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Reviewing & Exploring the utility of Spy Robot's in Construction Industry

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ABSTRACT:Construction industry is a major provider for employment for around 16 percent of the population in India and contributes to more than 5% to the nation's GDP. The site monitoring & supervision on the construction activity plays a very important part during various kinds of construction projects. The complexity of modern day structures due to its unconventional work techniques, method's & other critical work circumstances; sometimes makes it very difficult for human beings to physically access the required location on site and observe the work. Lack of proper supervision can often lead to poor quality of work and may result into structural failure or some serious mishap. Also human life is also at risk if human's are required to access the risky site location's like on high elevation walls, high roof & ceiling structures, deep foundation pits, dark cramped up spaces etc. In such scenario's robots installed with Infrared and Night vision camera's and other related sensor's & equipment's can be deployed to carry out the task of site inspection & surveillance. Using Wi-Fi technology for communication the robots can be operated over long distances. Also with control of such robot's from over Android based Smartphone; the utility of these becomes much flexible and user friendly.

KEYWORDS: Building Construction, monitoring, Supervision, workmanship, Human Safety, Wi-Fi, Night Vision Camera, Node MCU, Android Smartphone, PIR sensor, Metal Detector, etc.

I.INTRODUCTION

The advancement of building materials and construction technology has enabled the modern day Architect's and Civil Engineers to design the most magnificent structures of variety of possible unconventional shapes & sizes and achieve great feat's in construction in shortest possible time.For such built structures; the construction process consists of creating very complex building elements involving various large & small structural and aesthetic members.

Construction is a labour-intensive sector involving large amount of manpower for various activities & process which further requires much amount of monitoring & supervision by the architect's, site engineer's & supervisor's for achieving required workmanship & quality of work. Quality inspections are carried out in finished structures to ensure that the final outcome confirms with the required standard of quality and finish as required.

Before, during, and after a construction project, many assessments require the review of a worksite and surrounding area. Limited surveillance is also necessary for supervising workers and securing the site. In addition, project managers and supervisors must walk the site to conduct final inspections.

Apart from the difficulties faced by the construction industry the two factors safety and quality have been the major determining factors for the outcome of the construction projects. Due to faulty construction works and unsafe working conditions, the works have to be demolished and rebuilt leading to loss in labour time and escalation of cost the project.

In the situation as such the advancement of technology in recent years that have been found to be playing a major role across sectors such as manufacturing are finding their way into construction industry. Robotics and automation which has been the crux of scientific developments for the last century has been playing a major role in all other sectors except construction. A process to apply the same technologies in this field also will greatly benefit the outcome of construction activities

This paper deals mainly with the utility of Ground based surveillance robots and feasibility of its application in construction industry with aim to improve safety and quality standards in construction using Wireless Night vision camera technology.

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II.LITERATURE REVIEW

Application of automation and robotics in construction work execution
Author: Zuzana struková, Matej líška;
The paper discusses about the complexity of tasks on construction site and how robotics & automation can help the various construction activities. The construction of any building includes different stages of construction processes from earthworks, through construction of structure (concreting, frames assembly, walling etc.) to finishing works. Traditionally, the applied construction technologies within these stages are known as labour intensive and conducted in various dangerous situations. Moreover, problems relating to instability of labour force supply and the increasing labor costs are surfacing in the construction industry. It is desirable to lower the level of labor force dependence and increase efficiency by applying a specialized automation in construction sites. Hence, several researchers have intensively searched for suitable ways to introduce automation and robotics into construction sites.

Robotics and automated systems in construction: Understanding industry-specific challenges for adoption
Author: Juan Manuel Davila Delgado, Lukumon Oyedele * , Anuoluwapo Ajayi, Lukman Akanbi, Olugbenga Akinade, Muhammad Bilal, Hakeem Owolabi
This paper discusses about the ways in which robots can be used on construction site. Robotic systems and automation have proved to be very effective in other sectors for reducing labour costs while improving productivity and quality. Moreover, robotic systems can reduce injuries and free workers from conducting dangerous tasks. conventional construction methods have reached their limits and that automation and robotics technologies have the potential to address the productivity challenges of the construction industry. Robotics systems for construction were developed since the 1960s and 1970s at the same time when other industries started their automation, e.g. the automotive industry; however, the adoption of robotics in the construction industry has been very slow.

