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NLP based intelligent conversational agents to Internet of Things

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Abstract— Internet of Things is an emerging and significant technology shaping the future that connects things or physical devices with internet. It allows intersection of various technologies to make it more intelligent and efficient. In this paper we focus on integrating intelligent conversational agents or chat bots with IoT. Literature survey presents various features, underlying technologies, applications and challenges of IoT. Greater numbers of intelligent conversational agents are being adopted due to major progress in development of frame works and platforms. This paper explains specific integration of intelligent conversational agents in IoT. We analyzed loopholes of existing IoT systems and present ways to tackle them by incorporating intelligent conversational agents. Architecture has been proposed in this paper for implementing system platforms and frameworks for both commercial and open source. We have identified newer challenges that takes place in future and took forward directions with this integration, all of these directions have been addressed.

***Index Terms*- Internet of Things, Intelligent conversational Agents, Software Agents, Conversational User Interfaces, Natural Language Processing.**

I. INTRODUCTION

Generally IoT aims to connect everyday objects to internet. It introduces objects an era of interconnection of smart objects or things which are developed upon existing internet architectures. IoT becomes easier by assigning unique IP address to things by using standard communication protocols, IoT interconnects all this things by various technologies and are able to interact with each other to reach common goals.

Various components of IoT implementation are sensors, networks , standards, intelligent analysis, intelligent actions.

1. Sensors: IEEE defined sensor as an electric device that produces electrical, optical or digital data derived from physical condition or event. Sensors produce some data which is then electronically transformed by other device into information that is useful in decision making done by intelligent devices. There are two types of sensors active sensors and passive sensors and are selected based on various factors such as purpose, reliability, accuracy and so on.

2. Networks: second step transmits the signals collected by sensors over the network with various components including Routers, Bridges, LAN, WAN, MAN. Different parts of the sensors are connected to internet by Wi-Fi, Wi-max, ethernet, Long Term Evolution(LTE), Li-Fi.

3. Standards: The third step includes sum of all activities of handling, processing and storing data collected from various sensors. There are two types of standards used for aggregation purpose Technology Standards and Regulatory Standards. These standards are selected based on the IoT application used.

4. Intelligent Analysis: Summarization of data from information obtained through the above process in an intelligent and effective way to extract important information.

5. Intelligent Actions: Intelligent actions can be expressed as Machine to Machine, Machine to Human interfaces.

Fig 1 Implementation components

The goal of connection various things is to create situational awareness so it enables machines and humans to make sense of the situations and surroundings. It has various applications in manufacturing medical and health

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care, agriculture, building and home automation, transportation and energy management among others. A report estimated that there will be over 20 billion connected things in activity by 2020 with Cisco estimating the number to be over 50 billion.

II. SCOPE OF INTERNET OF THINGS

The RFID group defines internet of things as "World Wide Network of inter connected objects uniquely addressable, based on standard communication protocols". ITU defines Internet of Things as "A global infrastructure for the information society, enabling advanced services by interconnecting (Physical and Virtual) things based on existing and evolving interoperable information and communication technologies". Broadly this paper presents perspective of connected things and their applications. Here we create a separate and specific connection between the fragmented lower Open System Interconnection (OSI)layers and adopted upper layers of IoT for communication. It uses World Wide Web and standard network protocols.

The IoT system consist of Sensors (light, motion, temperature etc.), Actuators (sound, displays etc.), Computation (programs and logic), and Communication interfaces (wired or wireless).By using web Application Programming Interfaces (API) in Hyper Text Transfer Protocol (HTTP) based Representational State Transfer(REST) architecture provides limited interaction with Internet of Things. The Evans Data Corporation (EDC) report says that more than half of IoT developers connect their devices primarily through cloud. There is huge growth in development of cloud platforms such as IBM IoT platform, Microsoft Azure IoT, AWS IoT and Cisco IoT. The new generation of IoT applications concentrate on cloud based platforms with lower layers. we propose use of cloud based platform in our architecture. Submit your manuscript electronically for review.

Scope of Intelligent Conversational Agents

In this paper we propose Intelligent conversational agents simply called as chat bots or bots. An agent is "A self-contained, interactive and concurrently-executing object, possessing internal state and communication capability". The software agents can be closely associated with chat bots. The key properties of software agents are

1. reactive
2. pro-active and goal-oriented
3. deliberative
4. Continual
5. Adaptive
6. Communicative
7. Mobile.

