.

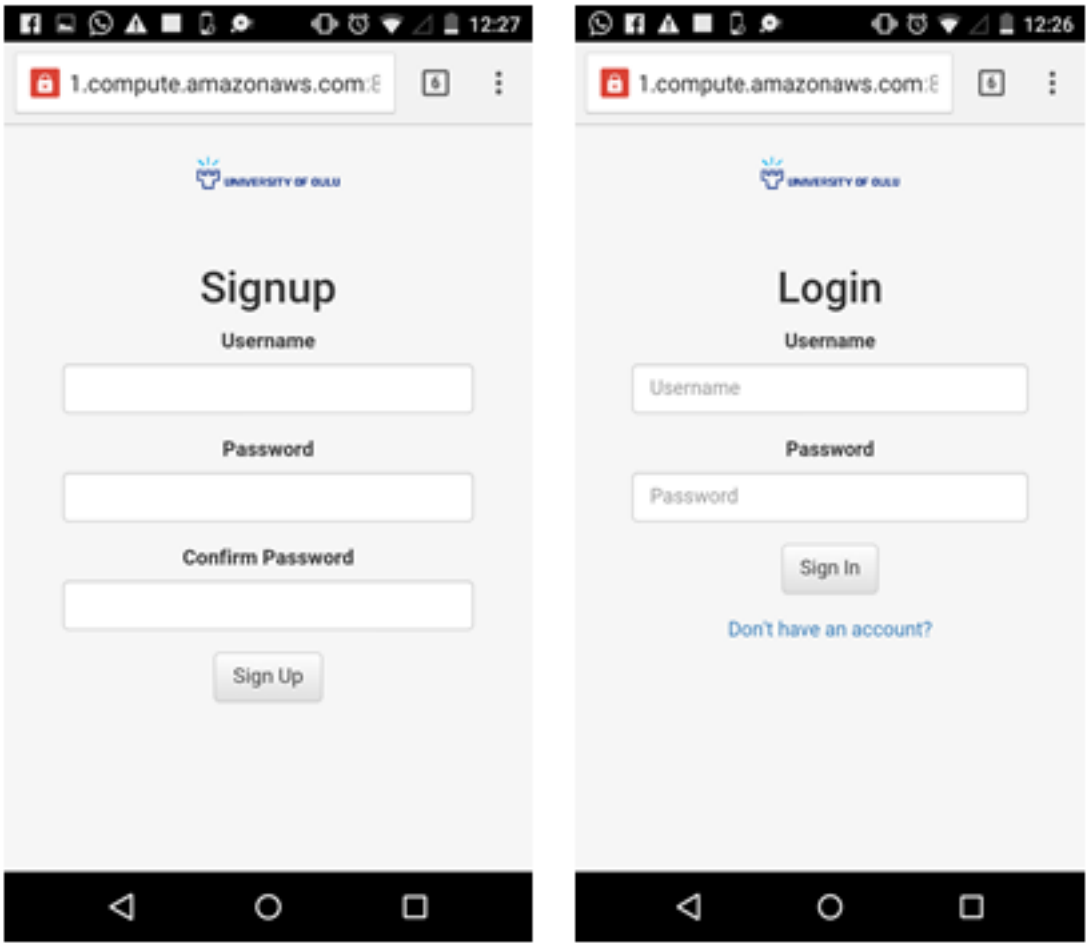

Figure 4: CrowdPickUp Signup and Login Panels.

3.7. Dashboard

CrowdPickUp has a dashboard which shows the summary of the tasks and coins earned for the current logged in user. The summary shows the number of individual tasks (Situated, Location-based and General) The CrowdPickUp dashboard screen is shown in Figure 5.

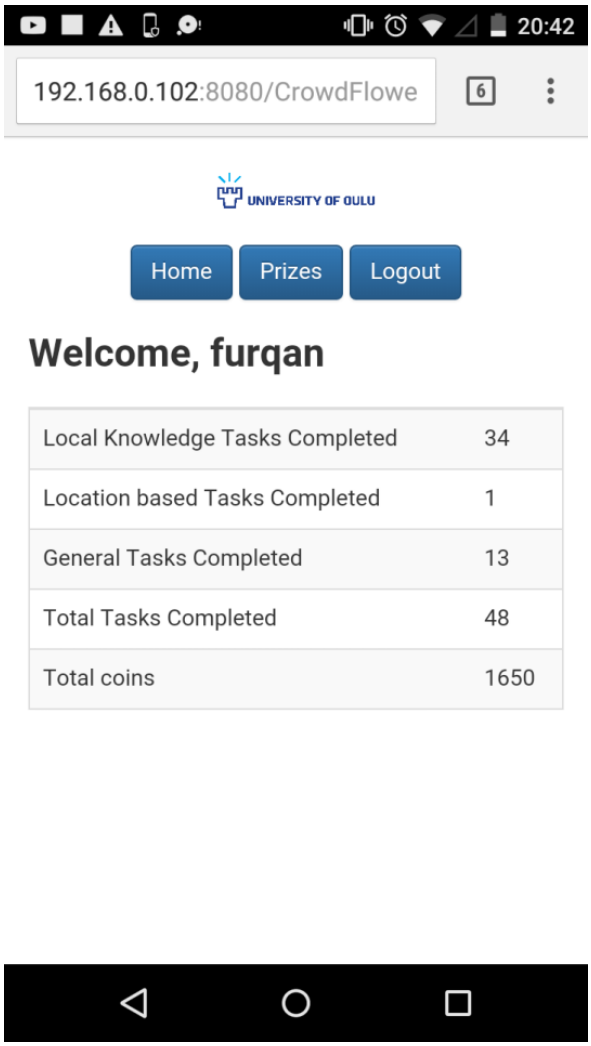

Figure 5: CrowdPickUp Dashboard Screen.

3.8. Shop

CrowdPickUp crowdsourcing system rewards its participants through incentives upon completing the tasks successfully. In order to incentivize the participants, we implemented an online shop with different prizes, which allow the participants to purchase the prize of their own choice according to the coins they earned.

There are three different types of prizes available, which the participants can purchase depending on their current balance. First, a ten Euro Voucher that requires 1000 Coins or more in the account in order to purchase it. Second, a twenty-five-euro voucher which requires a user to have 2500 coins or more in the account to purchase it, and third is a movie ticket which a user can buy if his/her account coin's balance is 975 or more. A screenshot of the prize screen is shown in Figure 6.