Terrestrial and autonomous vehicles:
This category includes terrestrial, aerial or nautical vehicles that can be piloted remotely, or which are autonomous (i.e. no conductor is required). These vehicles can be used for various tasks including

1) accessing extreme and dangerous environments, thus removing human workers from high-risk areas;
2) surveying and monitoring tasks; and
3) automated excavating, demolition and transportation of materials.

Terrestrial, aerial or nautical vehicles that can be piloted remotely or which are autonomous.

Construction robots may be involved in specific tasks, such as bricklaying, painting, loading, and bulldozing. These robots help to protect workers from a hazardous working environment, reduce workplace injuries, and address labor shortages

Many potential solutions rely on artificial intelligence and machine learning to deliver unprecedented levels of data-driven support. For instance, a driverless crane could transport materials around a worksite, or an aerial drone could gather information on a worksite to be compared against the plan.

Arduino based Spy Robot using Night Vision Wireless camera
Author: Vishwal Karad, Jasawini Pradhan, Meghana Patil, S.S. Jadhav.
This paper describes the Spy robot's utility to be operated at Night irrespective of the intensity of the available light. Also it explores the capability of fire & metal detection for such robot's.

Intelligent Spy Robot with Wireless Night vision camera using Smart Phone.
Author: K. Anil Bablu Louis, K.M.S.R. Tarun, T. Teja, B. Santhi Kiran.
This system is based on embedded systems and applicable software program that can monitor the surroundings. This system is developed using Bluetooth technology which can operate over a distance of 15.00 m.

Arduino controlled War Field Spy Robot using Night Vision Wireless camera and Android application.
Author: Jignesh Patoliya, Haarad Mehta, Hitesh Patel.
The main objective is surveillance of human activities in war field. The proposed robot is built to monitor war field using Wireless Night vision camera based upon Bluetooth technology and operated by Android application.

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Smart Phone based robotic control for surveillance applications.
Author: M. Selvam

This paper researches to establish control over wireless communication between mobile robot and Android GUI application. The main task elaborated here is to achieve control to surveillance robot through emerging Android technology.

Smart Phone controlled robot using ATMEGA328 microcontroller.
Author: Aniket R. Yeole, Sapna M. Brahmankar, Monali D. Wani, Mukesh P. Mahajan.

This paper explores the operating system of Android based smart phone program which can be developed effectively to control robots via Bluetooth connection.

III. SCOPE

The project managers and supervisor's conduct surveillance, surveying, and inspection;before, during, and after a construction project.Many assessments require the review of a worksite and surrounding area. Limited surveillance is also necessary for supervising workers and securing the site. In addition, project managers and supervisors must walk the site to conduct final inspections. Construction robotics and drones can help all of these processes.

Ground-based robots can survey a worksite and gather multiple types of data, depending on the sensors used. Augmented reality and virtual reality can enable operators to get a realistic and real-time feel for what the drones are seeing.Site inspection tasks take time and energy – and so a number of inspection robots are being developed which could help streamline the task. It is still early days for this technology.

Similarly, there are certain tasks in the construction activity that are repetitive in nature, like bricklaying, concreting, flooring, plastering etc. Repetitive tasks can often lead to fatigue & stress in humans. Also such tasks would consume much time for human's. Herein Robots can takeover humans for executing such tasks at an efficient accuracy and speed.

IV. REQUIREMENTS

4.1 Night Vision Camera

Night vision cameras are available in verity of types based upon in working range and image intensity. Night-useful spectral range techniques can sense radiation that is invisible to a human observer. Human vision is confined to a small portion of the electromagnetic spectrum called visible light. Enhanced spectral range allows the viewer to take advantage of non-visible sources of electromagnetic radiation (such as near-infrared or ultraviolet radiation).

Active infrared night-vision combines infrared illumination of spectral range 700–1,000 nm (just below the visible spectrum of the human eye) with CCD cameras sensitive to this light. The resulting scene, which is apparently dark to a human observer, appears as a monochrome image on a normal display device. Enhanced intensity range is achieved via technological means through the use of an image intensifier, gain multiplication CCD, or other very low-noise and high-sensitivity arrays of photodetectors.