This paper proposes the solutions to challenges faced in IoT with the use of Intelligent Conversational agents, software agents or chat bots. Intelligent agents may not only be computers but also humans or anything capable of goal oriented behavior. Generally, chatbots are classified into two types (a)Chatbots that function based on rules (b)Chatbots that function based on artificial intelligence. Chatbots that function based on rules are limited to only predefined command that exist in the software programmed Chatbots based on artificial intelligence are "Intelligent" as they can understand Natural Language, not only predefined commands can be answered but also new commands can be answered smartly as they interact more due to the ability to maintain different states. Virtual agents and Inter Personal agents (IPA) are based on the concept of chatbots function with artificial intelligence, which uses Natural Language Processing and speech recognition techniques. Apple Siri, Amazon Alexa, Microsoft Cortana, Google Assistant are various examples. This paper presents combining two different technologies and produces solutions to the challenges facing in IoT through chatbots.

III. LITERARURE SURVEY

Generally, we use internet in our daily lives to search for information , to check emails, for entertainment, playing games and connect to social networks. Around 3.4 Billion (40%) currently using world wide web, By 2020 it is going to increase to 7.6 Billion users among which majority of devices are mobiles and wearables. Hence Internet alone cannot handle all the issues of IoT. First we discuss the challenges facing by IoT and then proceed to solve by choosing intelligent conversational interfaces.

A. Challenges of IoT:

A large number of connected things have already started to crate various problems in application, data and device management in IoT. Cloud based platforms are being offered to address these issues such as Cisco IoT,

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IBM IoT, AWS IoT. Data deluge is one of the problems extracting information from the data in timely and efficient manner. DIKW (Data, Information, Knowledge, Wisdom) knowledge hierarchy tackles the challenges as we move up to the pyramid because data gets smaller but we cannot make predictions on data. Here chatbots are used to solve the problems of data and information management by mainly addressing upper layers of DIKW pyramid.

Data Context: Huge number of things are connected through a network to IoT, conveying information to human about all the devices connected is a challenge. Here chatbots are used as intelligent agents and understands user query and process information in their environment. chatbots simply the way we consume data through large screens and have access to large amount of data to simple conversational interface which is capable of delivering intelligent information with in chat app.

Information Retrieval: IoT is connected to enormously large number of devices and makes user difficult to find relevant information. Chatbots can solve this problem effectively by responding quickly to direct queries with accurate information. Chatbots can also derive its own knowledge.

Device and Application management: Operating all the thing connected through a single remote is highly difficult task. For example let us consider as situation a smart light and refrigerator both the things belong to the same network and connected to different control terminals and are independent and cannot communicate with each other, it is challenge for IoT to operate those two devices from internet remotely. chatbots can act as heterogenous devices by controlling those devices at a time remotely.

B. Conversational user interfaces

There are more active users for IM services than any other internet application including social networks, mailing applications. There are more active users for IM services than any other internet application including social networks, mailing applications. This report shows how the top ten messaging platforms alone account for nearly 4 Billion users. The global acceptance of chat based interfaces allows for ease of adoption and diffusion of newer technologies built on top of the Advancements made in the areas of AI (Artificial Intelligence), especially NLP (Natural Language Processing) have futured the efficiency and quality of Chatbots in terms of its conversation simplicity, easy adaptability and capabilities in allowing the user to make complex requests through simple natural language. Fig

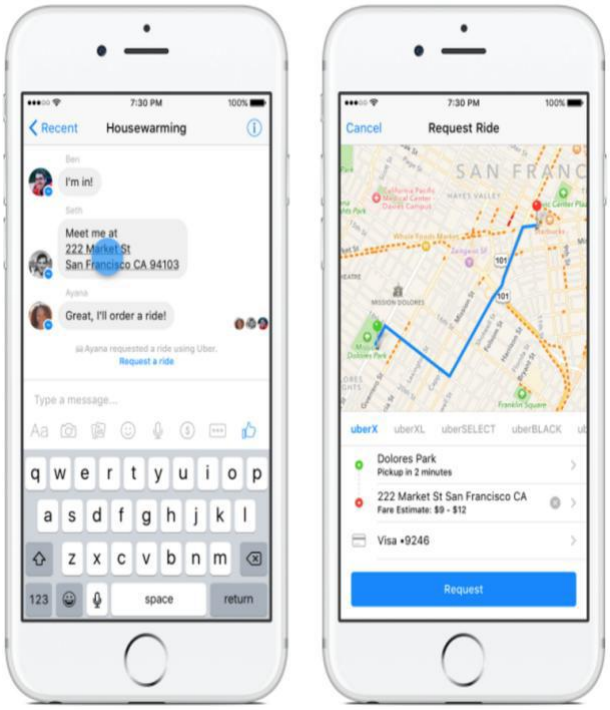

Fig 2:IoT chatbot conversation

IV. INTELLIGENT CONVESATIONAL AGENTS OVERCOME THE CHALLENGES OF IOT

These are the following examples

Use Case (1)

User :-"Turn on the lights in guest room"

Chatbot:-which light would you like to turn on lamp or table light?

