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Application of Internet of Things and Android Smartphone for Outdoor Exploration and Indoor Monitoring

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ABSTRACT: This paper presents the application of Internet of Things and Android to a robot for outdoor and indoor monitoring. Traditional method employed for building such a robot includes costly microcontrollers, sensors and communication modules which unnecessarily increase the cost and complexity of the system. Our project utilizes the Smartphone and Arduino microcontroller along with necessary sensors which satisfy all the requirements for the mentioned purpose. The Smartphone is an integration of all the sensors and modules and thus the use of Smartphone reduces the cost and complexity. The Robot can be controlled remotely using a Laptop or Tablet while the Smartphone provides live video to the user along with all the necessary sensor readings. The use of Internet for transmission as well as reception eliminates the range restriction and hence the Robot can be controlled from anywhere up to any range. Android gives the liberty to design any required application for outdoor exploration and indoor monitoring. Arduino provides easy interfacing with the Smartphone, Sensors and Android applications.

KEYWORDS: Internet of Things, Android, Arduino, Smartphone, Robot.

I. INTRODUCTION

The internet of information sources revolutionized the way we communicate in the world. The information sources and the humans are always connected through internet. In addition to connectivity anytime and anyplace for anyone, we will soon have another dimension in the world of information and communication technologies. The Internet of Things or IoT, is made up of smart objects such as today's mobile phones, tablets, alarm systems, home appliances and industrial machines that are always connected to the internet. In the near future they will all be always connected to each other through an internet of networks. The Internet of Things (IoT) is the network of physical objects devices, vehicles, buildings and other items embedded with electronics, software, sensors, and network connectivity that enables these objects to collect and exchange data. Experts estimate that the IoT will consist of almost 50 billion objects by 2020 [1].

Outdoor exploration implies obtaining information and details about the outdoor environment. Today outdoor exploration has become an integral part of research activities and surveillance operations . Usually the exploration is carried out for the places where humans cannot reach or it is too risky for human beings to go and obtain information. Areas such as country borders, enemy territory etc are the places where continuous surveillance and exploration is required at the same time if a hostage situation comes then exploration becomes an important part of the rescue operation. Generally for exploration and observation purposes a CCTV (Closed Circuit Television) Cameras are used. Spies and soldiers are sent to the sensitive places and areas to gather the information. In the above methods there are too many risks and flaws. In case of CCTV camera it is very easy to fool it and also they have blind spots. Similarly it is very dangerous to send humans to risky places and hence humans cannot always be used to acquire information from such places.

In such cases a robot equipped with all the necessary instruments could provide a great help. A robot having a camera and necessary sensors can go in the outdoor environment and can provide all the necessary information [2]. It can monitor the important places and can also go to the risky and sensitive places. By using robots for the mentioned purpose many precious human lives could be saved as one can get all the information and data without going to the risky place.

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Indoor monitoring has become an integral part of our lives. This is required in homes, garages, warehouses etc. Today indoor monitoring is also required in factories and industries. Indoor monitoring involves the measuring the indoor environment parameters and keeping a check on them. For example it may be required to monitor the room temperature of house or the temperature of a certain warehouse where it is necessary to maintain a particular temperature and humidity level for the goods stored. Indoor monitoring has been very difficult to implement until Internet of Things came into picture. Internet of Things is a network of physical devices embedded with electronics, softwares, sensors and network connectivity. Using this new technology the indoor environment can be easily monitored and controlled.

For Indoor monitoring purpose robot can be mounted with sensors and communication modules to measure the Indoor parameters and report the user if the parameters increases or decreases beyond the threshold mark.

Thus our main goal was to make such a robot that will be perfectly fit for both Outdoor exploration and Indoor monitoring purpose.

II. RELATED WORK

Internet of Things has proven to be a boon for Outdoor Exploration and Indoor Monitoring. A lot of research has been done for transmitting live video, wireless control system of robots to establish long range communication. The most common method is to use a wireless camera along with costly sensors and mount them on the robot to get the live video and other environment parameter details. The robot is controlled either with Bluetooth or Zig-Bee.

For improving the communication range GSM has also been explored through the use of DTMF feature[2]. Some have also used GSM module to control the robot and to use the features like SMS and phone call [3]. A spy robot using GSM technology has been implemented with additional feature of wireless charging [4]. An autonomous robot for indoor surveillance has been built which builds the map of environment, self localizes and operates autonomously but requires Laser Range Finder, RFID (Radio Frequency Identification) and Vision Data to do the job [7].

