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Research on AI (Artificial Intelligence) with the Robotic Arm

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ABSTRACT

Robot operating system (ROS) is robot middleware. Although ROS is not an operating system, it provides the necessary services designed for a heterogeneous cluster of servers, controlling low-end devices, deploying functions, transmitting messages, and managing low-end devices. A set of ROS-based processes represented as architectural graphs that can receive and concatenate sensor data, state control, scheduling, actuators, and other messages.

The application of ROS to the product is in order to test and simulate the operation of the robot arm, thereby supporting researchers, improving, developing and deploying applications on robots smoothly.

Stemming from the above analysis, the topic completely meets the urgency posed by modern society.

***Keywords:** Robotic arm, Robot operating system, ROS, Artificial intelligence.*

1. Introduction

A robotic arm (also known as a robotic arm) is a type of mechanical arm, usually programmed, that functions similarly to a human arm; the arm can be the sum of the mechanism or it can be part of a more complex robot. The links of such a controller are connected by joints that allow rotational or reciprocating motion. Used in industrial production processes operated by humans, or in learning and research. It's most outstanding advantage is its flexible design, agile and meticulous operation and the ability to complete even small product details. A robot operating system, an operating system for robots, is a specialized software system for programming and controlling robots, including tools for programming, display, direct hardware interaction, and connectivity. Before robotic operating systems, every robot designer and researcher would spend considerable time designing the software embedded in the robot, as well as the hardware itself. This requires skills in mechanical engineering, electronics and programming.

ROS is a combination of expertise from different disciplines. ROS helps: Manage hardware by writing drivers; Manage memory and processes; Manage concurrency, parallelism and data consolidation; Provide abstract reasoning algorithms, using AI artificial intelligence in embedded programs.

2. Literature Review

Research status in the field

International studies

Polish engineer Łukasz Koźlik is building a robotic arm that can simulate complex human movements and lift 7 kg dumbbells, while the arm weighs only 1 kg.

Currently, the robotic arm has only half the number of artificial muscles compared to the muscles in the human hand, lacking the finger flexors, and the hand and wrist bone movement is still incomplete.

According to IFL Science, for the past 7 years, Łukasz Koźlik has set a goal to create the most advanced humanoid robot in the world. Realizing the potential of developing robots that mimic human muscle activity, he built a complex system of synthetic muscles, combined with software, towards a robot that can move quickly and efficiently. and affordable price. Motion sequences are written into simple commands on the software, sent to the robot arm.

Each muscle of the robot is a McKibben muscle or a pneumatic artificial muscle, after pumping air or water in, the muscles can be folded and released at will.

This method initially proved effective, helping the robotic hand to comfortably stretch each finger. The warm water flowing through the veins synthesizes almost like hot blood.

Engineer Łukasz Koźlik is building a torso and arms that fit into a skeleton. Working almost alone, he solicits donations from the online community through videos posted on YouTube and hopes to create a complete humanoid robot for them to become housekeepers, workers, and support drivers. People.

Startup Canadia Cobionix, a company of the University of Waterloo, developed a new automated robot called Cobi to help speed up the process of Covid-19 vaccination, New Atlas on 4/11 reported. This is introduced as the first robot to successfully inject humans intramuscularly without the need for subcutaneous needles.

The process of administering the Cobi vaccine goes as follows. Participants will first register online. Next, this person needs to go to a clinic or other location where the Cobi robot is installed and then present the ID card in front of the camera or touch screen interface. Meanwhile, the 3D depth sensing system will also recognize the presence of the injector.

After verifying the identity of the injector, the robotic arm will take the vaccine vial from the storage box. The LiDAR sensor on the robot's hand will create a 3D digital map of the injector's body. This map is analyzed by artificial intelligence (AI) software to determine the optimal vaccination site. Using needle-free technology, the robot delivers the vaccine in the form of a high-pressure liquid jet through a hair-sized hole.

A paralyzed man in the US has become the first person to have electrodes implanted in his sensory cortex, allowing him to feel his robot arm as it manipulates objects.

Nathan Copeland, 23, paralyzed after a car crash in 2016, was recommended by bioengineers to implant electrodes in his motor and sensory cortex to give him some possibilities. The ability to move objects through a robotic arm. David Putrino, chair of the rehabilitation innovation department at the Mount Sinai Icahn School of Medicine, told Health Day: "The feel part of what we do as human beings is really important. Without understanding our hands where you are in space ".