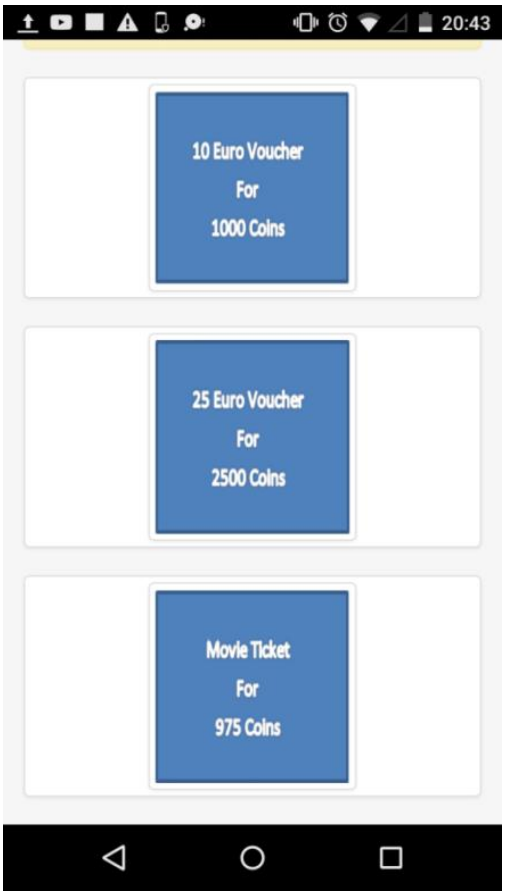

Figure 6: CrowdPickUp Prize Screen.

3.9. Help Menu

There is also a help center which can assist users in understanding the project and the ongoing study. The help menu also contains useful email addresses which the participants can use to claim their prizes. A screenshot of CrowdPickUp help menu can be seen in the Figure 7.

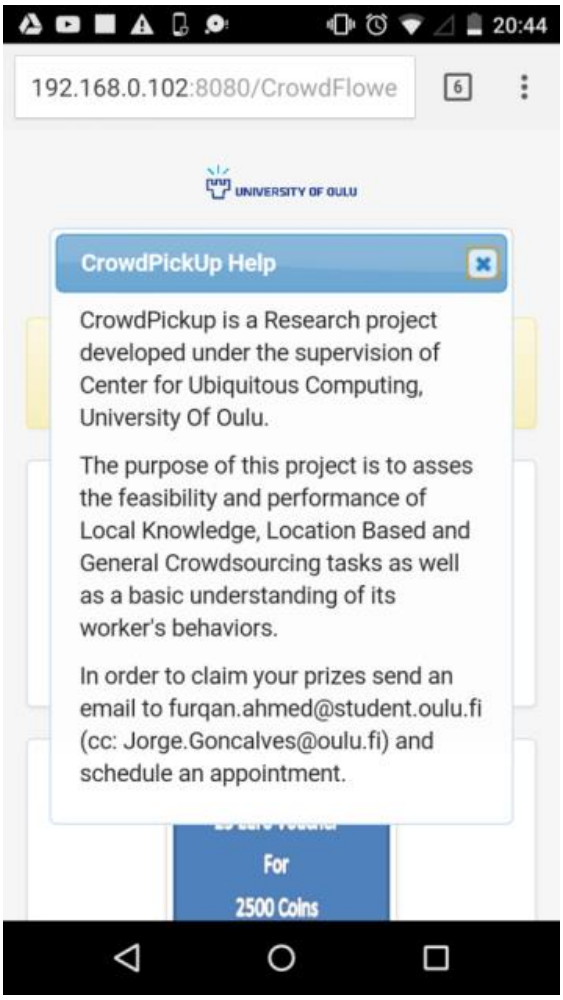

Figure 7: CrowdPickUp Help Menu.

4. STUDY DESIGN

We conducted a 19-day study to evaluate CrowdPickUp. Posters were placed at the notice boards and advertisement boards throughout our university campus and no further promotion was made. The advertisement poster of CrowdPickUp consisted of an A3 sized page with the name of the application at the top along with a small description of the project. The middle part of the advertising poster contained pictures of the prizes. The bottom part of our advertising poster contained a shortened URL along with the QR Code. Both allowed participants to access the platform. CrowdPickUp advertisement poster can be seen in the figure below.

Figure 8: CrowdPickUp advertisement Poster.

All the participants who actively participated in the study were incentivized through CrowdPickUp's online shop, which can be seen in the above Figure 6. In order to claim the prizes, participants needed to make a purchase and then send an email to the project members to fix an appointment with them. One of the project members then verified the participant's purchase and provides them with their prizes. We recorded participants' answers as well as completion times for each submission.

We designed three different categories of tasks (situated, location-based and general). Figure 9 is a tree diagram, which shows the structure of different categories present in our CrowdPickUp platform along with different tasks associated with these categories.