III. PROPOSED SYSTEM

Our system includes a four wheel robot, driven with differential drive mechanism with an Android Smartphone stacked on the it. The Smartphone has various necessary Android applications installed. The robot is embedded with Ultrasonic sensor, Temperature, Humidity sensors. A Laptop or Tablet is used to control the robot remotely over the Internet. Arduino microcontroller controls the robot's motion, sensors, and other essential hardware. The robot connects to the Smartphone via Bluetooth which is accomplished by the Bluetooth module and to the Internet via Wi-Fi module. The robot is provided with a battery to power Arduino, Sensors and the Smartphone. Fig. 1. shows an overview of the proposed system.

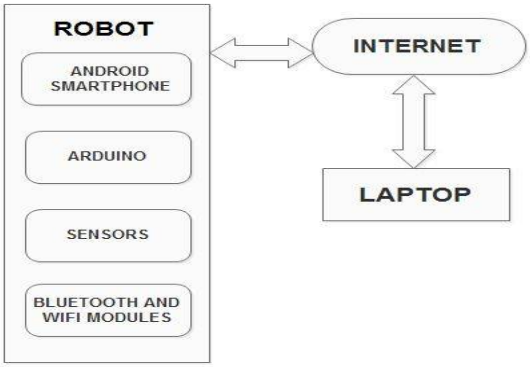

Fig. 1. Overview of System

In our systems, the Arduino controls the robot's motion and all the sensors. Arduino connects to Internet via Smartphone's Hotspot with the help of Wi-Fi module. The control signals are transmitted to the Android Smartphone from the Laptop via Internet. The Smartphone has an Application running which receives the control signals, these

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signals are then transmitted to Arduino via Bluetooth module and then Arduino moves the robot in the respective direction.

The sensors readings are taken by the Arduino and are transmitted to the Internet with the help of Wi-Fi module. The Smartphone also has an Application running which captures the live video of the scene and transmits it back to the user via Internet. The user can also view the Smartphone's sensor readings. The user can thus easily navigate the robot in Outdoor environment as well as monitor the Indoor environment. On the Laptop user can see the live video feedback, control the robot's motion and can see the live readings of sensors.

IV. SYSTEM DESCRIPTION

The system consists of a robot and a controlling device which could be a Laptop or a Tablet. A detailed block diagram is shown in Fig. 2. The robot has four wheels and a uses a differential drive mechanism to move forward, backward and take left or right turn. The distance between the front and back wheel is kept minimum. This mechanism offers better traction and zero turning radius.

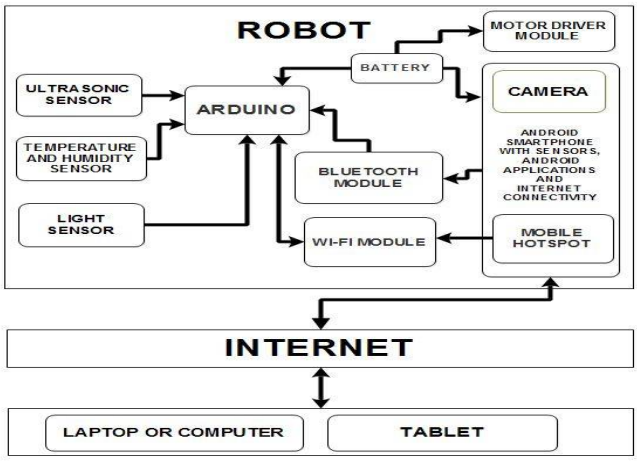

Fig. 2. A Complete Block Diagram

A. *The Arduino:*

Microcontroller used here is Arduino UNO board. The UNO is a microcontroller board based on the ATmega328P. The Atmega328 has 32 KB (Kilo Bytes) of flash memory for storing code. It has also 2 KB of SRAM (Static Random Access Memory) and 1 KB of EEPROM (Electrically Erasable Programmable Read-Only Memory). The board has 14 digital input/output pins, 6 analog inputs, a 16 MHz (Mega Hertz) quartz crystal, a USB (Universal Serial Bus) connection, a power jack, an ICSP (In-Circuit Serial Programming) header and a reset button. It contains everything needed to support the microcontroller. The UNO can be programmed with the Arduino Software [12].