4.2 Node MCU

Node MCU is an open source IOT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module. The term "Node MCU" by default refers to the firmware rather than the development kits. The firmware uses the Lua scripting language. It is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects, such as lua-cjson and SPIFFS.

4.3 Passive infrared sensor

A passive infrared sensor (PIR sensor) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. They are most often used in PIR-based motion detectors. PIR sensors are commonly used in security alarms and automatic lighting applications.

When a PIR sensor is configured in a differential mode, it specifically becomes applicable as a motion detector device. In order to implement this output signal for a practical triggering of a load such as a relay or a data logger, or an Alarm device alarm, the differential signal is rectified using a bridge rectifier and fed to a transistorized relay driver circuit. The contacts of this relay close and open in response to the signals from the PIR.

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4.4 Metal detector

A metal detector is an electronic instrument that detects the presence of metal nearby. Metal detectors are useful for finding metal inclusions hidden within objects, or metal objects buried underground. They often consist of a handheld unit with a sensor probe which can be swept over the ground or other objects. If the sensor comes near a piece of metal this is indicated by a changing tone in earphones, or a needle moving on an indicator. Usually the device gives some indication of distance; the closer the metal is, the higher the tone in the earphone or the higher the needle goes.

Larger portable metal detectors are used by archaeologists and treasure hunters to locate metallic items, such as jewellery, coins, clothes button and other accessories, bullets, and other various artifacts buried beneath the surface. Similar metal detecting technology can be used in robots for use on construction site to identify metal in concrete structures.

4.5 DC Motor

A DC motor is any of a class of rotary electrical motors that converts direct current electrical energy into mechanical energy.DC motors were the first form of motor widely used, as they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.

4.6 Mobile Phones or Personal Computer

To operate and control the robot a versetile contorlling device would be required.By the conventional method a dedicated remote controller would have to be used. Such type of controllers would have restrictions of specific and limited utility because of it’s limited control buttons and would always be required to carried alongwith the robot everywhere. To overcome this issue the operation & control of the robot would be done through an Android based Smart phone which will be very easy to use and user friendly and can be upgraded as when required.

4.7 WebPage

To operate the robot from the mobile device it would require to have a very robust user interface which can be easily used over large range of devices & user’s. A web page over a compatible browser can be a good viable option for displaying various control options of the robot and getting the tasks done by it. A web page (or webpage) is a specific collection of information provided by a website and displayed to a user in a web browser. A website typically consists of many web pages linked together in a coherent fashion.

The core element of a web page is one or more text files written in the Hypertext Markup Language (HTML). Many web pages also make use of JavaScript code for dynamic behaviour and Cascading Style Sheets (CSS) code for presentation semantics. Images, videos, and other multimedia files are also often embedded in web pages.

Each web page is identified by a distinct Uniform Resource Locator (URL). When the user inputs a URL into their browser, that page's elements are downloaded from web servers. The browser then transforms all of the elements into an interactive visual representation on the user's device.

If the user clicks or taps a link to another page, the browser repeats this process to display the new page, which could be part of the current website or a different one.

From the perspective of server-side website deployment, there are two types of web pages: static and dynamic. Static pages are retrieved from the web server's file system without any modification, while dynamic pages must be created by the server on the fly, typically drawing from a database to fill out a web template, before being sent to the user's browser.

4.8 Arduino Compiler

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++.It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards.

The source code for the IDE is released under the GNU General Public License, version 2.The Arduino IDE supports the languages C and C++ using special rules of code structuring.

V. PROPOSED SYSTEM

5.1 Installation

All the components shall be installed upon Node MCU is an open source firmware for which open source prototyping board designs are available. Both the firmware and prototyping board designs are source. The firmware

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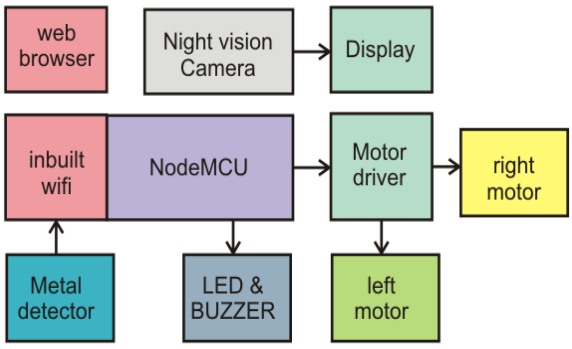
uses the Lua scripting language. The firmware is based on the eLua project, and built on the Espress if Non-OS SDK for ESP8266. The prototyping hardware typically used is a circuit board functioning as a dual in-line package (DIP) which integrates a USB controller with a smaller surface-mounted board containing the MCU and antenna.