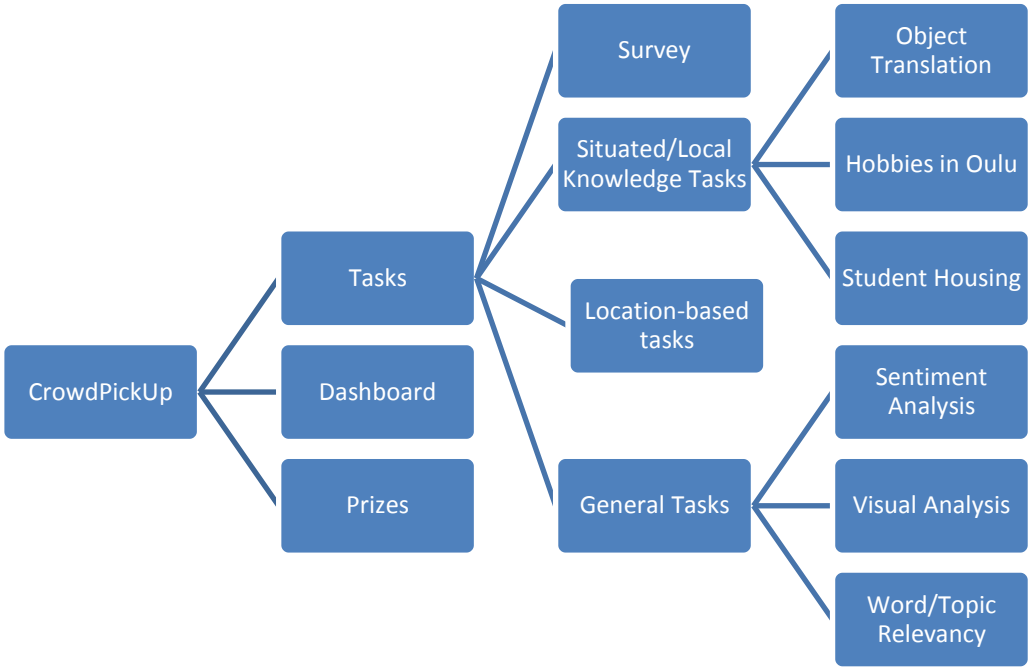

Figure 9: Tree diagram of CrowdPickUp's tasks

4.1. Situated / Local Knowledge Crowdsourcing Tasks

Situated/Local Knowledge task is the first category of our crowdsourcing platform, which requires the workers to have local knowledge related to Finland or Oulu. The tasks are design to allow workers to use their knowledge and experience that they came across while living in Oulu or Finland.

Figure 10: CrowdPickUp Situated/Local Knowledge Tasks Panel

4.1.1. Object Translation

Object Translation is one of the tasks that reside under Situated/Local Knowledge Tasks category. The workers are required to have basic to intermediate level Finnish language skills. The Object Translation task panel consists of an image of an object particularly a fruit and the workers needs to submit the task by identifying the name of the object and enter its translated text into Finnish. The task can be performed anywhere and contains 49 images of different objects. A new fruit is loaded on the same panel as soon as the worker submitted or skipped the task. Upon successful submission of the task, a worker was awarded with 20 coins whereas upon skipping the tasks a new object was loaded into the panel, but no coins were awarded to the workers.

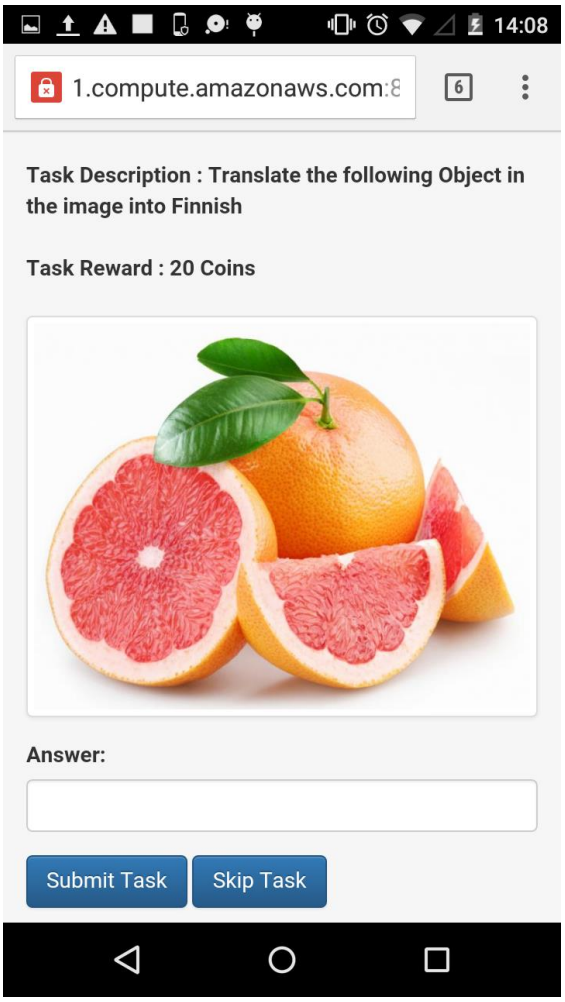

Figure 11: Object translation task panel diagram.

4.1.2. Hobbies in Oulu

In this task, workers are required to have knowledge of different hobbies that are possible or not to have in Oulu. In this task panel the worker will be shown a name of a hobby and the worker needs to enter into the text box describing how this hobby can be carried out in Oulu (how, when, where).

The task can be completed anywhere and it contains 39 different hobbies. As soon as the task is submitted a new hobby is loaded into the panel allowing the worker to complete as many tasks as she wants in quick succession. Upon successful submission of the task a user was awarded with 35 coins. When skipping the task, the worker was shown a new hobby in the panel, but no coins were awarded due to the skipping of the task.

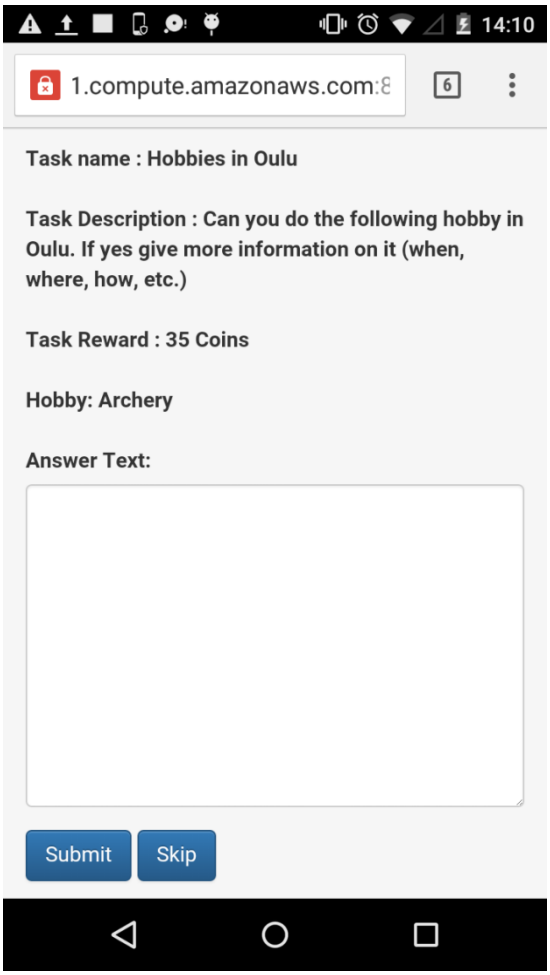

Figure 12: Hobbies In Oulu Task Panel.