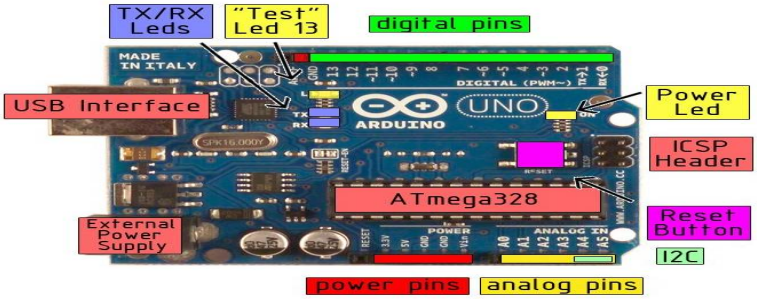

Fig. 3. The Arduino

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B. *Android Smartphone*

A standard Android Smartphone with Bluetooth, Internet and Camera is used. The Smartphone serves as a medium of Internet for Arduino via a Hotspot. The Smartphone's camera captures the live video and transmits it to the user over the Internet. The Smartphone connects to the Arduino via Bluetooth and thus transfers the user commands to it. Its inbuilt Sensors help to gather the information of environment. The Android Platform gives the freedom to make custom applications to control Arduino board and thus the robot. Smartphone stacked on robot can also be used to get live audio data as well as to send the same via Internet or GSM call. The use of Smartphone thus eliminates and reduces the cost and complexity.

Fig. 4. Android Smartphone

C. *The Wi-Fi Module*

The ESP8266 Wi-Fi Module is a self contained SOC (System On Chip) with integrated TCP/IP (Transmission Control Protocol/Internet Protocol) protocol stack that can give any microcontroller access to Wi-Fi network. Each ESP8266 module comes pre-programmed meaning, it can be simply hooked up to Arduino device to get Wi-Fi-ability. This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices [13].

Fig. 5. ESP8266 Wi-Fi Module

D. *The Bluetooth Module*

The HC-05 is the Bluetooth module used in the system. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps (Mega bits Per Second) Modulation with complete 2.4GHz (Giga Hertz) radio transceiver and baseband. It uses external single chip Bluetooth system with CMOS (Complementary Metal Oxide Semiconductor) technology and with AFH(Adaptive Frequency Hopping Feature). Bluetooth module is used for converting serial port to Bluetooth [14].

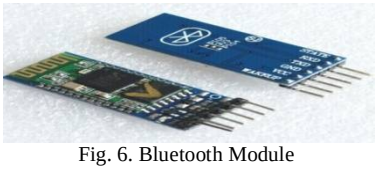

Fig. 6. Bluetooth Module

E. *Motor Driver Module*

The L293D Motor Driver Module is used to drive the motors of the robot. This is a 2-Channel motor driver module, a compact board that can be used to drive small robots. This module has two independent motor driver chips. The board can be operated from 2.5V (Volts) to 12V enabling this module to be used with both 3.3V and 5V microcontrollers. A PWM (Pulse Width Modulation) signal is used to control the speed of a motor and a digital output is used to change its direction.

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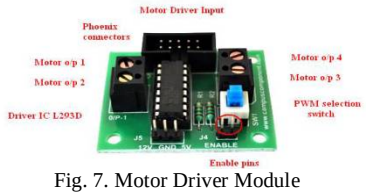

Fig. 7. Motor Driver Module

V. SENSORS USED IN THE ROBOT

A. *The Ultrasonic Ranging Module*

The HC-SR04 ultrasonic sensor uses sonar to determine distance to an object like bats or dolphins do. It offers excellent non-contact range detection with high accuracy and stable readings in an easy-to-use package. From 2cm to 400 cm. Its operation is not affected by sunlight or black material like Sharp rangefinder's are. It comes complete with ultrasonic transmitter and receiver module. This module is used for finding the distance of target from the robot [15].

Fig. 8. Ultrasonic Sensor.

B. *The Temperature And Humidity Module*

DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and NTC temperature measurement component, which connects to a high-performance 8-bit microcontroller, offering excellent quality, fast response, anti interference ability and cost-effectiveness. This sensor is used in robot for measuring temperature and humidity[17].


