Robotic Remote Surveillance and Control through Speech Recognition

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***Abstract*—**This paper deals with the remote based robotic surveillance system and control through speech processing. Robotic remote surveillance and control through speech recognition is a kind of simple Cyber Physical system. Cyber Physical system is connection between cyber world and physical world around us. Sensors in network map the physical parameters in digital, share the information with processors and CPS intelligently makes the decision after computing. Finally the decision command is translated into physical world by actuators. The speech commands from a user's distant location are carried over wirelessly to a multifunctional robot unit. Robotic arm over a base will act for voice commands sent over media. Desired surveillance will be facilitated by movement of robot and installed surveillance unit. Video stream feed to user is sensing of physical environment while actions of arm represent the role of actuator. This system used in the heavy industry in any environment.

Keywords- *speech recognition, robot, surveillance, control, cyber-physical systems, wireless transfer*

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I. INTRODUCTION

A cyber-physical system (CPS) is a system of collaborating computational elements controlling physical entities. Unlike more traditional embedded systems, a full-fledged CPS is typically designed as a network of interacting elements with physical input and output instead of as standalone devices. Cyber-Physical Systems (CPS) are integrations of computation, networking, and physical processes.

A system of collaborating computational elements controlling physical entities. It integrates physical devices, such as sensors and cameras, with cyber components to form an analytical system that responds intelligently to dynamic changes in the real-world scenarios. Embedded systems are connected and collaborated through the Internet of Things, providing wide range of innovative applications and services.

Sensors in network map the physical parameters in digital, share the information with processors and CPS intelligently makes the decision after computing. Finally the decision command is translated into physical world by actuators.

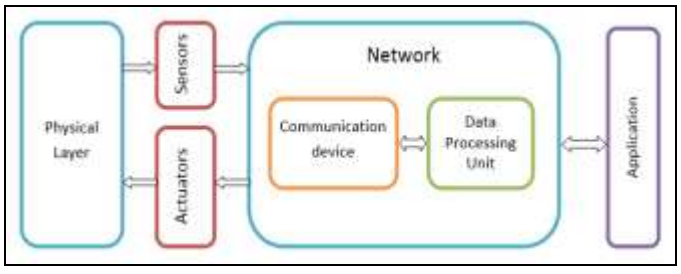

Figure 1. Block Diagram – Cyber Physical System

By merging computing and communication with physical processes CPS brings many benefits:

[1] Safer and more efficient system
[2] Reduce the cost of building and operating of the systems
[3] Build complex systems that provide new capabilities to physical systems

We propose a Robotic Remote Surveillance and control through Speech Recognition system which is simple kind of Cyber Physical System with data processing units, communication devices, sensors and actuators.

For performing communication between the machine and the human through speech, the intent is inferred through analysis on an embedded system; then human intent is translated into high-level robot control commands; robot performs the task under uncertain aim in the physical environment, where the effects are then observed by the human as an input for new decisions – closing the loop.

To capture a video signal at remote place where human interference is not possible or prohibited and perform its live streaming through wireless communication to the commanding controller

Facilitate the user to control the camera orientation and the movement of the robotic arm, to get desired surveillance and to perform desired actions through voice commands.

Such a project has huge applications both in domestic needs and industry. Speech commands to control the things in surrounding will prove to be very useful for handicapped people, bedridden patients. While wireless surveillance is

trending in business, industry has enormous need for remote monitoring and control in single package. So this project will prove to be significant.

In domestic sector the robot operated through speech recognition can be used as a care taker for bedridden patients and people with disabilities. It can also be used for performing various household chores like sweeping, gardening, serving etc. In the medical field, in case of highly infectious wards and epidemics where human interference is prohibitive, this robot can be used as a nurse. It can be used as waiters and servers at hotels. It has major applications in industries in security, maintenance and repairs sectors. This project has major applications in research sectors to explore extremely remote places, in laboratories where harsh conditions are required where human interference is impossible and harmful. It can be used to explore ores in the mines so that human lives are not compromised in case of any tragedies. Also, depending upon the applications ranging from full-fledged wars to covert operations, various sized robots operating on commands can be used in military and spyware.

II. LITERATURE REVIEW

The literature and survey in video surveillance systems is large. Traditionally, these systems were based on static sensor devices such as CCTV cameras. In recent times, surveillance drones and smart cameras are trending. CCTV cameras come with wired Connection. Considering the possibility of blind spots as CCTVs are stationary, they fail to perform detailed observation of area.

III. SYSTEM EXPLANATION

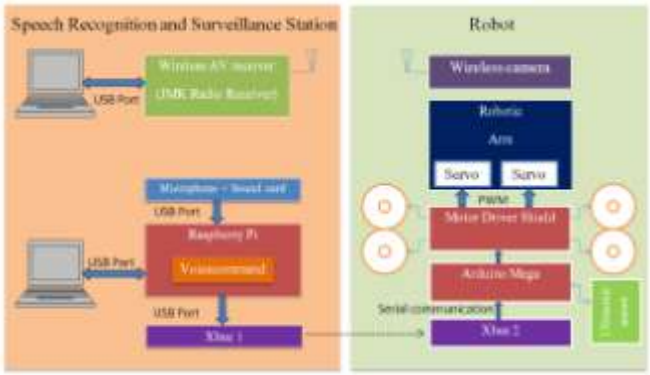

Figure 2. System Block Diagram

Xbee: XBee is a specification for Wireless Personal Area Networks (WPANs) operating at 868MHz,902-928 MHz, and 2.4 GHz. XBee modules are usually used in the application we used. It precisely falls in category of Monitoring and control.