This board attach night vision camera, this camera main use to capture day or night images. also this board connected passive infrared sensor and metal sensor, main use of this PIR sensor to sense any activity like human and animal this activity capture through the camera and providing signal through LED and BUZZER to smart phone.

Same as metal detector like bomb can detect that time buzzer sound is on to providing message through smart phone. This robot can be move with the base of DC motor.

5.2 Methodology

The camera captures the day or night image data which will be transferred to the display of android smartphone over Wi-Fi connection. A PIR sensor would detect any movement in the surrounding vicinity which would trigger a LED light would blink and a buzzer would beep and signal accordingly. The entire robot would be controlled through the android app on a smartphone over app's GUI control buttons.



Block Diagram

Surveillance robot mounted on metal tracks

More over the size & weight of the robot is also of prime concern as the robot will have to be made to operate at very small spaces and difficult terrain.

The overall assembly of the robot would be robust, water proof & shock proof so as to withstand critical working environments. The entire assembly shall have to be flexible enough so as to be mounted over wheelbase of varying size and terrains. The robot shall move over wheels or tracks as required.

VI.UTILITY

Robotic technology developed in this way can provide the construction industry with numerous advantages. Using robots forsurveying and monitoring tasks by making them accessextreme and dangerous environments, helps removing human workers from high-risk areas.With the goal of achieving increasing surveillance by robots the work can get done at a greater precision, accuracy, more speed and at cheaper costs.

Considering the difficult inaccessible location's and critical work situation's on the building & construction site like deep excavated ground surface, between close spaced walls, cramped up dark spaces within building elements like walls or shafts, or over high levels like metal roofing sheets over PEB structures, outer elevational projections of building or within metal ventilation ducts, utility ducts, false ceiling's etc.; such robots could easily reach such spaces and provide a proper view of the existing scenario and the constructed work. This would not only provide ease of vision to technical personnel's but also provides safety and convenience of observing remotely.

Also the Wi-Fi connection used for serial communication with the Android Smart phone will provide a robust & uninterrupted connection over longer range of distance efficiently and easily. The Android phone is available at cheaper cost and has a very user friendly interface making it easily operable by common user without much effort. Moreover,

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the robot can be operated by multiple android devices by various users without worrying to carry the remote controller along with the robot.

Also, there are many challenges to be addressed so that robots can be used effectively for construction, including: (i) high initial costs; (ii) low battery life, which restricts operation time; (iii) complex operability of hardware and software, which requires additional training and increases costs; (iv) false perceived levels of accuracy and tolerances, which could lead to errors and accidents; (v) stringent regulations that increase adoption costs; and lastly (vi) safety risk and hazard in case of malfunctioning of robots.

VII. FURTHER WAY AHEAD

With more advancement of technology, such robots can be enhanced by addition of more functions to it like metal detection, sonar ranging, etc.

Considering the advancement of technology over distant communications systems like IOT etc., the image feed of the camera can be broadcasted over remote devices over encrypted internet connection.

This could facilitate monitoring by other related officials without actually visiting the site location which could save much time, money and fuel.

Such robots could be mounted over drones to further provide access to higher and have an aerial view of the site.

VIII. CONCLUSION

Robotics can help all in the construction processes. Aerial drones and ground-based robots can survey a worksite at difficult & inaccessible work locations and gather multiple types of data, depending on the sensors used. Augmented reality and virtual reality can enable operators to get a realistic and real-time feel for what the Robots are seeing.The major difficulty of supervision and observation of critical components & building elements on construction site can be effectively overcome by use of such robots. The technology used is very user friendly and can be easily adopted widely.

