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DESIGN AND IMPLEMENTATION OF A MOBILE (WIRELESS) PHONE CONTROLLED ROBOT

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ABSTRACT

In modern technological innovation, robotics and artificial intelligence (AI) method are now applied to do our manual tasks. Robots are becoming common in our homes, public places, industries, entertainment, and relaxation centers hence, we need to control and monitor them for easy and suitable usage. In the research, we have not only proposed but developed a robot that can be controlled by mobile phones through which we can call for some emergency situations for the Fire brigade, Law enforcement agencies (Police, Army), National Emergency Management Agency (MENA), Area Guard so on. This mobile phone-controlled robot is powered by a 9V battery for the system circuit. Whenever the user calls the mobile phone, the call is received by auto-answer mode and as the call is ongoing, the user presses a button on his handset the tone that is generated is decoded by the DTMF decoder, and the command is passed to the pre-programmed microcontroller. The Microcontroller then processes the command signal which activates the motor driver ICs for motion. This system can also be useful in reconnaissance or surveillance and applicable anywhere the GSM network service is active. The designed system is compactable, robust, and cost affordable.

KEYWORDS:

Mobile Phone, Microcontroller, Robotand GSM Network.

I. Introduction

In recent time, ground breaking innovations are taking place in robotics field. Different types of robotic state of arts have taken place in 20th century which are aiming to assist more and more to the different human functions. The Oxford English Dictionary defines a Robot as a machine capable of carrying out a complex series of actions automatically, especially one programmable by a computer (Ben-Ari M. and Mondada F., 2018). Robots can be classified based on two (2) major criteria; environment/mechanism of interaction and application field. See figure 1 and figure 2 for better illustration.

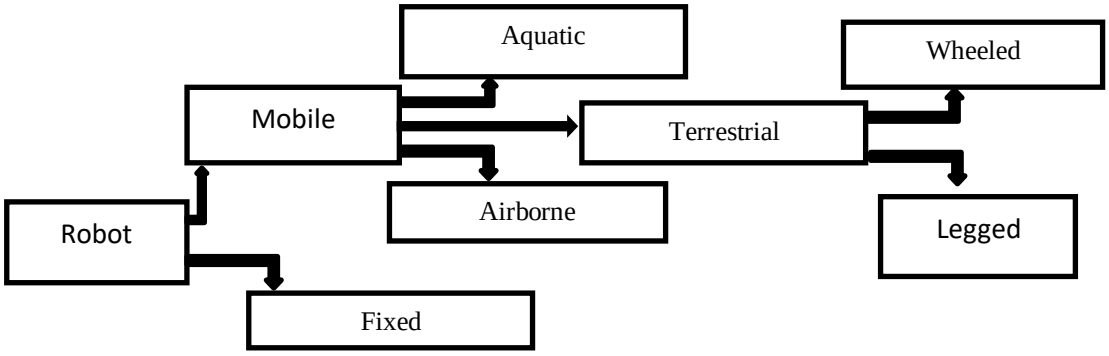

Fig. 1 *Classification of robots by environment and mechanism of interaction*

The Fixed robots comprise mainly of industrial robotic manipulators that work in well-defined and conditioned environments adapted for robots. Industrial robots have the ability to perform specific repetitive tasks such soldering or painting parts in car manufacturing plants. With the increasingly improvement of sensors and associated devices for human-robot interaction, robotic manipulators are increasingly used in less controlled environment such as high-precision surgery.

By contrast, mobile robots are expected to move around and perform tasks in large, ill-defined, emergency and uncertain environments that are not originally designed specifically for robots. They need to deal with situations that are not precisely known in advance and that change over time, especially in cases of emergency and security of life(Ben-Ari M. and Mondada F., 2018).