Now, bioengineers are stimulating Copeland's sensory cortex, allowing the system to provide him with information about how the robotic hand feels. When picking up an object, relying on tactile cues ensures that the object is firmly grasped. According to the engineers, Copeland can skillfully direct the robotic arm to the target significantly faster with sensory feedback. On average, he halved the duration of the task, from about 20 seconds to 10 seconds.

In the context that Thailand is grappling with the current wave of COVID-19 epidemic, researchers at Chulalongkorn University have developed a machine that can more effectively divide vaccine doses and optimize the current supply. a scarcer than expected.

Using a robotic arm, the 'AutoVacc' system was able to separate 12 doses of AstraZeneca's vaccine from a vial containing the vaccine within 4 minutes. This machine has been put into use at the school's vaccination center since August 23.

According to the researchers, the machine allows 20 percent more standard doses to be dispensed than divided by hand. The device only works with AstraZeneca multi-dose vials. Information on the vial says that each vial can take 10-11 doses of vaccine. Thailand is speeding up vaccination in an effort to control the wave of epidemics that have been rising since April until now due to Delta variant. Only about 9% of the country's more than 66 million people are fully vaccinated, while the supply is increasingly scarce.

The team said that it will be able to supply more than 20 AutoVacc machines in the next 3-4 months, but need more support from the government to be able to expand the use of this machine to the whole country.

Domestic studies

Currently, in our country, businesses and universities are very interested in technology competitions such as Vietnam-Robocon Robotics, international robotics. There are also many robot models for learning and research on the market with reasonable prices. With the strong development of the computer industry and the industrial revolution 4.0 in the world as well as in our country. The automation and robotics industry has also flourished, along with the demand for a qualified workforce who can master technology.

TTO - The 'robot arm for people with total hand paralysis' by Pham Duc Linh and Nguyen Duc An - students of Han Thuyen High School (Bac Ninh) - have just been awarded the third prize in the National Science - Technology Competition. economy in 2021.

Just six months before the national science and engineering competition, Linh and An rode motorbikes from Bac Ninh to Hanoi over 50 times. On average, twice a week, they travel dozens of kilometers and return to school in time the next day. The two of you pay attention to the details of how to make people with disabilities most comfortable when moving. For example, the arm is chosen to be designed with the material of a hollow and monolithic tube, inside using an elastic hollow wire wrapped with a zipper connected to the motor to ensure light, durable and comfortable to use.

The first robotic hand "made in Vietnam" researched and developed by Vulcan Augmetics costs VND 23-25 million. The project received the investment of Shark Lien, realizing the aspiration to reach out to the world.

3. Methodology

Research methods, research scope

- Research methods: Survey, Analysis, Design, Implementation and Synthesis

- Research scope:

+ Research on operating system for Robot ROS (Robot operating system - ROS)

+ Survey, select necessary hardware equipment

+ Research, design control system, monitor robot arm on ROS.

4. Main findings

Overview of ROS

ROS is robot middleware. Although ROS is not an operating system, it provides the necessary services designed for a heterogeneous cluster of servers, controlling low-end devices, deploying functions, transmitting messages, and managing low-end devices. A set of ROS-based processes represented as an architectural graph that can receive and multiplex sensor data, control state, scheduler, actuator, and other messages.

Characteristics of ROS

Some of the characteristics that make ROS an operating system to use are:

ROS is an open source operating system.

+ Full technical documentation, manuals and support channels.

+ One of the core issues that make ROS so powerful is its huge community. Resources contributed by the community are mostly built and developed from leading research institutes and universities.

The resources provided by ROS demonstrate strength in areas of robotics such as:

- Visualization
- object recognition
- navigation
- manipulation/grasping
- plugging in

Currently ROS only runs on Unix platforms. Software for ROS has been mainly tested on Ubuntu and Mac OS X. So far the ROS community has also started building for Fedora, Gentoo, Arch Linux and other Linux platforms.

ROS is not yet supported on Microsoft Windows.

The ROS operating system, along with its supporting tools and libraries, is usually released as a ROS Distribution, similar to a Linux distribution, providing a set of software for users to use, build, and develop.

ROS is an open source operating system, so it's attracting interest community to develop the system and its associated tools and libraries.

The ROS community participating in source code contributions is growing, however, it still focuses mainly on the United States, Western Europe, in addition to Japan as shown in the following distribution map:

In addition, according to the statistics presented in the following graph, we also see the development trend of ROS in the field of robotics around the world. ROS is a new operating system developed in recent times, since 2007 and increasingly proving its advantages.