Fig. 9. Temperature and Humidity Sensor

C. *Accelerometer Sensor*

DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and NTC temperature measurement component, which connects to a high-performance 8-bit microcontroller, offering excellent quality, fast response, anti interference ability and cost-effectiveness. This sensor is used in robot for measuring temperature and humidity during rescue operation [18].

D. *Magnetometer Sensor*

This sensor is able to detect magnetic fields. The magnetometer is one of the sensors that compass applications use to point at the planet's north pole. Applications made to detect metal use this sensor as well [18].

E. *GPS Sensor*

Location sensors detect the location of the Smartphone using either GPS, Triangulation of cell towers**,** Wi-Fi networks (with database of known locations for towers and networks) or location of associated cell tower or Wi-Fi network [18].

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VI. CIRCUIT DIAGRAM

The Circuit diagram has been made in Fritzing.

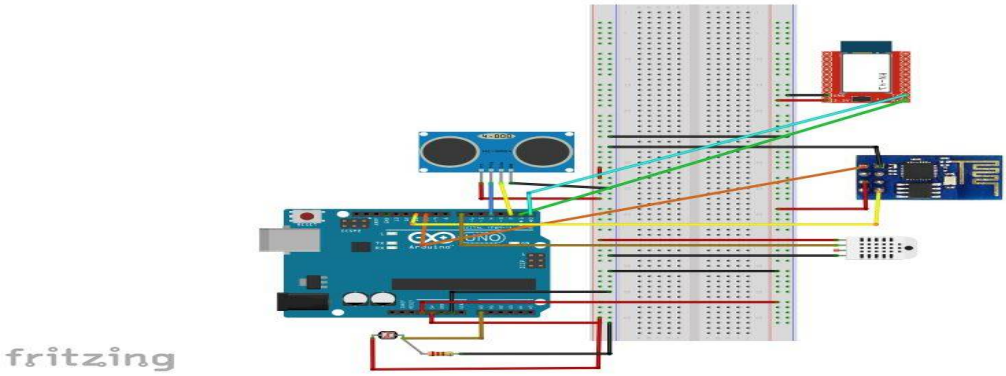

Fig. 10. Circuit Diagram..

VII. RESULTS

A *The Live Video Feedback.*

For getting the live video at the user end we have used a freely available application on Google Playstore named IP Webcam. IP Webcam turns Smartphone into a network camera with multiple viewing options. One can view camera on any platform with VLC player or web browser. For Indoor and Outdoor applications when user is within the range of the Wi-Fi, the live video can be seen by putting the IP address in the browser But when using mobile Internet the live video could be seen at Ivideon Cloud Service. There are various other application available like Ustream and Alfred but IP Webcam provides best video quality compared to others and it also works on any browser. Fig. 11 shows the live video snapshot taken from laptop where the video has been taken from IP Webcam.

