

INTERACTIVE COMMUNICATION FRAMEWORK FOR ENHANCED BUSINESS-TO-CONSUMER INTERACTIONS IN AN INTERNET OF THINGS ECOSYSTEM

BACKGROUND

Field of the Invention:

This invention relates to the field of Robots as a Service (RaaS). Specifically, the invention describes technologies and techniques for user involvement in a setup comprising many robots or Internet-of-Robots (IoR), leading to efficient Business-to-Consumer (B2C) strategies.

Description of the Related Art:

- With developments in the field of IoT and RaaS, an intelligent and adaptive application framework uniting consumers to business establishments is needed.
- Current systems provide services to monitor IoT devices while consumers have no direct access to the service agents themselves. Hence the need to develop scalable frameworks providing efficient business-to-consumer (B2C) interactions in accordance with the methodologies of service oriented architectures (SOA).

SUMMARY

- In any embodiment of the present invention, there are two subsystems: robotic service subsystem and user subsystem. Techniques and technologies for interaction between the two subsystems are disclosed. The robotic service subsystem acts as an abstraction, wherein users and robots communicate as if directly connected to each other. This layer of abstraction provides security and reliability, while allowing the robotic service management person to monitor these communications.
- In one embodiment of the present invention, the robotic service subsystem can have robots for deliveries, deployed in different hotels. The user subsystem application environment allows users to utilize the services provided by these robots, for instance, ordering an item to their room or scheduling a future delivery. The invention discloses methods therein for reliable communication protocols between the two subsystems and central management application of the robotic service subsystem.
- In another embodiment of the present invention, the robotic service subsystem can have robots meant for outdoor or indoor surveillance of certain areas. The user subsystem application environment allows users to communicate with the robots for important information, for instance, reporting activity within an area.
- In another embodiment of the present invention, the robotic subsystem can have robots for waiting tables in restaurants. Users interact with the robots through the user subsystem application environment for ordering items to respective tables.

This Summary was provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

- FIG. 1 is a diagrammatic abstraction of the business-to-consumer (B2C) application framework operation according to the embodiments of this invention.
- FIG. 2 is a diagrammatic view of communication framework uniting the two subdomains: robotic service subsystem and user subsystem.
- FIG. 3 is a logical flow of the functioning of application framework on the consumer side.
- FIG. 4 is a diagrammatic description of the services and components comprising the robot interaction unit.
- FIG. 5 is a process flow describing communications between consumers and robot in a business through the robot interaction unit.
- FIG. 6 is a diagrammatic description of the services offered by the framework cloud servers.
- FIG. 7 is a diagrammatic description of the methods exposed to a consumer through the consumer side application framework for any business embodiment.
- FIG. 8 is logical flow describing the steps involved in a business embodiment scenario where robotic agents are needed to deliver items in a hotel to room numbers.
- FIG. 9 is a snapshot of the application framework for consumers to sign up.

- FIG. 10 is a snapshot of the application framework allowing hotels to sign up for integrating butler services.
- FIG. 11 is a snapshot of the robot interaction unit in a hotel setup for interactions with the service agents deployed therein.

DETAILED DESCRIPTION

- [001]** For the purposes of promoting an understanding of the principles of the invention and the scope of applications involved therein, reference will now be made to the embodiments illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope is thereby intended. Any alterations and further modifications in the described embodiments, and any further applications of the principles as described herein are contemplated as would normally occur to one skilled in the art.
- [002]** The invention describes an application framework that unites consumers with the services offered by various embodiments of RaaS in business establishments employing robotic or automated service agents. From this point onwards, the scope of the term service agents will encompass both, robotic service agents as well as human agents unless specified. The application framework is also understood alternatively at a high level in terms of various aspects related to service oriented architecture (SOA) models for business process management systems (BPM).
- [003]** As shown in FIG. 1, a consumer can communicate with a robotic service agent in any business embodiment facilitated through the techniques and technologies of the application framework described in this invention. The framework is broadly categorized into four elements namely: consumer application **100**, framework cloud services maintained on a remote system **102**, business entities utilizing RaaS models for various embodiments **104**, and the robotic agents deployed for the execution of these services **106**.