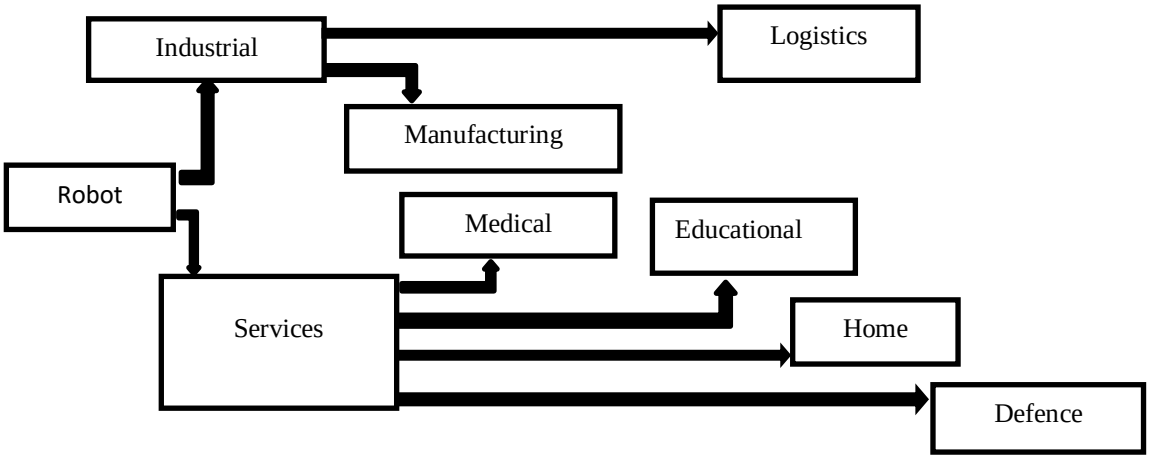

Fig. 2 *Classification of robots by application field*

Industrial robots are mostly used in order to facilitate manufacturing and improve quality of products. In this sector robots are developed for such application as connecting or joining, transportation of

materials, product packaging and other tasks. Robotics are now an evolving and accumulative instrument for practical life. Versatility, ingenious and accustomed with professional environment are fit with human operational daily activities whereas a robot is used as stand-in for humans to assist different tasks which are required to perform more sensible and on edge (Ctahar.blogspot.com. 2017).

Mobile controlled robot is a programmed machine which is inclined of assurance and reliability. For example, a local spying robot, pipe-line monitoring/inspection and bomb disposal being controlled by mobile device (phone) whose movements are directed by users provided direction. They are flexible to work in different locations and can serve around where the user directs.

These mobile controlled robots are controlled from a user end through a mobile phone. Within their power available locations; mobile robots are adjusted for seizing, grasping, or taking hold of something as their "Independence". Mobile Robot is composed of different types of major components such as a controller with application software, DTMF board, actuators, sensors and other associated devices. Above mentioned controller with its application software is written in high level languages like C, C++, Java, and Python.

Applied sensors in the mobile robot are dependent upon robots requirement which are mostly defined as proximity sensor to identify nearby objects, triangulation ranging for determination of location of a point, collision warning system by using radar or laser, dead reckoning functions to figuring out first starting point by using speed, direction, time and other specific parameters and methods.

To reduce the cleaning cost, robots are also used in different offices also. Cleaning robots can automatically organize their tasks without consuming extra energy. From all types of energy and financial consumption, cleaning robots are well performed and proved as cost efficient products. Due to having a huge contribution in economic sectors above mentioned mobile applications are now imperative for further development.

II. Review of Related Works

Related works have been done as seen in different publications and places such as industrial, medical, environmental, services robots, path planning and path optimization are available. According to one of the biggest scientific databases, ScienceDirect, more than 4500 scientific papers were published in 2019 using the term "Industrial robot" as a keyword and, in 2020, the number of papers with a similar interest and research direction increased to 5300 (ScienceDirect, 2021).

In medical sector, sensitive tasks are being handled by robots. In some cases, these operations may be limited but they are exceptional. In modern times, some surgeries are also being done by robots.In their work, YohannesKassahun et al. as cited by Kassahun, Y.; Yu, B.; Tibebu, A.T.; Stoyanov, D (2016), reviewed the role of machine learning techniques in surgery, focusing on surgical robotics. Surgery is not the only field in medicine in which robotic manipulators can be used. Another autonomous robotic grasping system, described by Downey, J.E., Weiss, J.M., Muelling, K. et al, (2016), introduces shared control of a robotic arm based on the interaction of a brain–machine interface (BMI) and a vision guiding system.

The broadest category is entertainment sector where robots are plays a vast and important role. In a research publication by SabeK. (2005), he X-rayed the technologies used in OPER-R. The OPER-R is a platform used by Sony to develop various types of robots, like quadruped robots, AIBO and humanoid robots QRIO and explained a new research technology called Intelligence Dynamics.

