GESTURE CONTROLLED CRANE USING ARDUINO MPU 6050

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ABSTRACT

In the context of further automation of manufacturing processes, automated transportation of heavy weights using cranes becomes more and more important. Applying the skills of robots to crane automation, a wide market of new applications could be developed. The crane hook represents the effectors of the robot. A load displacement system that have 5 Degrees OF Freedom(DOF) in a 3-Dimensional environment, which is controlled through Gestures of Hand and fingers Remotely for better Man-Machine interface, thereby improving the accuracy and control over the system. A wireless data glove was developed to control the crane remotely. This crane is a model for gesture controlled user interface (GCUI), and identifies trends in technology, application and usability. We present an integrated approach is real time detections, gesture based data which control vehicle movement and manipulation on gesture of the user using hand movements. A three-axis accelerometer is adaption. As the person moves their hand, the accelerometer also moves accordingly. The gesture is capture by accelerometer and processed by gesture. With each passing day the gap between machines and human are being reduced with the introduction of new technology. The future scope of advanced robotic arms that are designed like the human hand itself can easily controlled using hand gesture only. It is also having proposed utility in field of construction, medical science, hazardous waste disposal etc.

Keywords: *Gesture, crane, lifting mechanism, signal transmission*.

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1. INTRODUCTION

Till now cranes are one of the most important systems for material handling of heavy goods. Although automatic cranes are comparatively rare in the industrial practice. Because of the high potential of rationalization, in the past several attempts have been made. But, several reasons prevented the success of such systems. Till now, one of these reasons is the relation between investment costs and achievable cost savings. But, due to decreasing investment costs because of lower prices for hard- and software as well as for actuators and sensors the profitability of such systems is within reach. Another reason is the broad application field of cranes with very different specific demands. This results in two main directions for crane manufacturers. One group, mainly larger company, offers the crane as a standardized product like a milling machine. The larger companies are interested in an automated crane as a standardized product. The first idea in crane automation was calculating time optimal control functions minimizing the traveling time of the crane considering the boundary conditions of no load swaying at the target point. They read the sensor signals and calculate the input variable motor torque or reference position for the actuators based on the time reference functions of the trajectory generation module. The addition of gesture based control for the overhead crane will lead material handling in all aspects to a whole new level of experience.

2. Crane

A crane is a type of machine, generally equipped with a hoist rope, wire ropes or chains, and sheaves, that can be used both to lift and lower materials and to move them horizontally. It is mainly used for lifting heavy things and transporting them to other places. The first known construction cranes were invented by the Ancient Greeks and were powered by donkeys. Larger cranes were later developed, In the High Middle Ages, harbor cranes were introduced to load and unload ships and assist with their construction. The earliest cranes were constructed from wood, but cast iron, iron and steel took over with the coming of the Industrial Revolution.

3 GANTRY SETUP AND ITS FEATURES

An overhead crane has three main moving directions x; y; and z (Fig 1) for crane bridge, trolley and hoisting. Transmission of hoisting system, the driving force of hoisting mechanism is from motor. It transmits power to the high-speed shaft end of reducer by gear coupling. Then through reducer to reduce the high revolution of motor to the required revolution and output by low-speed shaft of reducer, so as to finish the lifting of the heavy objects up and down. Transmission of crane Trolley traveling system: the driving force of crane trolley is from stepper motor. It transmits power to the high-speed shaft end of reducer by toothed pulley and belt mechanism, so as to drive the trolley driving wheels rotating, so that finish trolley transport heavy objects by lateral movement.

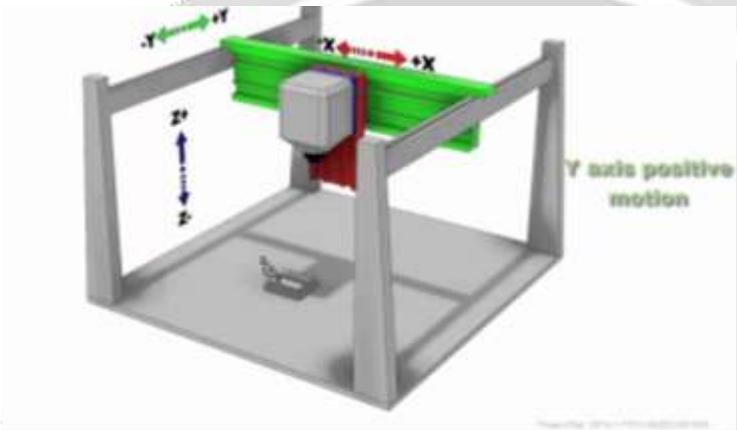

Fig 1 GANTRY SETUP

4 STEPPER MOTOR

The stepper motor is known by its property to convert a train of input pulses (typically square wave pulses) into a precisely defined increment in the shaft position. Each pulse moves the shaft through a fixed angle. Stepper motors effectively have multiple "toothed" electromagnets arranged around a central gear-shaped piece of iron. When the gear's teeth are aligned to the first electromagnet, they are slightly offset from the next electromagnet. This means that when the next electromagnet is turned on and the first is turned off, the gear rotates slightly to align with the next one. Each of those rotations is called a "step", with an integer number of steps making a full rotation.

