Mobile Manipulator using Jennic JN5148

Abhishek Telgu, Sagar Rathi, Saurabh Jathar, Tanaya Tavade

Abstract— **The objective of the paper refers to development of a hazardous object detection system that can be applied to the robotic arm gripper that will pick and place the object. The proposed scheme can accurately sense the relative distance between the object and robotic arm using a distance sensor, image processing algorithms and a camera device. Jennic's JN5148 microcontroller is preferred over the traditional microcontrollers because of its ultra-low power consumption, high performance and onboard 2.4GHz IEEE802.15.4 compliant transceiver which eliminates the need for expensive and lengthy development of custom RF boards. Therefore, communication is implemented using the wireless capabilities of Jennic JN-5148 and its own JenNet protocol stack. Image processing is implemented using MATLAB. The rack and pinion arrangement, along with dc motors, is used in the robotic arm.**

Index Terms— **Camera module, Distance sensor, Jennic JN5148, Mobile manipulator, RF transceiver, Robotic arm, Wireless microcontroller.**

I. Introduction

With threats of terror attacks in the country one should be alert when it comes to unidentified objects in the vicinity. Whenever such unidentified object is located proper handling and inspection of the object is a must. Same concept is applicable in the war field where the disowned property can be a hazardous material, a nuclear capsule or a dead bomb.

A hazardous material such as a dead bomb or a nuclear capsule in an area must be cleared immediately to prevent further threats to humanity. A human intervention to pick such a material is dangerous and therefore the need for an automated system that detects such materials and carries it away is understood.

Although the idea of our project is original, a number of projects with similar functionalities can be found. For example the British Police have a bomb disposal robot, the Israeli Army has it and it is also being used by bomb disposal squads and a number of states of USA. The most widely used bomb-disposal robots today is the Cobham tEODor which is a twin-track vehicle with a host of military applications. The bomb disposal squads of Pune have metal detectors and other equipment for bomb detection and disposal, but they have to risk their lives by approaching the bomb or the suspicious packet without any safety and precautions. 'DAKSH', developed by DRDO for Indian military is an electrically powered and remotely controlled robot used for spotting, handling and eradicating hazardous objects safely.

Our project aims to build a decisive mobile manipulator, which will automatically search and detect for hazardous material such as a dead bomb or a nuclear capsule in a particular area on manual guidance by precisely processing the captured images, comparing them with an available database and thus recognizing the object and if an unknown object is detected then the message "Object is unknown, may be hazardous" will be displayed.

II. System Structure

The system is designed to function in two parts: detection of hazardous object and then picking it up. To begin with the detection of an object, the distance sensor will send a high pulse to the microcontroller. The microcontroller will then activate the camera module which will take a snapshot and transmit over using the Jennic's RF communication channel. The image will be compared in MATLAB using the image processing algorithms. When the match is detected, the next function of picking up the object will be initiated. The computer will send the signal to the microcontroller to activate the motor of the robotic arm. The arm will pick up the object and place it in no man's land.

This can be represented by the following flowchart:

Manuscript received March 2014.

This work is supported by Defence Research & Development Organisation (DRDO) and Rajarshi Shahu College of Engineering, Pune. The paper was submitted for review on.

Abhishek Santosh Telgu, Electronics & Telecommunication, Pune University, Pune University, Rajarshi Shahu College of Engg, Pune, India.

Sagar Vishnu Rathi, Electronics & Telecommunication, Pune University, Pune University, Rajarshi Shahu College of Engg, Pune, India.

Saurabh B. Jathar, Electronics & Telecommunication, Pune University, Pune University, Rajarshi Shahu College of Engg, Pune, India.

Tanaya Surendra Tavade, Electronics & Telecommunication, Pune University, Pune University, Rajarshi Shahu College of Engg, Pune, India.