Another important area of robots application is in Path Planning and Path Optimisation. This specific area of application forms the basic foundation for this research. The process also known as robotic navigation aims to achieve accurate positioning and avoiding obstacles in the pathway. It is essential to satisfy constraints such as limited operating space, distance, energy, and time (Jose K., Pratihar D.K., 2016). The path planning and path optimization process comprises of these four major facets: *perception*, when the robot receives the necessary information from the sensors; *localisation*, when the robot aims to control its position in the environment; *path planning*; and *motion control* (Das, P.K.; Jena, P.K.,2020). The development of autonomous robot path planning and path optimisation algorithms is one of the most challenging current research areas. Nevertheless, any kind of path planning requires information about the initial robot position (Dzedzickis, A.;Subaciute-Žemaitiene, J.; Šutinys, E. et al, 2022).

In recent times, restaurants are also using robots as a cook and to serve food. In a publication by India, P. (2017), China also implemented 18 types of restaurants with robots where they are cooking and serving to customers. Dumpling and Noodle robots are also now used for serving dishes. Above mentioned robots are manufactured by local companies and definitely directed from remote area. Artificial intelligence-enabled robotic applications are entering the restaurant industry in the domain of food processing and guest service operations. In a review assessing the potential for process innovation in the restaurant sector, an information process for the use of new technologies for process innovation was developed (Blöcher, K. and Alt, R.., 2020). However, the year 2020, particularly due to the circumstances of COVID-19, it has been a break through year in robot application in the food industry(Dzedzickis, A.;Subaciute-Žemaitiene, J.; Šutinys, E. et al, 2022).

In another publication, famous car manufacturing company Ford Motor is using 92 robots in their Indian factory. The programs of these robots are sourced consecutively from ABB Company; Sweden and DURR Company in Germany. In order to fulfil this gradual demand, cost efficiency, cutting edge quality and flexibility, Ford India Company imported those robots (Narasimhan, T., 2017).

Agricultural sector is another viable sector where robots are capable of assisting farmers with a wide range of operations; seedling identification and sorting, planting, crop monitoring, weather analysis, weeding, harvesting etceteria. Their primary role is to tackle labour intensive, repetitive, and physically demanding tasks. In animal husbandry, robots are used for feeding cattle, milking, collecting and sorting eggs for birds and autonomous cleaning of pens. Cobots are also used in agriculture. These robots possess mechanical arms and make harvesting much easier for farmers (Dzedzickis, A.;Subaciute-Žemaitiene, J.; Šutinys, E. et al, 2022).

III. System Design Methodology

System Design: This research aims to design a robot that can be moved using mobile phones by pressing the button. In this system design, the mobile phone is used as a remote controller to operate the robot within the active operation of a mobile network. The Microcontrolleris interfaced with a DTMF Board and DC motor.The Microcontroller acts as the key part of the device who controls the whole system operation. As the signal is transmitted from a mobile phone through a mobile network, data is passed to the DTMF Board. It was fed while the button is pressed; to make an input to the controller. The signal from the DTMF decoder is transmitted to the Microcontroller which performs the function of input signal processing and activates the appropriate motor that drives the robots to the supposed direction. To realize and accomplish the task the controller is programmed using specified written program coded by 'Java' language. Figure 3 below shows a simple block diagram which illustrates this system operation.

The diagram below also shows the 9Volts power source which is used to power the Microcontroller and the DTMF Decoder IC.

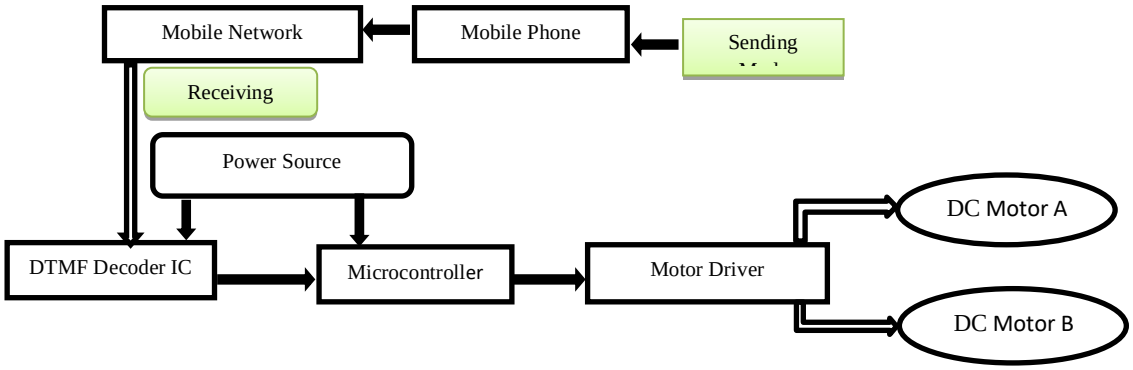

Fig 3: *Block diagram of Mobile Controlling Robot*

The model is organized based on a very simple and understandable working procedure. Firstly, turn 'ON' of the robot which makes use of a 9 volts power supply. This system programming made use of key 1 to 5 which correspond the different command for the direction of movement for the robot. In this regard, the selection of a particular key determines how the direction of the robot will be activated by the DC Motor via the microcontroller.