4.1.3. Student Housing

PSOAS is a student housing organization that provides students with housing at an affordable price. There are multiple locations in Oulu where the student villages or housing built by PSOAS. In this task a worker is required to have knowledge of different location where the student villages by PSOAS are built and they need to rate the place as per different measures i.e., cleanliness, nearby services, location, cost, internet and maintenance by selecting rating scale (Very Bad, Bad, Neutral, Good, Very Good, and Don't Know). The task can be submitted from anywhere and it consists of 11 different locations where PSOAS have developed the student housing.

A worker is required to have a good understanding and knowledge of the area. The task is worth 50 coins, which is paid to the worker upon successful submission of the task and in case of skipping the task no coins are awarded.

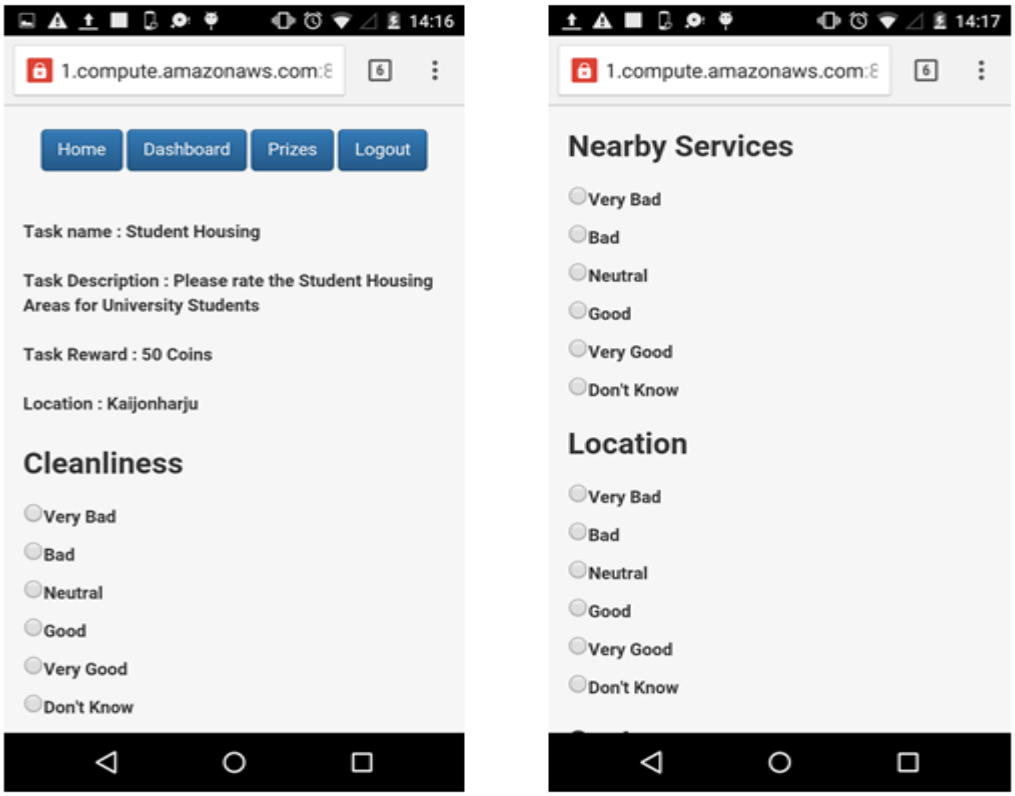

Figure 13: Student Housing Task Panel, part 1.

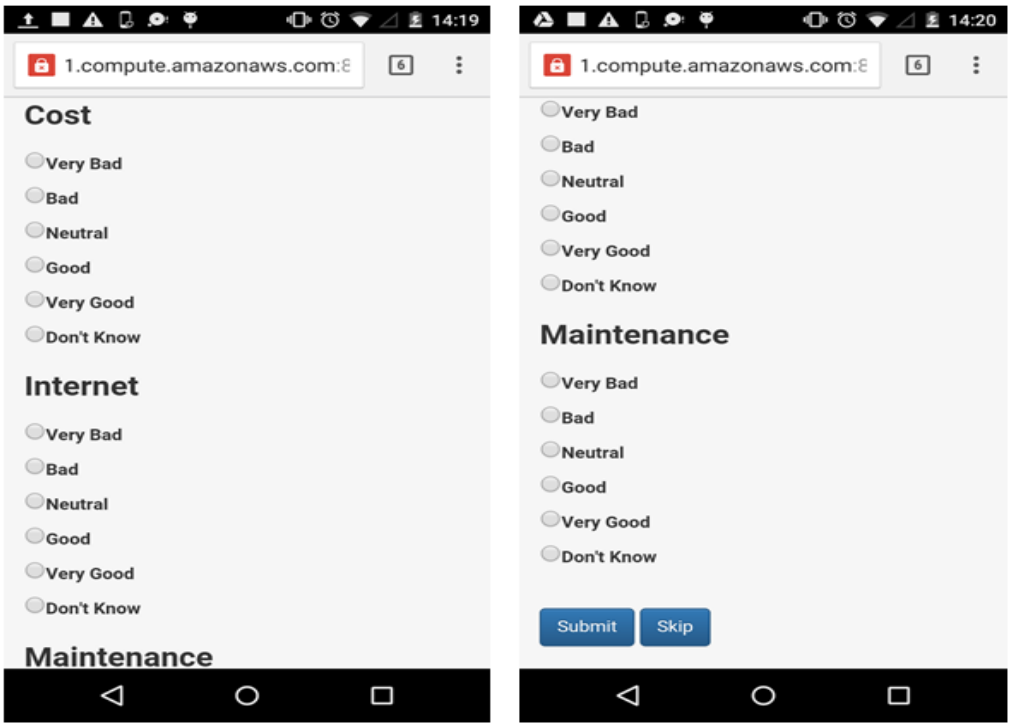

Figure 14: Student Housing Task Panel, part 2.

4.2. Location-Based Crowdsourcing Tasks

In the CrowdPickUp crowdsourcing platform, another category of crowdsourcing pickup tasks is Location-based crowdsourcing tasks. The workers are allowed to pick certain locations from the Location-based task panel as can be seen in Figure 15 from the City of Oulu where the workers need to be physically present at that location in order to submit the tasks. The task panel also has a map and a picture of the location which can be seen in Figure 16 to guide and help them find the places.