As a highly unautomated industry, construction robots will have a major impact on the construction industry. While manual labour will likely always be a huge component of modern construction, technology has been steadily improving since the first pulleys and power tools. Robots, drones, autonomous vehicles, 3D printing, and exoskeletons are beginning to help get the work done.

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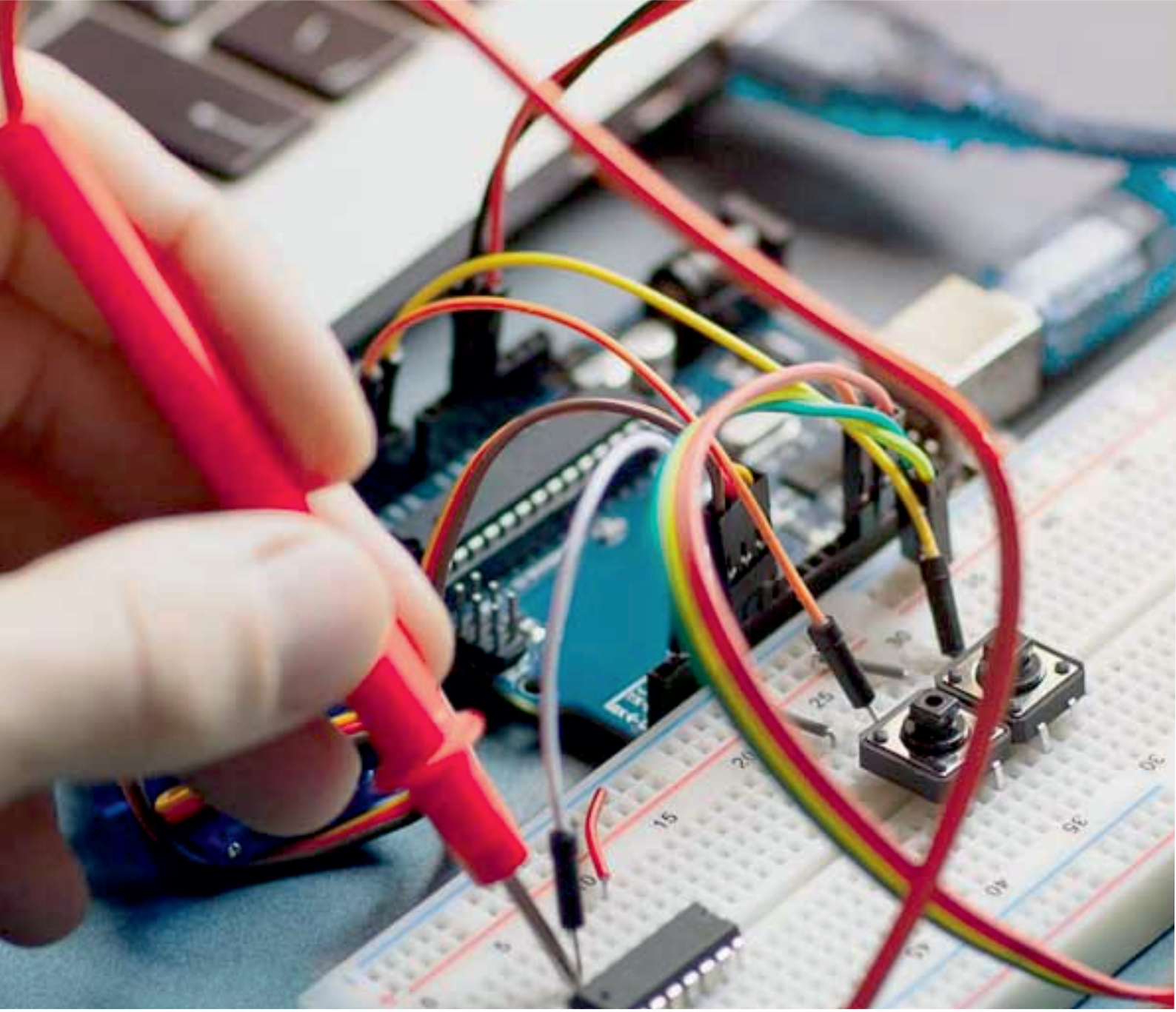

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