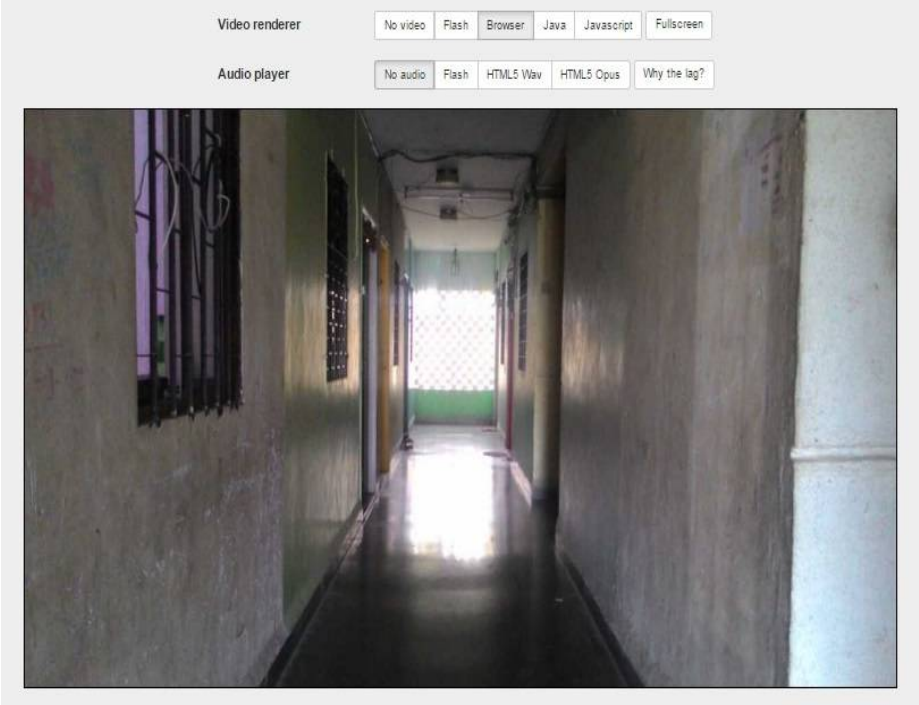

Fig 11. Live Video Feedback.

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B. *Robot Control over the Internet.*

For achieving the smooth control and to remove the restriction of controlling range we have used the Internet. We have used Mobizen Application both on the Android Smartphone and the Laptop. Mobizen allows the mirroring of Smartphone over the Internet on any device. This application works on Wi-Fi as well as mobile Internet. Thus the user gets the control of the Smartphone via any Laptop or Computer.

For controlling the robot we have made an Android application which connects with the Bluetooth module on the Robot. The command are sent from the application to the Arduino and then Arduino drives the Robot. The Android application is controlled via user over the internet thus allowing the remote access to the Smartphone and also to the Robot.

Fig 12. Android Application

The Application has Bluetooth connectivity, a browser to view the live video feedback if the user want to control and view with the help of a Tablet.

C. *Smartphone Sensor Readings on the Internet.*

The IP Webcam captures the live sensor readings and displays the graph on the Internet to the user. Sensor readings of Accelerometer, Magnetometer, etc and various other reading graph is available to the user.

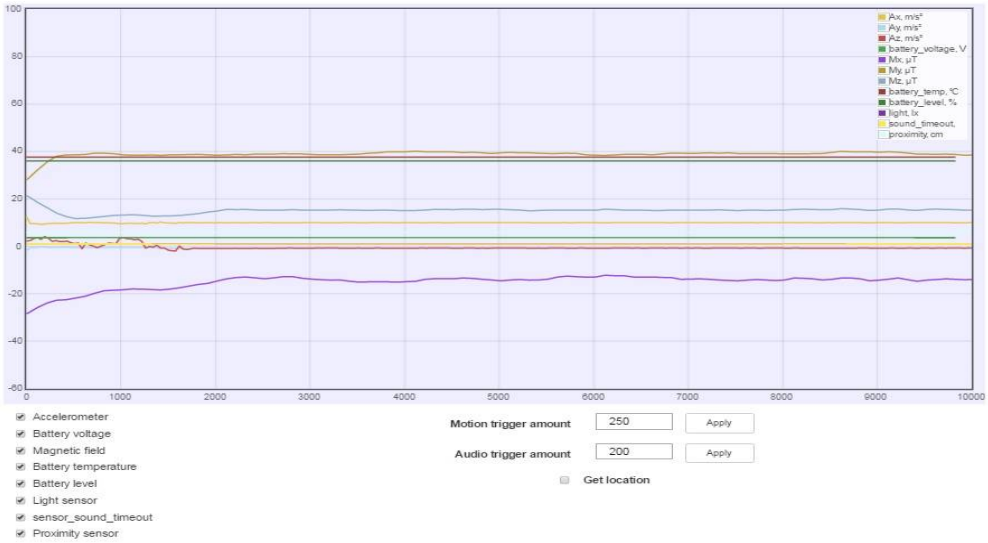

Fig 13. Smartphone Sensor Readings

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D. *The Ultrasonic sensor reading*

The Ultrasonic sensor measures the distance from the target and sends it to the Arduino which then calculates the target distance and sends it to the Android Application running on the Smartphone. The user can view the distance on the laptop by mirroring the Smartphone.

Fig 14. Ultrasonic Sensor Reading

E. *Temperature, Humidity and Light Reading.*

We have used temperature and humidity sensor to measure the respective parameters; for measuring the Light Intensity we have build a circuit using LDR, the Arduino will measure the light intensity and read the temperature and humidity readings and send it to Thingspeak channel over the Internet using the Wi-Fi Module. User can log in to the account and can view the reading anytime and anywhere.