- [004] The consumer is exposed to a certain set of functionalities of the business through the application framework. These functions or services can be requested by the consumer after proper authentication. Henceforth, the application framework behaves as a black box **108**, implying that the consumer is unaware of the specific processes and protocols involved in assignment of a service agent to implement the request. Specific details about these service components are described in later sections. The communication links between a consumer and service agent is successfully established if the consumer is connected to the world wide web (WWW) through any means. In an extension of this communication protocol, the user may be minimally needed to stay connected at least to the intranet of the business establishment through any wireless means including but not limited to Bluetooth and Wi-Fi. In another extension of this communication link, the robotic agents can manifest their presence for communications in form of a search service installed on the consumer's device. In another extension of this communication link, the service can be made available through the use of non-portable authorized installations of communication devices allowing the consumer to authorize and use the services offered. In certain embodiments, the need for framework cloud services may be omitted, resulting in direct connection of consumers to the business application framework **104**.
- [005] The application framework is necessarily asynchronous with very low latency and bandwidth of communications. This allows multiple users across various locations to use the framework for the RaaS solution offered by business establishments.
- [006] In one implementation of the framework, the consumer is granted view only functions instead of direct service related controls of the service agents. A view only setup provides the consumer access to information pertaining to the robotic system including but not limited to its location and activity. In addition, consumers may subscribe to notification services of the embodiment. These notifications may be specific or non-specific to the particular business embodiment and generated automatically or controlled by a business control agent.

- [007] As depicted in FIG. 2, the framework comprises two domains broadly: the robot service subsystem **110** and the consumer subsystem **112**. A primary aim of this invention is to unify the two subsystems through the application framework by offering a plurality of services **102**. All the business entities (**114** and **116**) reside in the robot service subsystem, while all the consumers (**126** and **128**) are present in the user subsystem.
- [008] Each business entity can implement any particular embodiment of the RaaS platform as described in the Summary (**120 A** and **120 B**). In one particular implementation of **120**, the robot can provide surveillance and security related services. In another implementation of **120**, the robot can provide room delivery services in a hotel. In yet another implementation of **120**, the robot can provide services in a restaurant environment for food delivery to tables. Another implementation of **120** can involve medicine and surgical equipment delivery in a hospital environment.
- [009] Various embodiments of robots deployed by the business entities are controlled centrally through a computing system called the robot interaction unit **118 A** and **118 B**. The robot interaction units are responsible for communicating between the central business control person and the service agents. The robot interaction unit should necessarily provide the central business control person with a graphical user interface (GUI) that allows access and control over the services offered by the robot embodiments and the service agents.
- [0010] The consumer subsystem is exposed to a set of services through the application framework. These services are broadly classified as those pertaining to robotic service (**122 A** and **122 B**) or other services (**124 A** and **124 B**). The term robot service encapsulates all the services offered by any RaaS implementation in business establishments, meant to serve consumers, through direct involvement or not. The term *other services* encapsulates human service agents and any services provided to the consumers by the specific business establishment.
- [0011] In one implementation of the robot embodiments **120**, the serving agents can also involve humans through a connected portable unit, including but not limited to their smartphones or tablets. This implementation ensures that a consumer's

request is relayed to all service agents in the business establishments, for least delay in response.

[0012] FIG. 3 shows the high level steps involved in a process flow for one implementation of the application framework. In one form, the process of FIG. 3 is at least partially implemented by the application framework across computing nodes residing at different locations. The process flow is executed each time a consumer wishes to access the services provided by the robotic service subsystem **110** of any business establishment. The procedure begins at **140** with providing an application framework for the consumers to log in or signup. Following this step, the framework is operable to allow communications with consumers through a URI (for instance, using REST protocol or its extension thereof). The services offered through this communication module can vary suitably depending on the type of embodiment used in the business establishment **144**. Several types of functions including but not limited to the following can be exposed to the consumer: access to robot locations, requesting a delivery, requesting a wake up call, requesting an automated future delivery, requesting payment options, requesting food delivery to tables. Any RaaS functionality can thereby be exposed to the consumer through the framework.

[0013] In one implementation, the system performs the above mentioned process operations in order to enable the consumers to directly interact with the business entities, both, robotic and human service agents, comprising an extension of RaaS setup.

[0014] The framework is further operable to allow bi-directional communication of consumer events to the cloud servers **146**. The definition of consumer events is: any data or information that is transferred between the framework and consumer at any time. In one such operation scheme, the RaaS implementation can provide notification services about nearby events with respect to the consumer's location. In another operation scheme, consumers can provide suspicious activity based data in appropriate format to the framework, which is further processed by the service agents in business establishments.