The workers were given general questions related to the place e.g.., is there any good local food restaurant nearby, the available services present there, whether the location is easy to find or not by using scales i.e., Very Bad, Bad, Neutral, Good and Very Good. the task completion reward is 250 Coins. There is no skip functionality in Location-based tasks as the worker can pick a favorite location of his/her choice from the list shown in the task panel.

In order to verify if the worker was in the correct location we used their GPS location co-ordinates which were then translated into physical address of the current location that consist of complete Street Address, City, Country and Postal Code. In order to implement this functionality, Google Map API was used. Upon the task submission the system first makes an ajax request to Google Map's API and receives a response which contains the complete address where the user is currently present. This is then compared with the address generated by CrowdPickUp's Location-based task. The GPS (Global Positioning System) is a pre-requisite and should be activated by the participants in order to submit the tasks.

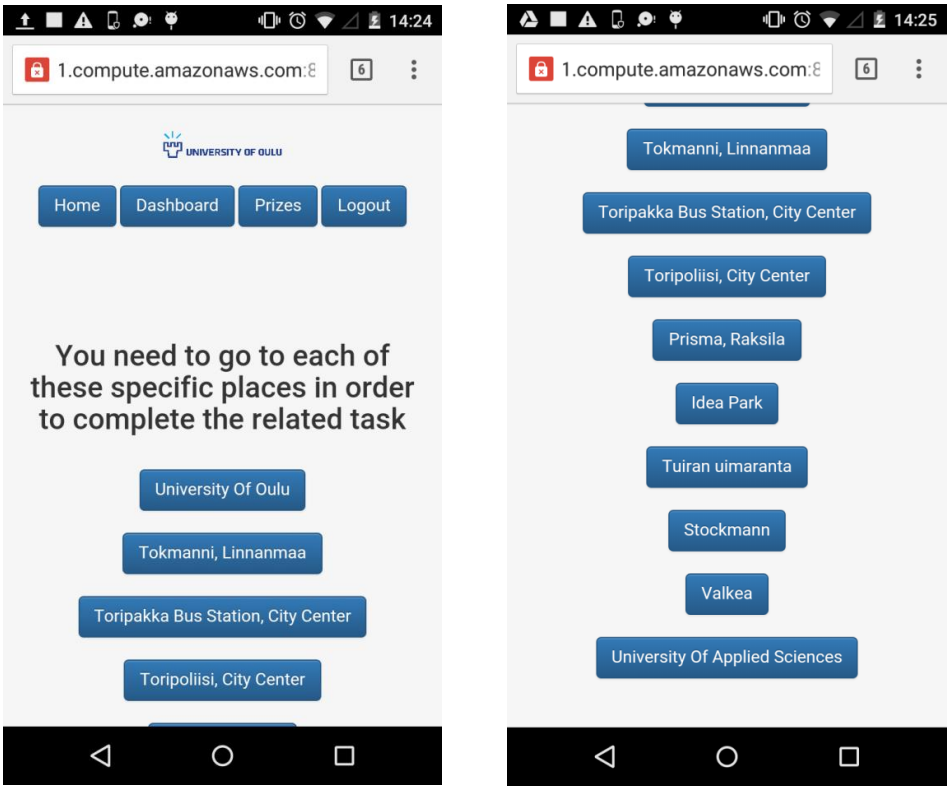

Figure 15: Location-based Task Panel

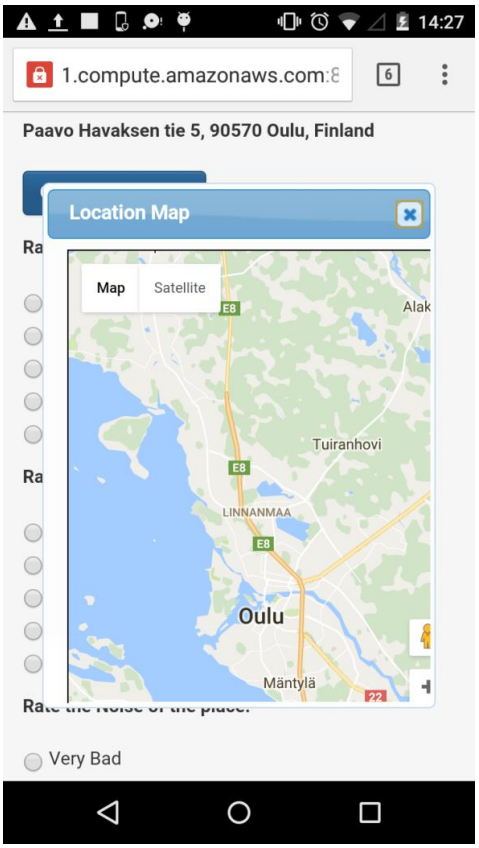

Figure 16: Location-based Task Panel with Google map

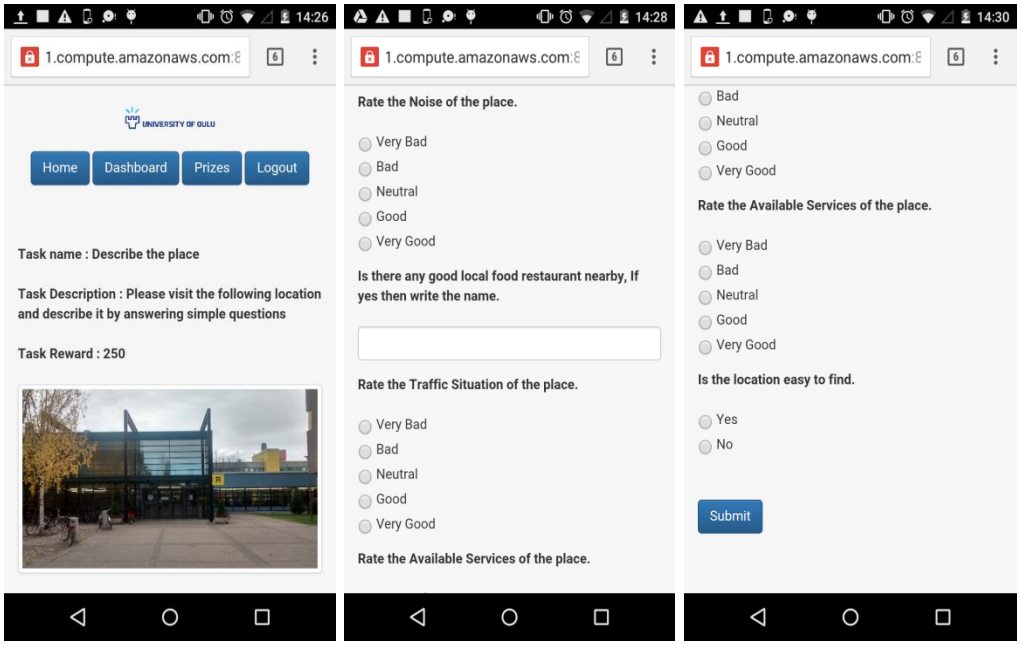

Figure 17: Location-based Task Panel with questions and ratings.