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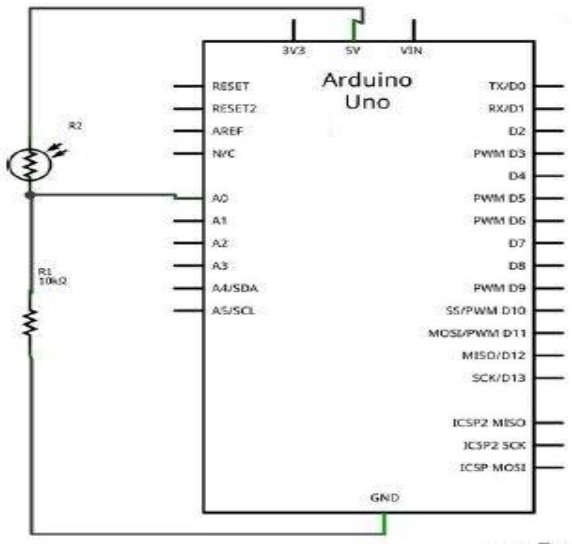

Fig 15. Light Measurement Circuit

Fig. 15 shows the circuit diagram for measuring the light intensity which consists of Arduino, a resistor and Light dependent resistor. Arduino measures the light intensity and sends the reading to Thingspeak cloud using Internet.

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Fig 16. Temperature Reading

Fig 17. Humidity Reading

Fig. 16 shows the temperature reading along with the date and time on Thingspeak cloud. Thingspeak collects the readings and plots them with Time on X axis and Temperature on Y axis. The plot helps the user to observe and analyze the variation in temperature over a certain period of time. Fig. 17 shows the plot of Humidity reading taken with the help DHT11 sensor. The X axis is Time and Y axis is Humidity.

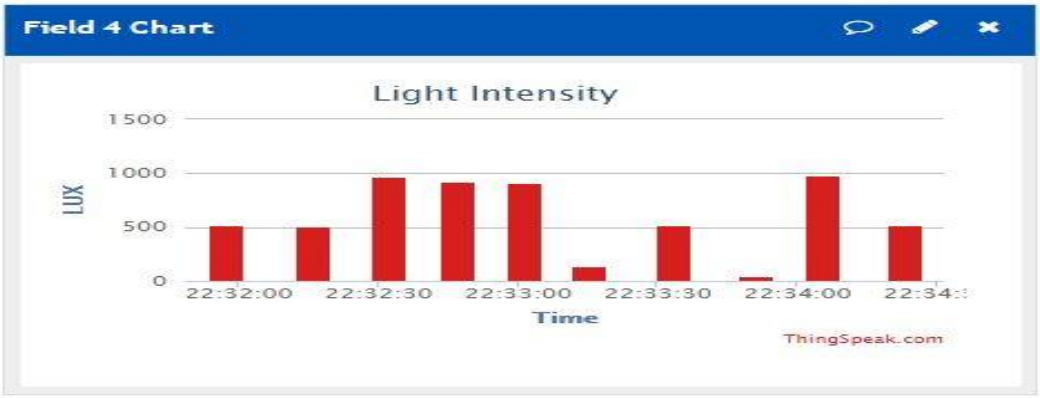

Fig 18. Light Intensity Readings

Fig 18. Shows Light intensity readings taken and collected at various time intervals. The plot shows variation of light intensity during the time period.

Thus the sensors measures the respective parameters and sends it to Arduino, the Arduino then sends it to the Thingspeak cloud via Internet. The user can monitor the readings anytime and anywhere and can take necessary actions.

VIII. CONCLUSION AND FUTURE WORK

Our project provides a cost effective Robot for exploration and monitoring purposes. The system has all the required sensors and accessories. The use of Smartphone solves the problem of limited controlling range, provides easy and portable Internet connectivity to the Arduino microcontroller.

Android platform the liberty to build and use Android applications as per the need. The robot can be easily controlled remotely with the help of a laptop or a Tablet over the Internet.

For Outdoor exploration it can go to any location and can sent the live video of the place. The sensor values are available to the user.

For Indoor monitoring it can monitor the indoor environment. The user can have the live view of the surrounding as well as the sensor readings. The Arduino can be programmed and an Android application can be made to alert the user via a phone call or short message if any particular environment parameter exceed the threshold value.