Next, Application of ROS

Building robotics applications on the basis of ROS will reduce a significant amount of programming and system setup work. These sections can take advantage of the extremely rich open source resources of the community. According to ROS, we can compare the required engineering workload and core research workload as follows:

Compare the volume of science between using ROS or not. From that, we see that, with the efficiency from ROS, the time spent on basic engineering work will be greatly reduced, and thus, increase the time spent on the work. In-depth research, the scientific content achieved in the topic will be many times greater.

Robots and sensors supported by ROS:

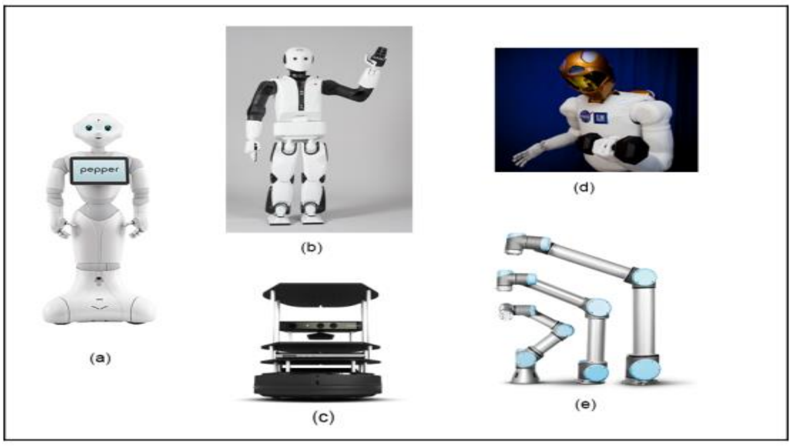

Fig.1. Robots powered by ROS

ROS model

Basically ROS files are laid out and work like this, from top to bottom in the following order, metapackages, packages, packages manifest, Misc, messages, Services, codes:

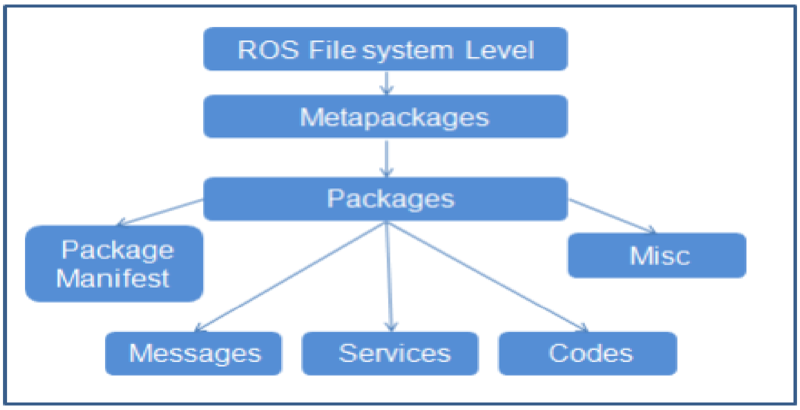

Fig.2. ROS model

In which, the total package (Metapackages) is a group of packages (packages) that are related to each other. For example, in ROS there is a total package named Navigation which contains all the packages related to the robot's movement, including body movement, gear, related algorithms like Kalman, Particle filter, etc. When we install the total package, it means that all the subpackages in it are also "installed".

Packages, here this is what I translate as packages for easy understanding, the concept of packages is very important, we can say that packages are the most basic atoms that make up ROS. In a package that includes, ROS node, datasets, configuration files, source files, all wrapped up in a "package". However, although there are many things in one, package, but to work, we only need to care about 2 things in 1 package, that is the src folder, which contains our source code, and the file Cmake.txt, here is where we declare the necessary libraries to execute (compile) the code.

Interaction between nodes in ROS

ROS computation graph is a panorama picture of the interaction of nodes, topics with each other.

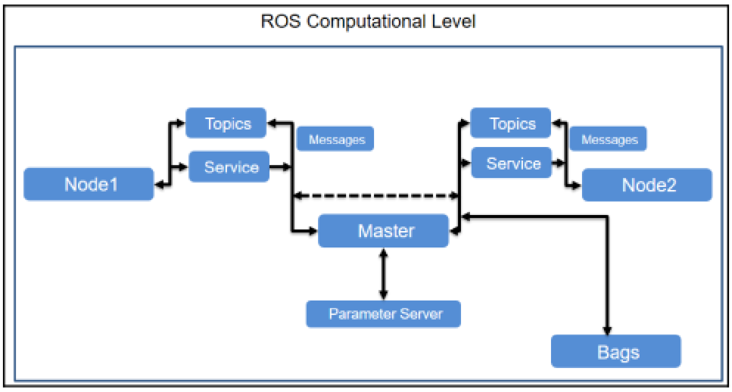

Fig.3. Interaction model between Nodes

In the image above we can see that the Master is the node that connects all the remaining nodes, the remaining nodes that want to communicate with each other must go through the Master node.