- [0015] In one embodiment, consumer events **146** may be implemented as asynchronous publish-subscribe (pubsub) channels. An example of this is using the MQTT protocol or its extension thereof to maintain a bi-directional, asynchronous, low latency and low bandwidth consumer event framework. Any other means of implementation utilizing TCP/IP protocols or their extensions is implied hereby (for example, socket.io protocol). The process then ends at stage **148** after the consumer logs out of the application environment.
- [0016] FIG. 4 is diagrammatic description of the robot interaction unit **160**. This unit provides services to each business establishment that are responsible for maintaining communications with the service agents. At least one human operator per business is required to monitor and manage the robot interaction unit.
- [0017] In one implementation, the robot interaction unit is developed as a web service maintained on framework cloud servers **102**. Each business establishment can access this service through appropriate registration and login.
- [0018] In another implementation, the robot interaction unit is developed as a standalone native program. This program is supplied to each business establishment deploying the RaaS systems, to be operated within the framework described in this invention.
- [0019] After proper instantiation of the robot interaction unit, the following services are made operable in part, completely or with appropriate extensions thereof. A notification center **162** is provided that is responsible for reporting information from the service agents to the operator. This information can be any alerts or requests generated by the service agent, manually or automatically.
- [0020] The robot interaction unit can also provide a method **164** for overriding the robotic agent controls to manual or semi-automatic if needed. The method should necessarily provide subroutines to identify each robotic service agent deployed in the business establishment. This identification can be based on a unique numbering system generated through framework cloud servers **102** at the time of deployment. The method can include in part or with extensions, routines to manually guide the robotic agent, routines to access the camera feed of the robotic agent, routines to shut down or reboot and routines to allow the robot to speak a

particular text. These overriding method routines can be instantiated independently for each robotic agent without affecting the operation of other service agents.

- [0021] The robot interaction unit can provide services indicating the status of each service agent deployed in the business establishment. The status information can be set as one or more of the following, depending on the robot embodiments: IDLE, SERVING, HUMAN ASSISTANCE NEEDED, FAULTY, NO LINK, and/or others. Custom status information can also be used instead of or in addition to above mentioned information.
- [0022] In certain implementations, the service agent embodiments can set a status variable called TIME TO SERVICE COMPLETION. This status variable denotes the estimated time before the service agent returns to IDLE state.
- [0023] The robot interaction unit is responsible for maintaining a database **168** of consumer generated responses appropriate to the robot embodiments. For example, a service robot can send customer's satisfaction rating to the unit for proper storage and future retrieval when required. In one implementation of the database service, it may be stored on the computing unit of the business establishment running the robot interaction unit. In another implementation, this database is stored on framework cloud servers **102**. The database can be of the following types: relational database management systems (RDBMS), NoSQL or non-relational database, text files, extensible markup language (XML) files, and/or others. This database system service is intended at providing better services to consumers utilizing the RaaS services of any business establishments.
- [0024] The robot interaction unit can also provide services **170** for robotic subsystem control persons, that allow retrieval and viewing/editing of information about the consumers currently active within the business establishments. This information can in turn be used to deliver more personalized services to the consumers for instance custom notification services based on consumer's preferences.
- [0025] In one implementation of consumer information services **170**, the framework is also given permission to track, learn and save the preferences of consumers through an algorithm employing methods for machine learning or its extension.

- [0026] The robot interaction unit can also provide services **172** that allow activation or deactivation of consumer logins at any time. This service is intended to maintain records of consumers currently utilizing the service agents deployed within a business establishment. Following activation, consumers are exposed to a set of services through their application environments **248**. In one implementation of this service, the process of activation or deactivation is performed manually by consumers on their application environments **248** followed by verification by respective business establishments. In another implementation of this service, the process of activation and deactivation can be performed by the control person managing the robotic interaction unit through on site authentication, for instance, using QR codes, password, and/or other means.
- [0027] Turning now to FIG. 5, a process flow of one implementation of the application framework in a business establishment **200** is shown. The process depicts steps and techniques involved when a consumer inside a business establishment utilizes the services of the particular RaaS embodiments deployed therein. Authenticated/Activated consumers can independently communicate with the service agents through the communication links **202** and **204** via robot interaction unit **160**. These links can be facilitated through protocols including but not limited to: REST or its modification, Bluetooth, or radio links. These communication links may optionally involve framework cloud servers for transmission.
- [0028] Following request of a service by a consumer, appropriate commands are sent to the robot interaction unit for processing. The consumer to control link (**202 A** and **202 B**) can be established through the application environment of the consumer. In most implementations, this link follows a RESTful protocol or its modification through framework cloud servers to finally relay the request to the robot interaction unit. This is generally implemented as: `http://<framework cloud services URI>:<port>/?user=<userid>&request=<requestid>`. In another implementation of this link, the user's application environment can send this request to framework cloud servers through publish-subscribe channels using MQTT. In this implementation, consumer's application environment is connected to a REQUEST channel, where messages like `<userid>:<request>` can be sent.