Fig 2 STEPPER MOTOR

5 LIFTING MECHANISM

Cranes may use a combination of simple mechanisms, to get the advantage and lifting machines, mechanical objects. Overhead crane is balanced on a fulcrum that allows you to lift heavy objects with fewer forces. The lifting mechanism uses a combination of gear train to increase the torque output of the motor based on which the load carrying capability of the crane is determined. This lifting mechanism (Fig 3) is based on the fact that the gear ratio and the load capacity of the motor used in the mechanism.

Fig 3 LIFTING MECHANISM

6 SERVO POWERED GRIPPER

Grippers are used for holding or grabbing the object/material that is supposed to be handled. In Gesture O Crane, we will be using a servo motor (Fig 4) powered gripper which can provide a higher torque even though the size of the motor is small. Two servo motors are attached against each other in such a way that they can hold the object in place. This setup is small and space conservative and also provides a really high grabbing force and torque.

Fig 4 - 9G SERVO MOTOR

7 MOTOR DRIVER

A motor driver is a little current amplifier; the function of motor drivers is to take a low-current control signal and then turn it into a higher-current signal that can drive a motor. These circuits are often used in robotics and other applications to allow DC motors to run forwards or backwards. The term H Bridge is derived from the typical graphical representation of such a circuit. An H bridge is built with four switches (solid-state or mechanical). When the switches S1 and S4 (according to the first figure) are closed (and S2 and S3 are open) a positive voltage will be applied across the motor. By opening S1 and S4 switches and closing S2 and S3 switches, this voltage is reversed, allowing reverse operation of the motor. The internal connection of a typical motor driver is as shown in fig 5.

A common variation of this circuit uses just the two transistors on one side of the load, similar to a class AB amplifier. Such a configuration is called a "half bridge". The half bridge is used in some switched-mode power supplies that use synchronous rectifiers and in switching amplifiers.

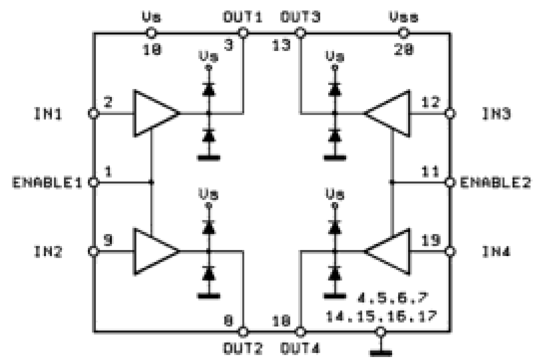

Fig 5- L293D INTERNAL CONNECTIONS

The half-H bridge type is commonly abbreviated to "Half-H" to distinguish it from full ("Full-H") H bridges. This commonly used H-Bridge drives the motor based on the signal given by the microcontroller governing the operations, which in turn functions based on the signal of the gesture.

8 BELTS AND PULLEY SYSTEM

A belt is a loop of flexible material used to link two or more rotating shafts mechanically, most often parallel. Belts may be used as a source of motion, to transmit power efficiently or to track relative movement. Belts are looped over pulleys and may have a twist between the pulleys, and the shafts need not be parallel. In a two-pulley system, the belt can either drive the pulleys normally in one direction (the same if on parallel shafts), or the belt may be crossed, so that the direction of the driven shaft is reversed (the opposite direction to the driver if on parallel shafts). Toothed pulley is used to match the belt and also to transfer the torque to the system. This mechanism is the most efficient and more economical in all aspects.

Fig 6 TOOTHED BELT AND PULLEY SYSTEM

9 GESTURE CONTROL COMPONENTS

The Gesture is the hand movements which the on-board microcontroller captures with the help of suitable sensors and process the valuable information to make the displacements of the system. The system is designed to fit in hand in order to make it a more efficient and operational way of communicating with the system in a much friendly manner in spite of the person using it. Since the introduction of gesture controlled, anyone can control the system by using the sensor. This method is a much friendly way to interact with the system.

9.1 GLOVES

Since the working is based on hand gesture based, we will be using a glove to hold the components required. A glove (Fig 7.1) is a garment covering the whole hand. Gloves have separate sheaths or openings for each finger and the thumb; if there is an opening but no (or a short) covering sheath for each finger they are called Fingerless gloves. Fingerless gloves having one large opening rather than individual openings for each finger are sometimes called gauntlets, though gauntlets are not necessarily fingerless. Gloves which cover the entire hand or fist but do not have separate finger openings or sheaths are called mittens. The gloves act as an insulation layer for the components from our skin as the human body generates sweat and also we have static electricity inbuilt in us, the gloves also acts as a protective layer for the components from our body.