Nodes: ROS nodes are simply the process of using the ROS API to communicate with each other. A robot can have many nodes to perform its communication. For example, a self-driving robot will have the following nodes, the node that reads data from the Laser scanner, Kinect camera, localization and mapping, the node that sends the speed command to the rudder system.

Master: ROS master acts as an intermediary node connecting between different nodes. The Master covers information about all the nodes running in the ROS environment. It will exchange details of one node with another to establish a connection between them. After exchanging information, communication will begin between the two ROS nodes. When you run a ROS program, ros_master must always run first. You can run ros master by ->terminal->roscore.

Message: ROS nodes can communicate with each other by sending and receiving data in the form of ROS messages. ROS message is a data structure used by ROS nodes to exchange data. It is like a protocol, formatting information to send to nodes, such as string, float, int, etc.

Topic: One of the methods to communicate and exchange messages between two nodes is called ROS Topic. ROS Topic is like a message channel, in that channel data is exchanged by ROS message. Each topic will have a different name depending on what information it will be in charge of providing. A Node will publish information to a Topic and another node can read from the Topic by subscribing to it. Just like if you want to watch my videos, you have to subscribe to my channel. If you want to see what topics the program you are running has, the command is rostopic list, if you want to see a certain topic see if there are nodes that are publishing or subscribing to it. Then the command is rostopic info /name-topic. If you want to see what's in that topic, type rostopic echo /topic name.

Service: Service is a different type of communication method than Topic. Topic use publishes or subscribes interaction but in service it interacts in request-response style. This is the same as the network side. A node will act as a server, there is a regular server running and when the Node client sends a service request to the server. The server will perform the service and send the results to the client. The client node has to wait until the server responds with the result. Server is especially useful when we need to do something that takes a long time to process, so we leave it on the server, when needed, we call.

The way the system is built like in ROS allows the information source and the recipient to be separate, and the relationship is made through the "name" attribute. “Name” is a very important attribute in ROS: nodes, topics, services, and parameters are all named. Each ROS Client library supports command-line remapping of these names, so that the compiled program can be reconfigured at runtime even while operating in a Computation Graph structure.

For example, to control a device such as a Hokuyo laser range-finder laser sensor, we can start the hokuyo_node driver, which is responsible for reading parameters from the laser and then sending (publishing) messages in the form of sensor_msgs/LaserScan to a topic named scan. To process data from the sensor, we can write a node using the laser_filters package, this node will subscribe to the topic scan. After registration, the filter will automatically start receiving messages from the laser sensor.

Because of the above-mentioned outstanding features, I decided to use ROS as a software to communicate and read values from the RPLIDAR A1 radar laser sensor, then calculate and make 2D mapping. Because ROS can connect many components and abstract resources, it is very convenient for future development to large projects.

5. Discussion and Conclusion

The world is currently in the process of industrial revolution 4.0, it offers all kinds of opportunities to change the face of economies.

Automation and robotics is an important trend of the future of industry. Automation offers higher levels of accuracy and productivity. This technology can even work well in some harsh work environments that are not safe for humans. The robot industry in the world today is developing very strongly with many different manufacturers of industrial robots. There are many countries in the world doing research in this field such as: Japan, USA, Australia, Russia, etc.

The products are industrial robots that are widely applied in many different fields, robots are also applied in very diverse environments such as in factories, in space, under the sea or even in sewage pipes. Purpose to serve production, even to serve entertainment needs as well as take care of people.

Last but not least, Chen et al (2021) mentioned the position of mechanical arm in people's life is getting higher and higher. It replaces the function of human arm, moving and moving in space. Generally, the structure is composed of mechanical body, controller, servo mechanism, and sensor, and some specified actions are set to complete according to the actual production requirements. The manipulator has flexible operation, good stability, and high safety, so it is widely used in industrial automation production line.

And Ganesan et al (2021) pointed that Because of its high accuracy work and simplicity of carrying out heavy operations, the Articulated Robotic Arm was gaining a lot of traction in the industry. The modeling and study of an adaptable robotic arm that can be used for material management activities is the subject of this research. SOLIDWORKS® software was used to design and simulate the articulated robotic arm with an object handling effector. In the early stages of modeling, an examination such as research of the finite element approach would be extremely beneficial.