Mobile number should be dialled which is interfaced to robot at remote location to move. The mobile phone is automatically connected to Auto Answer option in mobile phone like two systems to operate. It is necessary to be ensured that DTMF tones sending facility should be in active mode for both mobiles to ensure the robot works in the desired way. After connection, the system becomes achievable to operate the robot using the keyboard in particular desired direction for making a process successful. Flow chart of the whole circuit is very helpful and explicit for perceiving the working principle of the given model. The operational flow chart for this simple system is shown in fig 4.

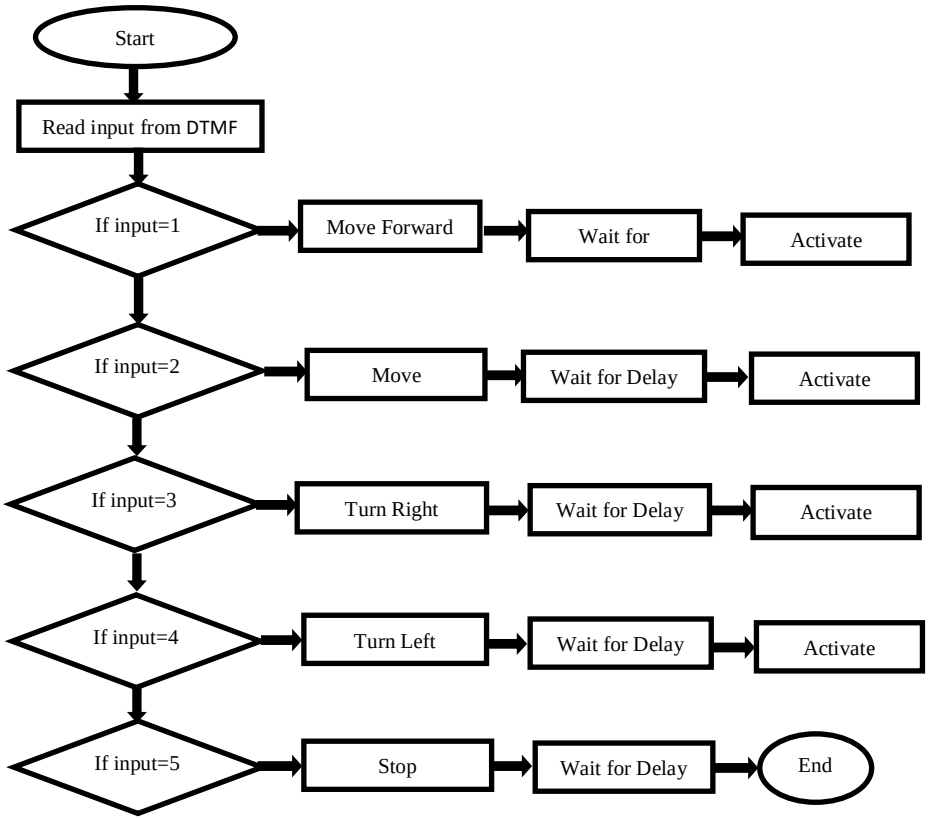

Fig 4: *Flow Chart for System Design*

System Setup: The main purpose of this system realisation was to build a communication between the mobile phone and provide the facilities to operate the robot physically from a remote location. This purpose is suitable for the places where mobile phone operational network is available and can be used for making the transaction easier to easier. The device is responsible for including two interface systems. One of these interfaces is applicable between the installed actuators and a transmitting mobile phone, the rest interface is actively operating between the receiving mobile phone and the robot device. The interface on the transmitting side would allow occurrence and encipher of signals appropriate for transmission with the application/usage a mobile device. The interface on the receiving side would activate the signals acknowledged by the mobile phone and regulate the robot device. The simple block diagram that illustrates the methodology of the system setup is in in figure 5.