Fig 7.1 GLOVES

9.2 MICROCONTROLLER

The data capturing and processing of the gesture components is done by an on board microcontroller installed on the glove. It is an ATMEGA 328PU DIP28 (Fig 7.2) microcontroller.

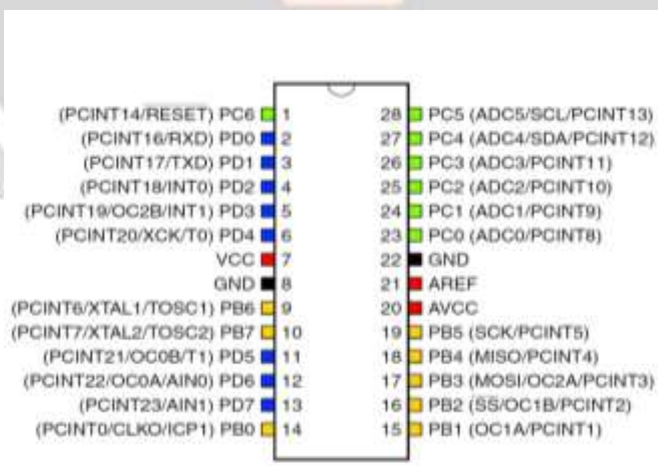

Fig 7.2 ATMEGA 328PU

It houses the following features under its hood:

- The high-performance Microchip pico Power 8-bit AVR RISC-based microcontroller combines 32KB ISP flash memory with read-while-write capabilities
- 1024B EEPROM

- 2KB SRAM
- 23 general purpose I/O lines
- 32 general purpose working registers
- Three flexible timer/counters with compare modes
- Internal and external interrupts
- Serial programmable USART
- A byte-oriented 2-wire serial interface, SPI serial port, a 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages)
- Programmable watchdog timer with internal oscillator
- Five software selectable power saving modes
- The device operates between 1.8-5.5 volts.

By executing powerful instructions in a single clock cycle, the device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed.

9.3 INERTIAL MEASUREMENT UNIT

Inertial Measurement Unit (IMU) sensors are one of the most inevitable type of sensors used today in all kinds of electronic gadgets. They are seen in smartphones, wearables, game controllers, etc. IMU sensors help us in getting the attitude of an object, attached to the sensor in three dimensional space.

The IMU sensor used is an MPU-6050 as shown in Fig 7.3. The MPU 6050 is a 6 DOF (Degrees of Freedom) or a six axis IMU sensor, which means that it gives six values as output. Three values from the accelerometer and three from the gyroscope. The MPU 6050 is a sensor based on MEMS (Micro Electro Mechanical Systems) technology.

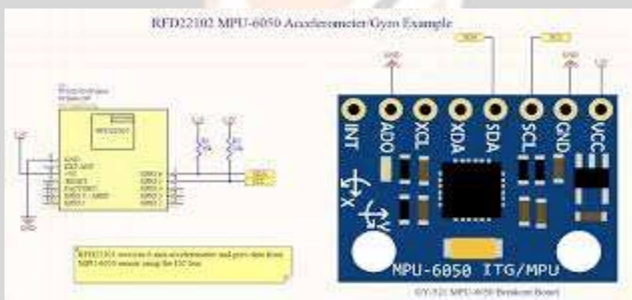

Fig 7.3 MPU-6050

Both the accelerometer and the gyroscope is embedded inside a single chip. This chip uses I2C (Inter Integrated Circuit) protocol for communication. The values it is capable of capturing is as shown in Fig 7.4.

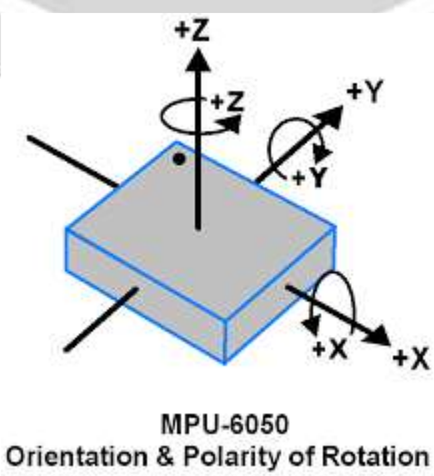

Fig 7.4. MPU-6050 ORIENTATION

Hand Gesture control tracking is made based on the axes the sensor is capable of. The motion is explained in the Fig 7.5. Forward, Backward, Left, Right , Up and Down are the six axes used in the system. The data is collected and processed based on the signals sent by the sensor.