- This request is relayed to the robot interaction unit **160** of appropriate business establishment, that has subscribed to the same channel.
- [0029] After reception of request by the robot interaction unit, it is relayed to a service agent in IDLE state or least TIME TO COMPLETION in order to execute the task. This is done through message passing over the service agent to control links **204 A** and **204 B**.
- [0030] Turning now to FIG. 6, various services offered by the framework cloud servers are depicted **102**. These services are instrumental towards proper functioning of the entire framework. Each service is necessarily asynchronous and has the ability to handle many consumer or business requests at any time. These services can be implemented in programming languages like python, node.js, go, scala, vala, java, C++, and/or others.
- [0031] Framework cloud services **102** can include a service **220** for maintaining a database of consumers signed up for using the service facilities provided by various business establishments. The database can be of the following types: relational database management systems (RDBMS), NoSQL or non-relational database, text files, extensible markup language (XML) files, and/or others. The database is used for the purposes of authenticating a consumer's intention to utilize the RaaS facilities.
- [0032] Framework cloud services can also provide a service **222**, which maintains a database of the identifications of robots and service agents deployed at various business establishments. This database can also be of similar types as mentioned for service **220**. Additionally, the database can also store a variable indicating the category of services utilized by the business establishments. In all implementations, this database is necessarily used to record the amount of lease time of each robot per business establishment. This is done to facilitate operations within RaaS methodologies.
- [0033] Framework cloud services can also provide a service **224** for the purpose of routing requests from consumers and businesses along appropriate channels. Routing services are utilized primarily for establishing control links between the consumer's application environment **248** and the service agents deployed within

the business subsystem. In one implementation, routing services are implemented as MQTT channels receiving and transmitting data in formats like JSON, XML, and/or others. In another implementation, these routing services can be written in programming languages like python, java, and/or others to respond to RESTful queries or their extensions thereof.

[0034] Framework cloud services can optionally provide file or data storage services **226**.

This service can be implemented as a HTTP method wherein the service is operable to store data from service agents and business establishments. An example of such a data can be sensor data log files from each robotic service agent.

[0035] Framework cloud services necessarily host the robot interaction units **160**. As described earlier, these units provide each business establishment with a GUI to control and monitor the service agents deployed. By deploying the robot interaction unit services on the cloud, it is easy and straightforward to provide any updates, which are ultimately reflected across all business establishments immediately.

[0036] Finally, framework cloud services can also provide business interaction services **228**. These services provide business establishments with options to communicate any information to administrators of the framework. For example, in one implementation, business establishments can have access to service **228** that allows them to report any errors or malfunctioning equipment in the service robots to the administrator. In another implementation, this service can provide online communication facilities with the administrator. These services **228** are primarily meant for the purpose of facilitating better business to consumer relationships through proper maintenance of the robotic service agents.

[0037] Turning now to FIG. 7, the application environment **248** as exposed to the consumers and services offered therein are depicted. This application environment is exposed to the consumers after proper authentication. In one implementation, the consumer application environment is designed as a native program to run on computing devices like tablet computers, mobile phones, and/or other personalized mobile devices. In another implementation, the consumer application

environment is designed as a cross platform HTML based program, residing standalone on the consumer's computing device or accessible through TCP/IP over the WWW.

- [0038] The consumer application environment necessarily provides communication services **240** that allow consumers to interact with service agents within a business. This can happen through a RESTful API or pubsub protocols like MQTT, that communicate to the robot interaction units through the cloud. These services can include request for item delivery to room, scheduling a future delivery (for instance, morning tea at a certain time), and/or others. In another implementation, services may include the function to call a service agent to the consumer's location.
- [0039] Consumer application framework can also optionally provide services **242** to indicate check in or check out at designated business locations. Thereafter, the consumer is exposed to functions resulting from the particular embodiments deployed at the business establishments.
- [0040] In certain business establishments, the consumer application framework can also provide services **244**, that provide location information about each deployed service agent. The service can optionally provide a method to distinguish human and robotic service agents if needed. In certain implementations, location can be obtained through the global positioning system (GPS). The service can also optionally choose to track the consumer's location in order to expose certain functions.
- [0041] The consumer application framework should necessarily provide functions **246** to the consumer for controlling various levels of access needed by the service agents at any business establishment.
- [0042] Turning now to FIG. 8, the figure describes a high level process flow for consumers to interact with business establishments specifically employing service agents for delivery of items, in most cases consumables, to consumers in a hotel. The process begins at **260** by providing an application framework for the consumer to sign in or sign up. After authentication by the consumer **262**, the application environment exposes functions and services relevant to the particular

embodiments. This step particularly logs the information needed by the service agents, for instance their room numbers and names.