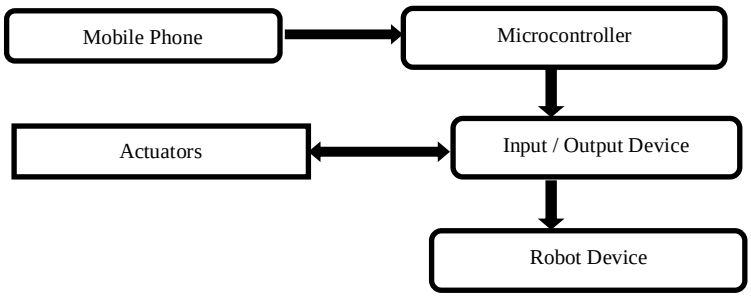

Fig 5: *Block diagram of System Interface*

IV. System Development and Implementation

The DTMF (Duel Tone Multiplexed Frequency) is the identical tones for various keys of the dial pad. When someone dials a telephone or mobile number, the keypad input will usually generate this DTMF tone. This tone helps to identify key numbers. In this system implementation, an IC that can detect this DTMF tone and decode the key number from tone is used. This IC is MT8870 DTMF decoder. This decoder receives signal input from audio output of a cell phone; it decodes the tone and sends output in BCD (Binary Coded Decimal) value. For this system implementation, the microcontroller deployed is PIC16F73B microcontroller. The system is configured to read the BCD code from MT8870 and then executing the rest of the work from that command. MT8870 has 4 output pins connected with 4pins of Port A, MCU is reading this 4pins of Port A as it decode the command. Whenever 'forward' command is detected, MCU triggers another driver IC named LM293D which is a duel motor driver IC. This LM293D is made up of 4 inputs, 4 outputs, 2 enable pins which are used to enable the channel. Input 1and 2 are associated with output 1and 2 and Enable 1 is responsible for controlling these two pins. When motor need to run forward, input 1 is high while input 2 is low for both motor. On the other hand when motor need to run backward, input 1 is low while input 2 is high. In this input manner, left or right turns are made. Figure 6 is the photo, showing the components of the developed system.

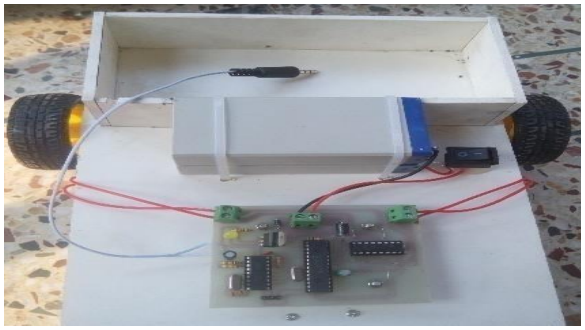

Fig 6: *System diagram*

Testing Robot Operation: The test running of our prototype system was carried out for an hour in a room which was approximately 300 metres. Our purpose was searching the different object through our device and we started with few different object places in different locationsof the room. We moved the robot from an initial point and kept a mobile phone attached with the device to connect with the robot from another phone. Then we controlled it (via mobile phone) to search those objects from the starting point as our requirements. In addition, we made effort to control it from different room and different spaces. While carrying out this project, we considered the following factors; call cost, internet data tariff, voltage power, time of searching and so on. At the end of the testing procedure, observation and analysis, it was cleared that during any disaster with this robot it will be possible to communicate with any location remotely.

V. COST ANALYSIS

Battery volt consumption:

We used 9volts battery to power our system which can perform about 36 hours. However, our system was monitored for only a hour.The table 1 shows the chart of using amount of voltage of our constructed device during monitoring time:

TABLE 1: *Voltage Consumption*

Time (Hours)	Voltage (Volts)
10	2.50
5	1.25
3	0.75
2	0.50
1	0.25

So during our experimental time we used 0.2 volt of 9 volt battery.

Time of searching:

We calculated the time required by our system for searching objects using relationship betweenvelocity (v), distance(s) and time (t).

$$V = s/t$$

So, $t = s/v$, where $V=3.55m/s$ for our dc motor.

We calculated this in different conditions such as

No Object: when there was a object in the room our system search the entire room for the object and it took 84.51 seconds to finish.

Object in free space: When there was no barrier we kept our object in closer distance and our system took 28.17 seconds to find the object.

Object hidden behind barrier: For last search, we kept an object in distance about 100 metres and we hided our system behind barriers that made the distance about 200 metres from the object. Finally our device took 56.34 seconds to search for it.

See summary of the table below.