ISSN: 2278 – 7798

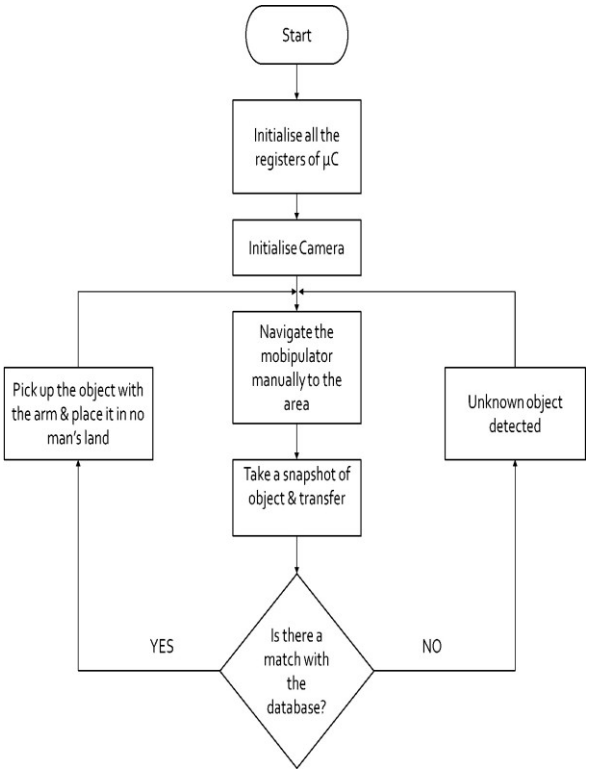

Figure 1. Flowchart of system

III. METHODOLOGY

A. CONTROL STATION

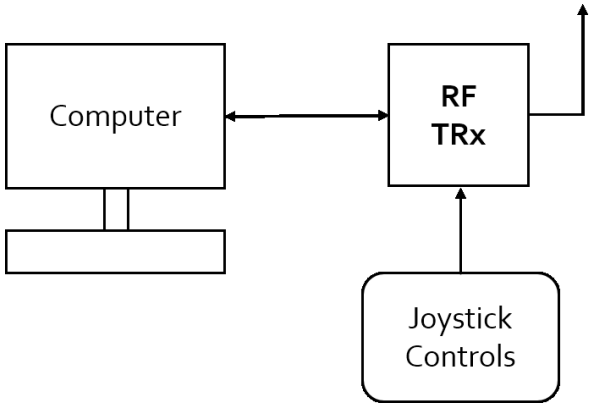

Figure 2. Block Diagram of Control Section (Transmitter)

A computer with a Jennic transceiver is present at the control station. The images captured by the camera module are sent wirelessly through the Jennic transceiver on the robot at the field. The database of the object which is to be recognized is present at the control station. The comparison between the received images is done with the database using image processing toolbox. Once the match is found, the computer will transmit the controlling signals to activate the robotic arms. The navigation of the robot on the field will also be done at the control station using joystick.

Image processing toolbox from MATLAB will be used in our proposed scheme. MATLAB can process 3-4 frames per second [3] [4] and has easy interfacing with Zigbee module.

B. FIELD

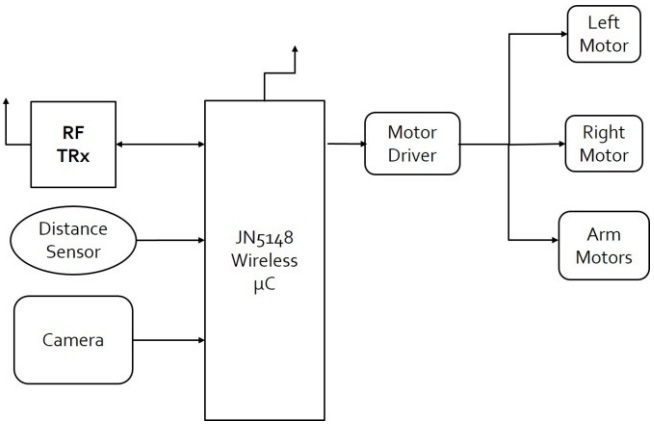

Figure 3. Block Diagram of Receiver

At the field, a robot with a camera, Jennic transceiver microcontroller and robotic arm with gripper mounted on it will be present. Depending on the navigational commands from the controlling section, the robot will move forward, backward, turn left or right. The camera module on the robot will be activated when the distance sensor senses an object in its range. The images taken is now transferred to the control station. When the match is found the controlling signal is sent by the microcontroller to the robotic arm.

The arm designed for the proposed work is of 2-DOF. The vertical motion of the arm is controlled with rack and pinion arrangement. Dc motors of 30 and 45 rpm are used.

The camera module used is equipped with SPI and UART port. The image sensor is a CMOS sensor with 0.3mp. The resolution of the camera is 640*480.