- [0043] Following exposure of available services offered by the business establishments, consumers can place request for delivery of requested items **264**, in their respective application environments **248**. This request is passed on to the robot interaction unit of the business through the framework cloud servers. In step **266**, the robot interaction unit checks for idle or nearest time to completion service agents using service **166** and assigns one to attend to the request.
- [0044] Following service agent assignment, the agent can in turn be required to reach the designated delivery pickup area or a service area on specific floors. By utilizing the robot communication services **240**, the service agent generates appropriate notifications for completing delivery request at step **268**. It can also involve a step where the consumer is able to communicate delivery confirmation through their application environments or through the service agent. The process ends at **270** after delivery confirmation is logged in consumer response database **168** for future reference.
- [0045] FIG. 9 shows an example of the framework rendered as a native application on a consumer's device. Relevant information like consumer's name, username and password are required for signup. In other embodiments of the application, other relevant information can be filled in optionally.
- [0046] FIG. 10 shows an example of the framework rendered as a web application that allows hotels to sign up for the services offered by the framework. Hotels can optionally enter their electronic menu in the system that is later made visible to the consumers checked in the particular hotel. These options form a part of the services offered by the hotel through their respective service agents.
- [0047] FIG. 11 shows an example of robot interaction unit provided by the framework as a web page, for interaction with service agents in a hotel environment setup.

WHAT IS CLAIMED

1. A computer-implemented method for providing end consumers an application framework, through the steps of:

Allowing users to sign up for the services being offered by the business.

Communicating with the cloud based central server via a URI using REST protocols or their extension, to activate application by consumer's choice.

Providing service appropriate to the embodiments of the RaaS through functions exposed by the application, for instance, hotel services, surveillance, domestic energy management, food delivery at tables or any RaaS application thereof.

2. A method of claim 1, wherein the user subsystem application is activated by the consumer or a third party using QR codes or other means of authentication like user login with password.

3. A method of claim 1, wherein the user subsystem has access to certain exposed functions of the robotic subsystem services through the application framework, that may be used to:

Control a plurality of robots for a certain action.

Subscribe to notification services by the robotic service subsystem.

View the data provided by the RaaS embodiment in any appropriate mobile computing device.

4. An extension of claim 1, wherein humans can also be a part of robotic service subsystem and communicate with the user subsystem, through an application interface running on their phones, tablets or any portable computing device.

5. A computer implemented method for business or robotic service subsystem side providing a control person:

Services to monitor requests pertaining to business specific robot embodiments in their installations, through a robot interaction unit.

Methods to control a robot or a plurality of robots comprising the IoR asynchronously for specific functions or complete manual override.

Services to generate notifications for subscribed active consumers for corresponding services in user subsystem.

Services to track the locations of robots deployed in the business installation.

6. A method of claim 5, wherein the robotic subsystem control persons can instantiate a number of robots through the application methods, resulting in

instantiation of a new service agent providing similar set of services as the other service agents. These service agents can refer to both robots and humans.

7. A method of claim 5, wherein the service agents deployed are able to communicate with the centralized system using wireless modules like WiFi, radio or GPRS.
8. A method of claim 5, wherein the service agents can be stopped or restarted without affecting the functionalities of other agents in the network.
9. A method of claim 5, wherein the service agents can communicate to the centralized system
Through a middleware service running on the business side centralized system.

Through the internet using URIs for each service agent in the robotic service subsystem.
10. A cloud based service that is responsible for exposing a subset of functionalities to the consumers in user subsystem as well as business entities in the robotic service subsystem.
11. A method of claim 5, wherein the robots register the state of their sensors to the cloud. This data is accessible to certain persons for monitoring any faults in the framework resulting from non-functionality, dysfunctionality.
12. A method of claim 5, wherein the service agents are able to share relevant information and data with each other through protocols defined by the business application interface.
13. A method of claim 6, wherein the business application framework allows business entities to dynamically deploy the service robots on a loan basis or as permanent installations.
14. A method of claim 10, wherein the application framework tracks and learns through a machine learning algorithm, relevant habitual information about the consumers like preferred consumables, food/drink choices, and/or others. This information is utilized by the service agents automatically when serving a consumer, irrespective of their location.