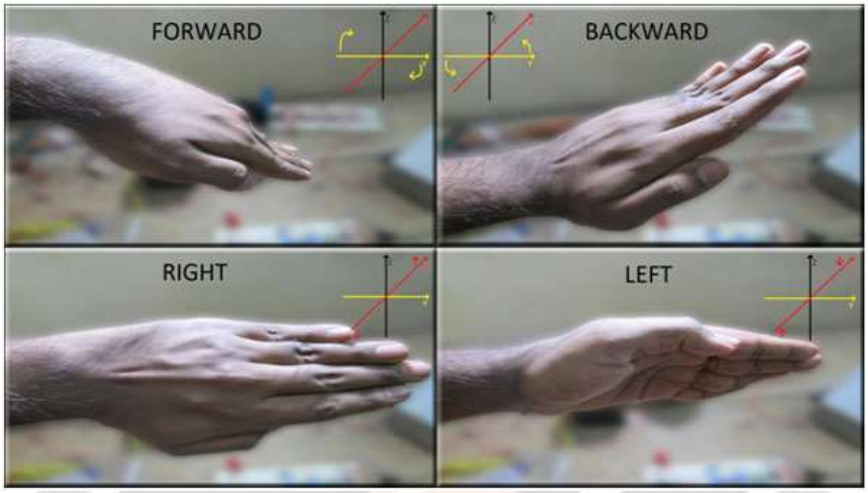

Fig 7.5. HAND GESTURE

10 SIGNAL TRANSMIMSSION

Used for communication between the Arduino board and a computer or other devices. All Arduino boards have at least one serial port (also known as a UART or USART): Serial. It communicates on digital pins 0 (RX) and 1 (TX) as well as with the computer via USB. Thus, if you use these functions, you cannot also use pins 0 and 1 for digital input or output. You can use the Arduino environment's built-in serial monitor to communicate with an Arduino board. Click the serial monitor button in the toolbar and select the same baud rate used in the call to begin. Serial communication on pins TX/RX uses TTL logic levels (5V or 3.3V depending on the board). Don't connect these pins directly to an RS232 serial port; they operate at +/- 12V and can damage your Arduino board. The Arduino Mega has three additional serial ports: Serial1 on pins 19 (RX) and 18 (TX), Serial2 on pins 17 (RX) and 16 (TX), Serial3 on pins 15 (RX) and 14 (TX). To use these pins to communicate with your personal computer or other device with serial communication enabled, you will need an additional USB-to-serial adaptor, as they are not connected to the Mega's USB-to-serial adaptor. To use them to communicate with an external TTL serial device, connect the TX pin to your device's RX pin, the RX to your device's TX pin, and the ground of your Mega to your device's ground.

11 CONCLUSIONS

In this paper an automated crane as a large-workspace robot was presented. In comparison to the state of the art in crane automation the method has the capabilities of a trajectory tracking control opposite to the point to point control in industrial practice. The discussion of the industrial systems leads to the problem that the broad application field, each with specific demands, prevents till now the success of automated crane systems. For that reason the presented control concept is characterized by modularity in two directions. The first flexibility is given by the modularity of the decentralized control concept. The control modules can be combined in that way, that only the necessarily needed automated axes are implemented tuned to the given application. The second flexibility is given by the modularity of the control modules itself. Feed forward, feedback control, and disturbance estimation can be combined tuned to the necessarily needed positioning accuracy and allowed residual sway. Together this offers a broad spectrum of solutions starting at a low cost solution with low requirements and ending with highly specialized automated systems. Consequently the effector of the crane robot needs to be completely integrated into the automation system, which was till now a significant drawback of existing industrial automated cranes. Therefore, the effector is equipped with active auxiliary axes to orient the load around three angles. Furthermore, firstly a concept is presented which includes also the damping of secondary oscillations, like tilting and torsion oscillations.

This is an important precondition for the interaction of the rope-guided effectors with the environment in fully automated manufacturing system. The trajectory tracking controller herein developed is

12 FUTURE WORKS

In the receiver section a wireless camera is placed to monitor the performance of robot arm so that in medical field along with patient side (Robot arm side) 5 vital parameters (ECG, Respiration rate, Pulse rate, Temperature, Heart beat) of patient is monitored. This is a preventive measure for any imbalance in victim's metabolism (temperature, pressure, heart rate), ALARM in transmitter's section (physician side) will be ringing, which in turn brings into notice of physician that patient is in some critical situation, so that the physician immediately going to stops the action of robotic arm and he will inform the nearby doctors to take care of patient. This robotic arm developed is to reduce man power in medical field; take care of patient in absence of specialist/surgeon and to impart the robotic in medical areas.

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