Arduino Mega: Arduino is an open-source electronic prototyping platform allowing to create interactive electronic objects. We have deployed Arduino mega in this system as it has more GPIOs.

Raspberry Pi: Raspberry pi is a pocket-size computer based on Linux. We have used Raspberry Pi2 model B as a platform for speech recognition. We have used Raspbian which is a free operating system based on Debian optimized for the Raspberry Pi hardware.

Wireless AV camera and receiver : Wireless AV surveillance kit consists of wireless camera with antenna and wireless AV receiver with tuner at 2.4GHz frequency. The software used for displaying live video stream is TVHomeMedia3 on Windows7 Operating system.

The whole project is divided into two main parts as-
[1] Speech Recognition and Surveillance Station
[2] Multifunctional Robot

In the first part, Raspberry Pi 2 Model B is the main controller unit for speech recognition which is connected to Monitor display through HDMI to VGA converter and keyboard, mouse, USB sound card ,and Xbee Series 2 module though USB ports. We have installed the speech recognition software 'Voicecommand v3.0' by Steven Hickson on the Raspberry pi. Voicecommand v3.0 was developed for the Raspberry Pi but will work on any Linux system with a microphone attached. It is a crude program, which uses Google Voice API for speech to text conversion and basic comparisons to determine if your voicecommand has a format specified in a configuration file; if it does, it runs the corresponding Linux command. It supports auto-completion and variables as well as command verification, a continuous mode, and other options.

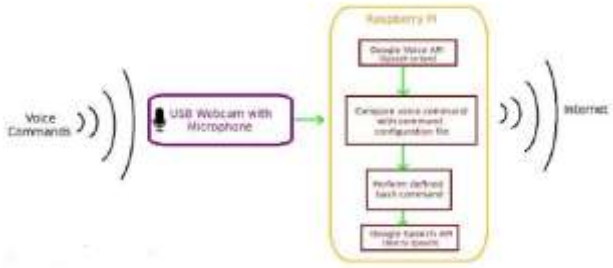

Figure 3. Working of Voicecommand software

Xbee S2 module is connected to Raspberry Pi to transfer the command wirelessly over to the multifunctional robot.

In surveillance station, we have connected wireless AV Receiver to another personal computer via Universal Serial Bus. To display the live video feed on the monitor, we have used TVHomeMedia3 software.

Multifunctional robot runs on Arduino mega microcontroller board. Adafruit motor driver shield is connected to Arduino mega to provide sufficient current for operation of robot. To carry out various operations by the robot, four DC motors (200 rpm) and two servo motors are connected to the motor driver shield. A moving arm is made up of servo motors to perform actions.PWM signal generated from Arduino board will enable the servo motors to rotate 0 to 180 degree. Pick and place task of robot is performed by robotic arm. Xbee S2 module is connected to the controller to achieve wireless intent transfer. A wireless camera is mounted on the chassis which is powered by 9V battery. The robot functions on a 12V lithium battery connected to Arduino mega board.

IV. SYSTEM IMPLEMANTATION

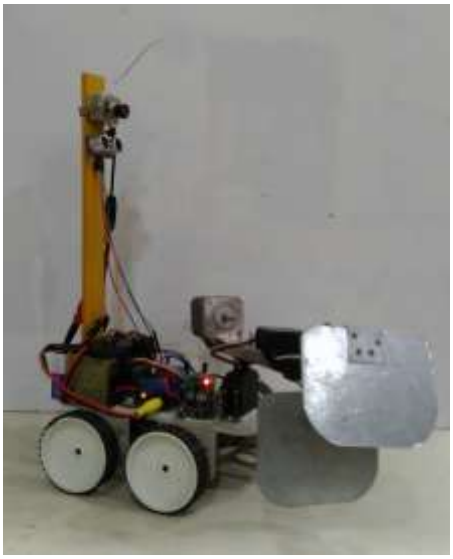

Figure 4. Multifunctional Robot

Figure 5. Live Video Streaming obtained by wireless camera

In the speech recognition unit of system, user can send the voice commands through the microphone attached to the USB sound card. The Voicecommand v3.0 converts the speech commands into text and executes the respective commands for that word. The respective programs corresponding to the given commands are written in Python shell. These programs then get executed and appropriate alphabet is sent to the robot wirelessly through Xbee module. The commands sent over Xbee are received by the Xbee module on the robot and microcontroller IC decodes them to perform various tasks. These tasks include various movements of robot such as pick and place actions of robotic arm and forward, backward, left, right movements of the robot. The camera mounted on robot continuously streams the live video feed. It is then received with the help of wireless AV Receiver on the other PC at surveillance station. Ultrasonic sensor module detects the obstacles in the path of robot and prevents the robot from any damage. When robot is performing some actions, a continuous video is transmitted wirelessly to surveillance station. By observing the system environment, the user at the remote end i.e surveillance station can send corresponding voice commands to perform required actions.