6. Research Limitation

Authors can expand study for other practical applications of robotic arm.

Declarations

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Consent for publication

Authors declare that they consented for the publication of this research work.

References

[1] Chen et al. (2021). Robotic Arm Control System Based on AI Wearable Acceleration Sensor. Mathematical problems in engineering, https://doi.org/10.1155/2021/5544375.

[2] Lindner, T., Milecki, A. & Wyrwał, D. (2021). Positioning of the Robotic Arm Using Different Reinforcement Learning Algorithms. Int. J. Control Autom. Syst., 19: 1661-1676.

[3] Ganesan et al. (2021). Robotics arms for material holding process in industries. Harbin Gongye Daxue Xuebao/Journal of Harbin Institute of Technology, 53(9): 17-27. DOI:10.11720/JHIT.5392021.2.

[4] Hoang Van Thu et al. (2021). Applications of infrared rays and designing a system for controlling infrared rays system. Turkish Journal of Computer and Mathematics Education, 12(7).

[5] M.T. Richardson, (2001). Thermal triage, Fire chief, 45/9: 24-27.

[6] J.G. Riker, (2002). Tips for using thermal imaging cameras, Fire Engineering, 5: 18-23.

[7] J. H. Kim, J. W. Starr, B. Y. Lattimer, (2015). Firefighting Robot Stereo Infrared Vision and Radar Sensor Fusion for Imaging through Smoke. Fire Technology, 51: 823-845.

[8] G. Parent, Z. Acem, S. Lecheˆne, P. Boulet, (2010). Measurement of infrared radiation emitted by the flame of a vegetation fire. International Journal of Thermal Sciences, 49: 555-562.

[9] Du, Jc., Huang, Qx. & Yan, Jh. (2012). Method for determining effective flame emissivity in a rotary kiln incinerator burning solid waste. J. Zhejiang Univ. Sci. A., 13:969-978 https://doi.org/10.1631/jzus.A1200168

[10] Y. -C. Chen, J. -P. Su, C. -H. Tsai, M. -C. Chen, W. -J. Chang and W. -J. Wu, (2022). iVoiding: A Thermal-Image based Artificial Intelligence Dynamic Voiding Detection System. International Conference on Artificial Intelligence in Information and Communication (ICAIIC), pp. 027-029.

[11] C. Song and S. Lee, (2022). Accurate Non-Contact Body Temperature Measurement with Thermal Camera under Varying Environment Conditions. 16th International Conference on Ubiquitous Information Management and Communication (IMCOM), pp. 1-6.

[12] S. Durgapurohit, J. Granthi, S. Daware, V. Dange, M. Mhetre and A. Kadu, (2022). Real Time Electric Hazard Detection System Using Thermal Imaging. 4th International Conference on Smart Systems and Inventive Technology (ICSSIT), pp. 624-629.

[13] Cilulko, J., Janiszewski, P., Bogdaszewski, M. et al. (2013). Infrared thermal imaging in studies of wild animals. Eur J Wildl Res., 59:17-23. https://doi.org/10.1007/s10344-012-0688-1.

[14] Szajewska, A. (2017). Development of the Thermal Imaging Camera (TIC) Technology, Procedia Engineering, 172.

[15] Saikh, S. et al. (2019). Current Trends in the Application of Thermal Imaging in Medical Condition Analysis, International Journal of Innovative Technology and Exploring Engineering (IJITEE), 8(8).

[16] R. R. Yakkati, S. R. Yeduri and L. R. Cenkeramaddi, (2021). Hand Gesture Classification Using Grayscale Thermal Images and Convolutional Neural Network. IEEE International Symposium on Smart Electronic Systems (iSES), pp. 111-116.

[17] K. -T. Hsu, B. -S. Wang, C. -H. Lin, B. -Y. Wang and W. -P. Chen, (2021). Development of Mountable Infrared-Thermal Image Detector for Safety Hamlet. International Conference on Electronic Communications, Internet of Things and Big Data (ICEIB), pp. 105-109.

[18] lectropeak, (2020). Oled 0.95 inch I2C, OLED Display Datasheet.

[19] Panasonic, (2020). AMG8833 Sensor, Infrared Array Sensor Grid-EYE.

[20] http://wiki.ros.org/rosserial_arduino/Tutorials/Arduino%20IDE%20Setup.

[21] https://www.youtube.com/watch?v=hehCcHwFiuk.

[22] http://arduino.vn/bai-viet/181-gioi-thieu-servo-sg90-va-cach-dieu-khien-bang-bien-tro.