User :-both.

Chatbot:-both the light are turned on.

Usecase (2)

User:-Help me set up my new device

Chatbot:-which device would you like to set up

1.smart kettle, 2.smart lock

User: 1

Chatbot:- Enter a pattern for smart lock

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User:- ******
Chatbot:- Lock has been set up.

V. SYSTEM DESIGN

It consists of IoT system and chatbot system which are connected

➢ ***IoT system:*** Uniquely identifiable IoT devices can be accessed and controlled using web API's. For example zetta is a platform through which users can create full-fledged IoT cloud based systems.

➢ ***IoT cloud platform*:** IoT systems deals with various fragmented technologies in embedded devices from protocol to various services and integrations. Our system access and control the embedded devices through API of cloud platform, irrespective of protocols and standards used in embedded systems. Various IoT platforms include IBM IoT, Azure IoT, Cisco IoT etc.

 chatbot system*:* These are the applications which are run on terminals and supported mobile devices. They are build upon instant messaging platforms. Popular chatbots are Facebook, Telegram, Skype, Line, Kik, slack. This paper explains integration of chatbots as text based inputs to IoT. By using software development kit we can integrate voice/speech/text based intelligent personal agents such as Amazon Echo and Google Home.

➢ ***Chatbot engine:*** Chat interfaces which are used in Instant Messaging (IM) platforms (Such as Facebook Messenger, Slack, Kik, and Telegram) have been immensely popular and continue to show steady growth. It is th most important component of chatbot. It is also called as Natural Language Understanding engine. It translates natural language to machine understandable action. Chatbot engines are highly complex and uses various techniques.

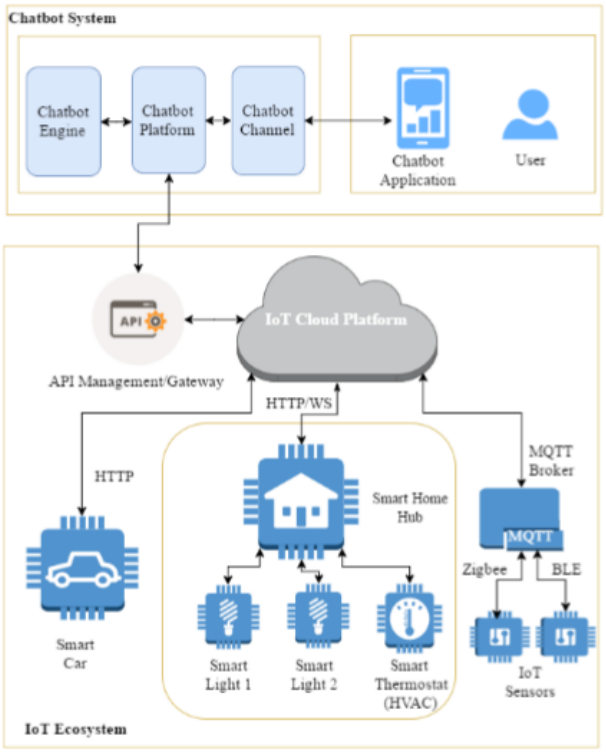

Fig3: proposed system of IoT chatbot system

Such as Natural Language Processing, Artificial Intelligence and Machine Learning to provide accuracy. the processing capability is offered by many companies as Software-as-a-service(SaaS), AI-as-a-Service that are applied to chatbot applications using APIs. For example Wit.ai, Microsoft LUIS.

VI. FUTURE WORK

This paper has put forward some of the challenges solved by using intelligent conversational agent. The research work has to be done on improved decision making, sharing of bigdata from millions of sensors improves the accuracy of the system instead of sharing nothing. Techniques such as human swarming has to be implemented as it sends real time feedback loops. Semantic web has to be developed to make system more efficient

A. Figures
Fig 1: implementational components of IoT
Fig 2: IoT chatbot conversation
Fig 3: proposed system of IoT chatbot system

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C. Abbreviations and Acronyms
IoT: Internet of Things
EDC: Evans Data Corporation
API: Application Programming Interface
OSI: Open System Interconnection
HTTP: Hyper Text Transfer Protocol
REST: Representational State Transfer Architecture
IM: Instant Messaging