TABLE 2: *Computation of searching time*

Parameter/Variable	Distance (Metres)	Velocity (m/s)	Time (Seconds)
No Object	300	3.55	84.51
Object in free Space	100	3.55	28.17
Object hidden behind Barrier	200	3.55	56.34

VI. Conclusion and Future Scope

This developed'**Mobile Controlled Robot'** is at relatively less cost which might help in various steps and we can assure that it will handle different emergency situations in very smart way. This type of wireless communication will cause many advantages such as robust control, minimal interference and a large working range. We can also control it with the app "DTMF tone generator. **Mobile Controlling Robot** concept is a new dimension of creativity which is found to be very useful and usable for security and emergency situations. This development may have been attained by many others before now but ours is best as we tried to build a robust and unique system at a very cheaper cost and we desire to work with it for further options.

REFERENCES

1. Ben-Ari M. and Mondada F. (2018). 'Elements of Robotics' [Online] Available at https://www.researchgate.net/publication/320674637_Robots_and_Their_Applications. Accessed 27th June, 2022.
2. Blöcher, K. and Alt, R.., (2020). 'AI and robotics in the European restaurant sector: Assessing potentials for process innovation in a high-contact service industry'. Electronic Markets, Springer. IIM University of Gallen, Switzerland. 31(3). Pp. 529–551.
3. Ctahar.blogspot.com. (2017). '10 Things We Couldn't Do Without Robots'. [online] Available online at: http://ctahar.blogspot.com/2016/05/10- things-we-couldnt-do-without-robots.html Accessed 23rd August, 2022.
4. Das, P.K. and Jena, P.K.(2020). 'Multi-robot Path Planning using improved Particle Swarm Optimization Algorithm through novel Evolutionary Operators'. .Applied Soft Computing92.106312
5. Downey, J.E., Weiss, J.M.,Muelling, K.,Venkatraman, A.,Valois, J.S., Hebert, M.,Bagnell, J.A., Schwartz, A.B. and Collinger, J.L.,(2016). 'Blending of brain-machine interface and vision-guided autonomous robotics improves Neuroprosthetic arm performance during grasping'. Journal of Neuroengineering. Rehabilitation. 13 (28).
6. Dzedzickis, A.,Subaciute-Žemaitiene, J., Šutinys, E.,Samukaite-Bubniene, U. andBucinskas, V.,(2022). 'Advanced Applications of Industrial Robotics: New Trends and Possibilities'. Applied Science12(135).
7. India, P. (2017). 'A Chinese restaurant where robots cook and serve food'. [online] Businessstandard.com. Available at: http://www.business-standard.com/article/pti-stories/achineserestaurant-where-robots-cook-and-serve-food113011400385_1.html. Accessed 13 Aug. 2017.
8. ISO 8373:2012 'Robots and Robotic Devices—Vocabulary'. [Online] Available at https://www.iso.org/standard/55890.html. Accessed 7th April, 2021.
9. Jose, K. and Pratihar, D.K., (2016). 'Task allocation and collision-free path planning of centralized multi-robots system for industrial plant inspection using heuristic methods'. Robots Autonomous System. 80, Pp. 34–42.
10. Kassahun, Y., Yu, B., Tibebu, A.T., Stoyanov, D., Giannarou, S.,Metzen, J.H. and Vander Poorten, E., (2016). 'Surgical robotics beyond enhanced dexterity instrumentation: A survey of machine learning techniques and their role in intelligent and autonomous surgical actions'. International Journal of Computer Assisted Radiology and Surgery. 11(4).
11. Narasimhan, T. (2017). 'Ford installs 92 robots at Chennai unit'. [online] Businessstandard.com. Available at: http://www.businessstandard.com/article/companies/ford-installs- 92-robots-at-chennaiunit-110071700038_1.html. Accessed 13th August, 2017.
12. Recode. (2017). 'Domino's is going to use sidewalk robots in Germany to deliver Pizza'. [online] Available at: https://www.recode.net/2017/3/29/15100748/dominos-deliverpizzarobots-germany-starship. Accessed 13th August 2017.
13. Sabe K., (2005). 'Development of Entertainment Robot and its Future'. [Online] Computer Science Digest of Technical Papers 2005.Symposium on VLSI Circuits. Pp. 2-5. Doi,10.1109/VLSIC.225.1469320.
14. ScienceDirect Search Results; Keywords (Industrial Robot). Available at https://www.sciencedirect.com/search?qs=Industrial%20robot. Accessed 7th April 2022.