4.3. General Tasks

With these tasks, workers do not have any restrictions of location or local knowledge of the City of Oulu or Finland. Every task that comes under the category of General Tasks can be completed and submitted from any place and require basic skills of analyzing visual images and textual sentences. General Task category panel can be seen in the Figure 18 below.

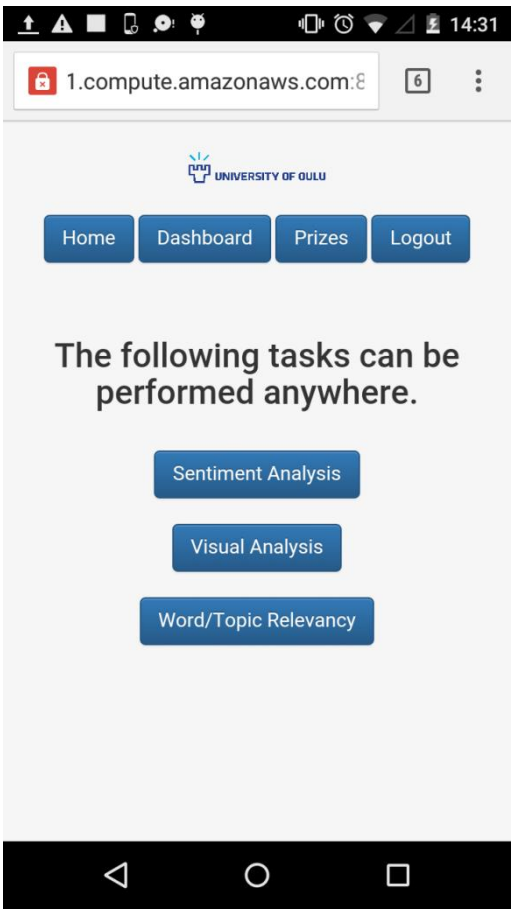

Figure 18: General Tasks Category Panel.

4.3.1. Sentiment Analysis

In this task, the worker shown in the task panel with a sentence and three possible answers i.e., negative, neutral and positive for the given sentence which he/she needs to pick.

The workers earn 10 virtual coins for submitting each sentiment analysis task and upon skipping, no coins earned. In both cases, a new task is loaded to the task panel. There are 31 sentiment analysis tasks available for workers to complete. The task panel can be seen below in Figure 19.

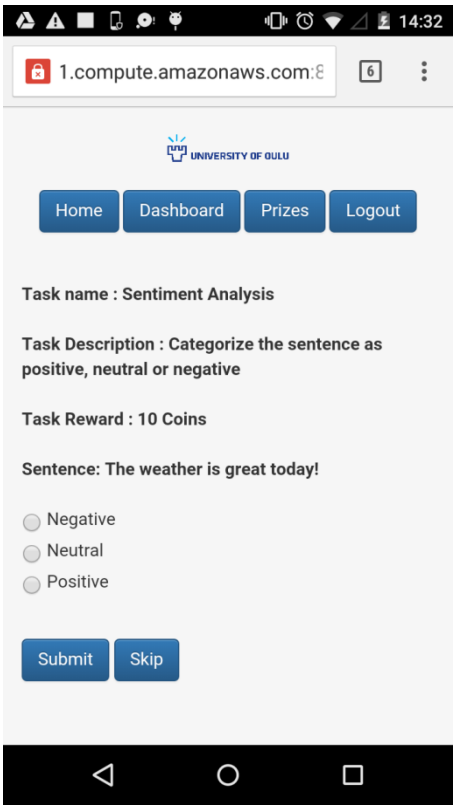

Figure 19: Sentiment Analysis Task Panel.

4.3.2. Visual Analysis

Visual Analysis tasks entail observing physical and external features of any object without the use of any instrument to estimate the results. Here, workers were shown an image of a place having two building marked with numbers i.e., 1 and 2 and the worker needs to analyze which building is closer. The choices are shown on the task panel in the form of radio buttons which a worker can select to submit the task result.

Upon each task submission, the worker is rewarded with 10 Coins and upon skipping the task no coins are awarded to the worker. There were 29 tasks available for workers to complete. Visual Analysis task panel can be seen in the below Figure 20.

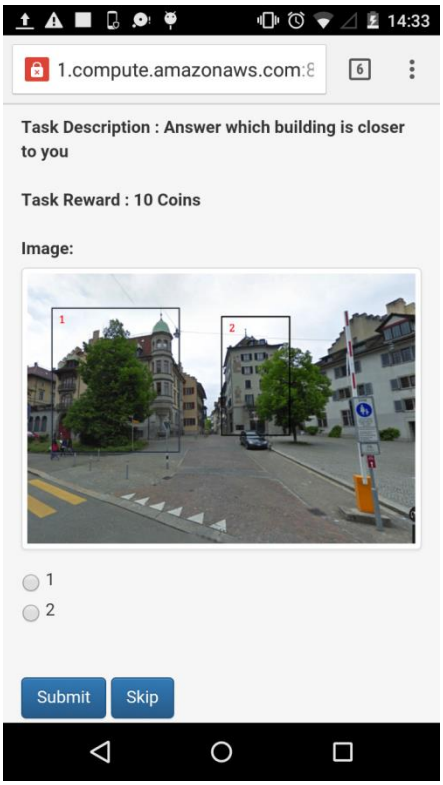

Figure 20: Visual Analysis Task Panel.

4.3.3. Word/Topic Relevancy

The workers were shown a sentence along with three words and he/she needs to pick which one is relevant to the sentence. This task required workers to have a good command on English language and good knowledge of reading and understanding sentences.