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The project offers a lot of scope for adding newer features and sensors. We can program the robot such that it can detect objects and reach them on its own. Thus, we can make it completely autonomous. The wheels can be replaced by tracks thus making it possible to explore hard to reach locations. The body can be improved and sealed to provide protection and reduce the weight. A robotic arm can help the robot to pick up and collect the objects. Battery of both the Robot and the Smartphone can be kept at optimum level by Solar charging.

REFERENCES

1. Anup W. Burange, Harshal D. Misalkar, "Review of Internet of Things in Development of Smart Cities with Data Management & Privacy", in International Conference on Advances in Computer Engineering and Application (ICACEA), 2015 IEEE.
2. A. S. M. Zadid Shifat, Mohammad Shaifur Rahman, Md. Fahim-Al-Fattah, Md. Asadur Rahman, "A Practical Approach to Microcontroller Based Smart Phone Operated Robotic System at Emergency Rescue Scheme", in The 9th International Forum on Strategic Technology (IFOST), pp.414-417, 21-23 Oct. 2014.
3. M. Kumar, N. Kaushal, H. Bhute and M. K. Sharma, "Design of cell phone operated robot using DTMF for object research", in Tenth International Conference on Wireless and Optical Communications Networks (WOCN), Bhopal, 2013, pp. 1-5.
4. M.Balakrishnan, S.P.Jaya kumaran, S.Gowthaman, G.Rathana sabhapathy, "A Smart Spy Robot Charged and Controlled by Wireless Systems", in IEEE Sponsored 2nd International Conference on Innovations in Information Embedded and Communication Systems, 2015 International Conference on, Coimbatore, 2015, pp. 1-4.
5. Saliyah Kahar, Riza Sulaiman, Anton Satria Prabuwono, Nahdatul Akma Ahmad, Mohammad Ashri Abu Hassan, "A Review of Wireless Technology Usage for Mobile Robot Controller", in International Conference on System Engineering and Modeling (ICSEM 2012, vol. 34 (2012), pp 7-12.
6. Donato Di Paola, Annalisa Milella, Grazia Cicirelli and Arcangelo Distante, "An Autonomous Mobile Robotic System for Surveillance of Indoor Environments", in International Journal of Advanced Robotic Systems, Vol. 7, No. 1 (2010), ISSN 1729-8806, pp. 019-026
7. Tomoaki Yoshida, Keiji Nagatani, Satoshi Tadokoro, Takeshi Nishimura and Eiji Koyanagi, "Improvements to the Rescue Robot Quince Towards Future Indoor Surveillance Missions in Fukushima Daiichi Nuclear Power Plant", in Springer Tracts in Advanced Robotics 92.
8. Sarath Chandran.C, Anjaly K,"Real Time Video Controlled Traction for Surveillance Robots in Coal Mines", in International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering, Vol. 2, Issue 1, January 2014.
9. P. Vanitha Sri, S. Sharmila, K. Karthik, "A Surveillance Robot for Home Security with Docking System", in International Journal of Science, Engineering and Technology Research (IJSETR) , Volume 4, Issue 11, November 2015.
10. Ujwala G. Meshram, Shubhangi Borkar, "Design and Implementation of Robot Motion with IR Wireless Camera", in International Journal on Recent and Innovation Trends in Computing and Communication, Volume 3, Issue 2, February 2015.
11. Chinmay Kulkarni, Suhas Grama, Pramod Gubbi Suresh, Chaitanya Krishna, Joseph Antony, "Surveillance Robot Using Arduino Microcontroller, Android APIs and the Internet", in First International Conference on Systems Informatics, Modelling and Simulation, 2014 IEEE.
12. Arduino Website [Online]. Available: https://www.arduino.cc/en/Guide/Introduction.
13. Sparkfun Website [Online]. Available: https://www.sparkfun.com/products/13678.
14. ArduinoInfo.Info Website [Online] Available: https://arduino-info.wikispace.com/Bluetooth-HC05-HC06-Modules-How-To
15. ElectroSchematics.com Website [Online] Available: http://www.electroschematics.com/8902/hc-sr04-datasheet.
16. Dht11 temperature and sensor module [Online] Available: http://www.uugear.com/portfolio/dht11-humidity-temperature-sensor-module.
17. M.Sc. Maximilian Schirmer, Jun.-Prof. Dr.-Ing. Hagen Hopfner, Smartphone Hardware Sensors, in mobile media group.