At the initial stage of development, as the camera module is continuous the power consumption of the system is large. So to cope up with the stringent power usage limits, the distance sensor is used. When the object is detected in its vicinity the high pin on the sensor will turn the camera module on. The microcontroller is set to receive the serial data at 9600 baud-rate. Its output data format is 8-N-1, i.e. 8 bit data bytes, no parity bits and 1 stop bit.

Rechargeable dc lithium battery of 12V is used as the robot (receiver section) is wireless system on the field.

C. SOFTWARE

Image processing and RF communication is an important aspect of the project. MATLAB and Eclipse IDE is being used for the same. Altium is used for PCB designing. Programming is done in C/C++ language.

III. ALGORITHM:

A. SYSTEM

1. Start.
2. Initialize all the registers of Jennic JN5148 µC.
3 .Initialize the camera. Navigate the mobipulator towards the object manually.

4. Take the snapshot of the object.
5. Transfer the image using the JenNet. Compare the image with the database using MATLAB image processing tools.
6. If a match is found, pick up the object with the robotic arm and place it in no man's land.
7. If no match found, display "Object is unknown, could be hazardous" and go for next object.

B. IMAGE PROCESSING

1. Start
2. Capture image.
3. Apply Gaussian filter to remove noise.
4. Convert colored image to gray scale image.
5. Apply image enhancement technique.
6. Apply region growing and border detection technique.
7. Compare the images using correlation property.
8. If match found send high signal to microcontroller.
9. If match not found go to step 1.
10. End

C. COMMUNICATION

1. Start
2. If output pin of distance sensor is high, stop the robot, start the camera module and transmit the images.
    1. If match found, turn on the robotic arm
    2. Else start the robot.
3. Else goto step 2.

IV. RESULT

1. The mobipulator will pick up the object only after it has been identified as hazardous.
2. The determination of the object as hazardous will be obtained after its captured image is matched with the database images.
3. The object will be picked automatically by the robotic arm on the bot.
4. The mobipulator will be navigated manually using the Jennic's on-chip RF communication modules.

V. CONCLUSION

The mobipulator designed, would traverse and search for the hazardous object in the given area under the manual guidance. Therefore, the further scope could be automating the traversing of the mobipulator without human intervention or need. Also, the mobipulator sends the images back to the transmitting area for comparison with the database. If we could install image comparison and processing circuit on the mobipulator itself, it will eliminate the need of a software image processing tool and also save time.

.

ACKNOWLEDGMENT

This work is supported by the Defense Research & Development Organization (DRDO) at Armament Research & Development Establishment (ARDE), Pashan, Pune. We are thankful to the Department of Electronics and Telecommunication, Rajarshi Shahu College of Engineering for all the support it has provided us. We express our deepest sense of gratitude towards our Honourable Head of department Prof. D.G.Bhalke for giving us permission to use the college resources and his constant encouragement for this work.

REFERENCES

Books:
[1] Gonzalez and woods, "Digital Image processing", Pearson education.
[2] Arthur Weeks Jr., "Fundamentals of digital intake processing", PHI.

Papers:
[3] Shyam R.Nair, Design of a Robotic arm for picking and placing an object, International Journal of Scientific and Research Publications, Volume 2, Issue 5, May 2012.
[4] Guo-Shing Huang, Hsiung-Cheng Lin, Po- Cheng Chen, "Robotic arm grasping and placing using edge visual detection system", Pages 1-4, 8th Asian Control Conference (ASCC), Kaohsiung, 2011.
[5] Manjunath, T.C., "Novel design of a wireless communication based automatic surveillance system for detection of suspicious objects", Pages 1-7, Internet, 2009. AH-ICI 2009. First Asian Himalayas International Conference, Nov. 2009, Kathmandu

Abhishek S. Telgu is currently pursuing the undergraduate course Bachelors of Engineering in Electronics and telecommunication at Rajarshi Shahu College of Engineering, Pune.

Sagar V Rathi is currently pursuing the undergraduate course Bachelors of Engineering in Electronics and telecommunication at Rajarshi Shahu College of Engineering, Pune.

Saurabh B. Jathar is currently pursuing the undergraduate course Bachelors of Engineering in Electronics and telecommunication at Rajarshi Shahu College of Engineering, Pune.

Tanaya S. Tavade is currently pursuing the undergraduate course Bachelors of Engineering in Electronics and telecommunication at Rajarshi Shahu College of Engineering, Pune