Each task gave 10 coins as a reward to the workers upon the task completion and no coins were awarded in case a task is skipped. There are 27 sentences and/or phrases and 80 words available in the platform for the workers. The Word/Topic relevancy task panel can be seen in the Figure 21 below.

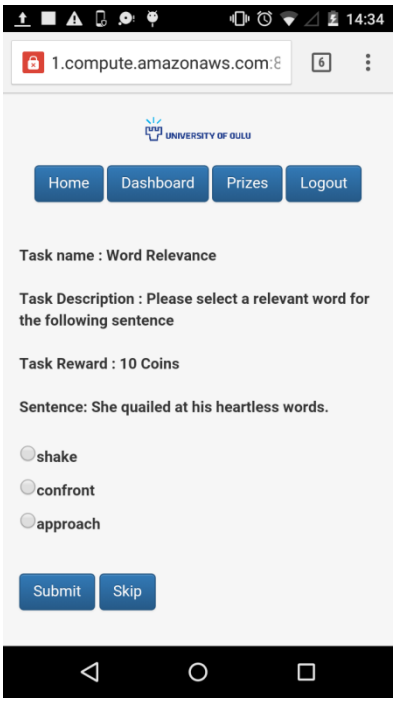

Figure 21: Word/Topic Relevancy Task Panel.

4.4. Survey

Every participant could complete the survey only once and had the highest amount of coins as a reward (300). The survey had the following questions:

- Gender
- Age
- Education
- Field of Study
- Time Living in Oulu
- Past crowdsourcing experience

5. RESULTS AND EVALUATION

5.1. General Statistics

This section illustrates the general statistics of different tasks and user activities during the period of the evaluation of CrowdPickUp crowdsourcing task-pickup platform. In total, 6661 tasks were completed and 520 were skipped. The breakdown of the tasks for the situated and general tasks are shown in the tables below, which shows the counts of total tasks completed, skipped, answered wrong and answered correctly. In the Location-based category there were a total of 191 tasks completed by the participants.

Tasks	Tasks Completed	Tasks skipped	Tasks Correctly Answered	Tasks Wrongly Answered
Object Translation	1610	340	1184	766
Hobbies In Oulu	1009	93	--	--
Student Housing	382	41	--	--
Total Count	3001	474	--	--

Table 1: Situated Crowdsourcing Tasks Count breakdown.

Tasks	Tasks Completed	Tasks Skipped	Tasks Correctly Answered	Tasks Wrongly Answered
Sentiment Analysis	1387	11	336	1062
Visual Analysis	1241	2	877	366
Word/Topic Relevancy	841	33	553	321
Total Count	3469	46	1766	1749

Table 2: General Tasks Count breakdown.

During the evaluation period of 19 days, 182,155 coins earned by the participants and 156,475 coins used in purchases through our online shop. Following graphs illustrates the statistics of CrowdPickUp system during the evaluation period.

5.2. Survey Results

A total of 47 participants filled out the survey task. This section of the chapter will give an insight about our participants age, gender, their education level and their field of study, etc.

8.5% of the participants belong to the age group of 15-20 years, 40.42% of the participants are between the age group of 20-25 years, 32% are between the age group of 25-30 years, 12.7% lies between the age of 30-35 years and 6.38% of the participants are between the ages of 35-40 years. 74% of the respondents were male (26% female). Most of the application users are male i.e., 74% and very few are females i.e., approximately 26%.

Participants reported being from various education backgrounds and levels. 29.78% have a Bachelor's degree, 44.68% belongs to Master's degree studies, 4.25% are from Doctoral Degree Studies and 21.27% of the participants are from High School and Lower education level. As far as the participant's fields of studies are concerned, 19.14% of participants are from IT-Related background, 6.38% are from Economics background, 4.25% of participants are from Science background, 34.04% are from Engineering background, 10.63% of the participants are from Arts background and 25.53% of the participants belongs to other fields of study.

Regarding time living in Finland, 14.89% of the participants have live in Finland for less than 1 year, 25.53% of the participants between 1 and 2 years, 14.89% between 2 and 3 years, whereas most of the participants are living in Finland for more than 3 years (44.68%).

The results also show that most of the participants were new to crowdsourcing platforms. 91.48% of the participants had no prior experience of working with crowdsourcing platforms before CrowdPickUp and only 8.51% of them have worked on such systems before.

5.3. Performance

This section reports the performance evaluation of different tasks of our CrowdPickUp crowdsourcing task-pickup platform. The following table shows the different tasks of CrowdPickUp crowdsourcing system along with each individual task's average time and standard deviation in seconds, as well as accuracy for the tasks that have ground truth.

Tasks	Time (Average)	Time (SD)	Accuracy
Object Translation	24.80 secs	23.62 secs	73.54%
Sentiment Analysis	5.80 secs	6.22 secs	73.90%
Visual Analysis	7.65 secs	11.41 secs	70.66%
Word/Topic Relevancy	14.36 secs	18.94 secs	65.75%
Student Housing	23.95 secs	16.58 secs	--
Hobbies In Oulu	29.53 secs	46.86 secs	--
Location-based Tasks	47.42 secs	34.84 secs	--

Table 3: Time and Accuracy table of CrowdPickUp Tasks.

As can be seen in the above table, the Object Translation Task has the highest accuracy and Sentiment Analysis has the lowest accuracy. Visual Analysis and Word/Topic Relevancy have accuracies above 70%. As far as time taken to complete the tasks is concerned, Location-based tasks have the highest completion time, which can be explained by the length of the tasks, while Sentiment Analysis Tasks have the lowest completion time.

6. CONCLUSIONS

In this thesis, we describe the design, implementation and evaluation of CrowdPickUp, a crowdsourcing task-pickup system that enabled workers to complete three different task categories i.e., situated, location-based and general tasks. The participants are required to use their existing knowledge related to the City of Oulu and Finland, go to certain locations to complete a task and/or complete simple visual/fluency tasks.

Several of our tasks enabled our participants to learn about their environment and context. For instance, with the Object Translation task participants were able to learn about new fruit objects and also learn the names of fruits in the Finnish language. With location-based tasks the participants visited different places in the City of Oulu and get to know about the environments and happenings of those areas. In Student Housing Task, participants discover student housing areas developed by PSOAS and those who are already living in those areas give their inputs about the situation of different PSOAS student housing areas. In Hobbies in Oulu task, participants were able to discover different hobbies and share their own opinions about the places where people can perform these hobbies.