V. RESULT AND DISCUSSION

The most simple and trending human – machine interface i.e. speech is used to deal with the surrounding. This system offers the most cost-effective speech recognition platform. With the execution of this system surveillance and control are perfectly integrated in single package. The wireless surveillance provided under this system is simple as well as stands as best alternative to conventional wired CCTV surveillance.

VI. CONCLUSION AND FUTURE SCOPE

Robotic Remote Surveillance and Control through Speech Recognition comes with basic speech interface and offers wireless surveillance as well as control in a single package. It is creating just an interface between a single robot to a single controller. High memory is required to control and get required data from multiple robots. As the Raspberry pi supports very less memory compared to the size of the data sent by the robots. Hence, to eliminate this drawback, the Raspberry pi can be given web support. The data collected by the multiple robots can be stored in the Web server through the Ethernet supported by Raspberry pi. Thus, the data will be accessible through various control and monitoring devices through the Ethernet. Thus, there will be integration of human commands, computation and control through cyber systems, developing it into a fully-fledged Cyber Physical System.

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REFERENCES

[1] K.-F. Lee, "Context-dependent phonetic hidden markov models for speaker-independent continuous speech recognition", IEEE Transactions on Acoustics, Speech and Signal Processing, vol. 38, no. 4, pp. 599-609, 1990

[2] Hector Perez-Meana, Advances in audio and speech signal processing: technologies and applications, US: Idea Group Publishing, 2007

[3] HONG Qingyang, ZHANG Caihong, and CHEN Xiaoyang, " Embedded speech recognition system for intelligent robot, " Mechatronics and Machine Vision in Practice, IEEE Press, Dec. 2007, pp. 35-38

[4] Dwivedi S, Dutta A, Mukerjee A and Kulkarni P,"Development of a speech interface for control of a biped robot, " Proc. 2004 IEEE International Workshop on Robot and Human Interactive Communication, IEEE Press, Sept. 2004, pp. 601-605

[5] Suma Swamy, Manasa S, Mani Sharma, Nithya A.S, Roopa K.S and K.V Ramakrishnan, "An Improved Speech Recognition System", LNICST Springer Journal, 2013

[6] Eben Upton,Gareth Halfacree, "Raspberry Pi User Guide manual" 2012

[7] L.R. Rabiner, "A tutorial on Hidden Markov Models and selected applications in SpeechRecognition", Proceedings of the IEEE Journal, Feb 1989, Vol 77, Issue: 2.

[8] Nirmal T M, "Multipurpose Robot for Patients and Military Applications", International Journal of Electronics Communication and Computer Technology (IJECCT) Volume 4 Issue 4 (July 2014)

[9] Christian Hernández, Raciel Poot, Lizzie Narváez, Erika Llanes and Victor Chi, "Design and Implementation of a System for Wireless Control of a Robot " , IJCSI

International Journal of Computer Science Issues, Vol. 7, Issue 5, September 2010

[10] Taskeen Sultana and Zeenath, "Communication of Multi Mobile-Robots' Based On ZigBee Network ", International Journal of Science and Research (IJSR)

[11] S.Suresh, Y. Sindhuja Rao, "Modelling Of Secured Voice Recognition Based Automatic Control System", International Journal of Emerging Technology in Computer Science & Electronics (IJETCSE) ISSN: 0976-1353 Volume 13 Issue 2 – MARCH 2015.

[12] Prasanna G. and Ramadass N. , "Low Cost Home Automation Using Offline Speech Recognition", International Journal of Signal Processing Systems Vol. 2, No. 2, December 2014

[13] Istvan I. Papp, "Hands free voice communication with TV," IEEE Trans. on Consumer Electronics, vol. 57, no. 2, pp. 606-614, May 2011.

[14] M Alkin, J., Li, X.,And B Ilmes, J. , "Energy and loudness for speed control in the Vocal Joystick", Automatic Speech Recognition and Understanding (Dec. 2005), pp. 409–414

[15] S Porka, A. J., and SlavikP. , "Vocal control of a radio-controlled car", ACM SIGACCESS Accessibility and Computing, 91 (2008), 3–8

[16] Dr. R. V. Dharaskar, S. A. Chhabria, Sandeep Ganorkar, "Robotic arm control using gesture and voice",International Journal of Computer, Information Technology & Bioinformatics (IJCITB) ISSN:2278-7593, Volume-1, Issue-1, 2013.

[17] Mr. Sabarish Chakkath , S.Hariharansiddharath , B.Hemalatha, " Mobile Robot in Coal Mine Disaster Surveillance", IOSR Journal of Engineering (IOSRJEN) e-ISSN: 2250-3021, p-ISSN:2278-8719, www.iosrjen.org Volume 2, Issue 10 PP 77-82, October 2012.