During 19 days of evaluation, 70 participants signed up with the CrowdPickUp crowdsourcing task-pickup system. One key part of the work is that the application is built to run on any mobile device browser as well as on desktop computer browsers, leaving it up to the workers to decide which they want to use. As future work, we would like to develop an administration hub from where the administrators can see the complete statistics of the system, and also approve and disapprove the tasks. In Object Translation Task the correct and incorrect tasks are identified manually due to the options given in the task panel is a text box where a user can type the translation of the object, so in the future we would like to change the input controls to checkboxes where the users can select the correct Finnish translation option for the current object displayed in the panel.

7. REFERENCES

[1] Vukovic, M., Kumara, S., Greenshpan, O. Ubiquitous crowdsourcing. In Adj. Proc. Ubicomp '10, ACM (2010), 523-526.

[2] Konomi, S., Thepvilojana, N., Suzuki, R., Pirttikangas, S., Sezaki, K., Tobe, Y.: Askus Amplifying Mobile Actions. Proc. Pervasive 2009, pp. 202-219.

[3] Alt, F., Shirazi, A., Schmidt, A., Kramer, U., Nawaz, Z. Location-based crowdsourcing: extending crowdsourcing to the real world. In Proc. NordiCHI '10, ACM (2010), 13-22.

[4] Gupta, A., Thies, W., Cutrell, E., Balakrishnan, R. mClerk: enabling mobile crowdsourcing in developing regions. In Proc. CHI '12, ACM (2012), 1843-1852.

[5] Goncalves, J., Ferreria, D., Hosio, S., Liu Y., Rogstadius, J., Kukka, H., Kostakos, V. Crowdsourcing on the spot: altruistic use of public displays, feasibility, performance, and behaviours. In Proc. Ubicomp '13, ACM (2013), 753-762.

[6] Hosio, S., Goncalves, J., Lehdonvirta V., Ferreria, D.,Kostakos, V. Situated crowdsourcing using a market model. In Proc. UIST '14. ACM (2014), 55-64.

[7] Goncalves, J., Hosio, S., Ferreria, D., Anagnostopoulos, T., Kostakos, V. Bazaar: a situated crowdsourcing market. In Proc. UbiComp/ISCW '15 Adjunct. ACM (2015), 1385-1390.

[8] T. Yan, M. Marzilli, R. Holmes, D. Ganesan, and M. Corner. mcrowd: a platform for mobile crowdsourcing. In SenSys ’09, pages 347–348. ACM, 2009.

[9] Vaish, R., Wyngarden, K., Chen, J., Cheung, B., Bernstein, M. Twitch Crowdsourcing: crowd contributions in short burst of time. In Proc. CHI '14, pages 3645-3654. ACM (2014).

[10] Do, N., HSU, C., Venkatasubramanian, N,. CrowdMAC: A Crowdsourcing System for Mobile Access. In Proc. IMC '12.

[11] Narula, P., Gutheim, P., Rolnitzky, D,. Kulkarni, A., Hartmann, B,. MobileWorks: A Mobile Crowdsourcing Platform for Workers at the Bottom of the Pyramid.

[12] Govindaraj, D., K.V.M, N., Nandi, A., Narlikar, G., Poosala, V. MoneyBee: Towards enabling a ubiquitous, efficient, and easy-to-use mobile crowdsourcing service in the emerging market.

[13] Feng, Z., Zhu, Y., Zhang, Q., Ni, L., Vasilakos, A. TRAC: Truthful auction for location-aware collaborative sensing in mobile crowdsourcing.

[14] Chen, Z., Fu, R., Zhao, Z., Liu, Z., Xia, L., Chen, L., Cheng, P., Cao, C., Tong, Y., Zhang, C. gMission: A general spatial crowdsourcing platform. In Proc. VLDB ’14, pages 1629–1632.

[15] Goncalves, J., Kukka, H., Sanchez, I., Kostakos, V. Crowdsourcing Queue Estimations in Situ. In Proc. CSCW ’16, pages 1040–1051, ACM (2016).

[16] Misu, T. Crowdsourcing for Situated Dialog Systems in a Moving Car. In Proc. INTERSPEECH ’14.

[17] Zambonelli, F, (2011) Pervasive urban crowdsourcing : Vision and challenges. In Proc. PERCOM, 2011.

[18] Marshall, Paul, Cain, Rebecca and Payne, Sarah R. (2011) Situated crowdsourcing: a pragmatic approach to encouraging participation in healthcare design. In Proc. Of Pervasive Health, pages 555-558, 2011.

[19] Ludwig. T, Kotthaus, C, Pipek, V. Situated and ubiquitous crowdsourcing with volunteers during disasters. In Ubicomp ’16, pages 1441–1447. ACM, 2016.

[20] Sasao T., Konomi S., Suzuki R. (2016) Supporting community-centric use and management of vacant houses: a crowdsourcing-based approach. In Proc. Of Ubicomp ‘2016, pages 1454-1459, 2016.

[21] Micholia P., Karaliopoulus M., Koutsopoulos I., Aiello L., Morales G., Quercia D. (2016) Incentivizing social media users for mobile crowdsourcing, 2016.

[22] Yang D., Xue G., Xi F., Tang J. (2012) Crowdsourcing to smartphones: Incentive mechanism design for mobile phone sensing. In Proc. Of Mobicom ‘2012, pages 173-184, 2012.

[23] Vaataja, H., Vainio, T., Sirkkunen, E. Location-based crowdsourcing of Hyperlocal news: dimensions of participation preferences. In Proc. Of GROUP ‘2012, pages 85-94, 2012.

[24] Bulut, M., Yilmaz, Y., Demirbas, M. Crowdsourcing location-based queries. PERCOM Worshops ’11, IEEE (2011).

[25] Rai, A., Chintalapudi, K., Padmanabhan, V., Sen, R. Zee: zero-effect crowdsourcing for indoor localization. In Proc. Mobicom ’12, pages 293-304, ACM (2012).

[26] Wu, C., Yang, Z., Liu, Y. Smartphones Based Crowdsourcing for Indoor Localization. IEEE Transactions on Mobile Computing, pages 444-457, IEEE (2014).

[27] Huang, Y., Shema, A., Xia, H. A proposed genome of mobile and situated crowdsourcing and its design implication for encouraging contributions (2016).