**Isaac Berrios**

**Patricio Vela**

**Auto-drone**

**Active Infrared Sensors for Proximity Detection**

**Introduction**

 Infrared radiation consists of electromagnetic waves that range from 0.75μm to 1000μm. Infrared radiation has several properties that make it useful in many applications. Infrared radiation is invisible to the human eye. The energy of infrared radiation is equal to the vibrational energy of molecules. This relationship makes it possible for infrared radiation to be utilized to detect molecules. Infrared radiation has a long wave length which translates to a more efficient transmission through a medium. Infrared radiation is emitted from all objects with a temperature above absolute zero. An application of infrared radiation is object detection and ranging through the use of an active infrared sensor or an infrared range finder [1].

**Commercial Applications**

An infrared range finder determines the distance of an object within a certain range of accuracy. They are used in a wide variety of applications, one of them being touchless buttons. A common example of a touchless button is an automatic faucet [2]. The infrared sensors utilized in automatic faucets are not required to detect range or motion, the sensors are only required to detect the proximity of an object [3]. The Sharp GP2Y0D815Z0F Digital Distance Sensor has an operative range of 0.5-15cm and is relatively small in size. This sensor costs approximately nine dollars per unit and is an ideal unit to use in a close proximity application such as an automatic faucet [4].

 Another application for infrared range finders is 2-D mapping. The sensors used in 2-D mapping are required to provide accurate measurements of distance over an extensive range; Alwan et al [5]. The Hokuyo PBS-03JN is a scanning infrared range finder that would be ideal for 2-D mapping purposes. This range finder has a motor that allows it to sweep within a 180 degree range with an operative distance of up to 3m. Each unit costs around $1100 **[**6].

**Technology Implementation**

 Active infrared sensors work in the infrared frequency range, from 300 GHz up to 400 THz. In a typical active infrared sensor package, a source emits infrared radiation and a detector measures the strength of infrared radiation that is returned. The source and the detector must face the same direction and be placed within close proximity of each other [7]. All objects emit infrared radiation, so modulation is used to determine the reflected infrared radiation, which originates from the source, from the background infrared radiation. The infrared signal transmitted by the source is typically transmitted on a 38 kHz carrier frequency and the detector device receives the reflected infrared signal and then demodulates the signal. Once the signal is demodulated it can be output into a digital signal that a microcontroller can interpret [8]. The effective range for most sensors is 2 cm up to 2 m [9]. Because infrared radiation will pass through transparent objects, infrared sensors cannot detect them. Detecting shiny can be difficult since the shiny object will greatly scatter the infrared radiation and the receiver will not obtain a good reading. Detecting black or white objects is difficult with infrared sensors because the received data from those types of objects will have a large variation [10].

**Components of the Technology**

An active infrared sensor is composed of five main components: an infrared source, medium for transmission, optical component, infrared detector, and signal processing. An infrared frequency LED is usually used as the source of infrared radiation. The medium for an infrared sensor is usually the atmosphere or a vacuum environment. The optical component is a Fresnel lens that used to limit the spectral response and focus the infrared radiation to the infrared detector. A photodiode is used as the infrared detector. The signal processing component usually consists of a bandpass filter stage and an amplification stage. The bandpass filter stage is utilized to only allow the modulated carrier frequency to pass through. The infrared radiation received at the photodiode is usually small in magnitude, so an amplification stage is used to amplify the received signal before it is passed to the output of the sensor [11]-[13].The bias voltage for a typical short range active infrared sensor is normally small, around 2-6 VDC [4]. For larger and more powerful infrared range finders, the bias voltage can range from 18-30 VDC [6].

**References**

[1] “Characteristics and use of infrared detectors,” Hamamatsu, Hamamatsu City, Japan, Tech. Report. Mar. 2011 [Online]. Available: https://www.hamamatsu.com/resources/pdf/ssd/infrared\_kird9001e.pdf. [Accessed Oct. 23, 2016].

[2] "Hands free automatic Faucets," 2015. [Online]. Available: http://www.macfaucets.com/howitworks. [Accessed Oct. 23, 2016].

[3] "Convenience of a hands-free faucet available at home," 2015. [Online]. Available: http://www.macfaucets.com/index.php?route=mblog/article&article\_id=4. [Accessed Oct. 23, 2016].

[4] Sharp, “GP2Y0D815Z0F,” GP2Y0D815Z0F datasheet. Available: https://www.pololu.com/file/0J813/gp2y0d815z\_e.pdf. [Accessed Oct. 23, 2016].

[5] M. Alwan, M. Wagner, G. Wasson, and P. Sheth, “Characterization of Infrared Range-Finder PBS-03JN for 2-D Mapping,” 2005. [Online]. Available: http://www.cs.virginia.edu/~gsw2c/research/ICRA05.pdf. [Accessed Oct. 23, 2016].

[6] "Scanning range finder PBS," 2011. [Online]. Available: https://www.hokuyo-aut.jp/02sensor/07scanner/pbs.html. [Accessed Oct. 23, 2016].

[7] ET 100b. Class Lecture, topic: “Survey of Electronics.” College of Southern Nevada. Aug. 24, 2011. [Online]. Available: http://sites.csn.edu/electronics/et100b/Week15.pdf. [Accessed Oct. 23, 2016].

[8] Al Ronzo, “IR Communication,” Sparkfun, Apr. 13, 2013. [Online], Available: https://learn.sparkfun.com/tutorials/ir-communication. [Accessed Oct. 23, 2016].

[9] Vishay Intertechnology, Inc. Technical staff, *Mid-range Infrared Sensors for Object Detection and Ranging,* Vishay Intertechnology, Inc. 2012 [Online], Available: http://www.vishay.com/docs/49009/49009\_pl0438.pdf. [Accessed Oct. 23, 2016].

[10] C.A. Berry. ECE425: Introduction to AI Robotics. Class Lecture, topic: “Common Sensing Techniques for Reactive Robots,” School of Electrical and Computer Engineering, Rose-Hulman Institute of Technology, Terre Haute, In, 2010. [Online], Available: https://www.rose-hulman.edu/~berry123/Courses/ECE425/Spring10\_files/Lectures/Lecture%204-1%20Slides.pdf. [Accessed Oct. 23, 2016].

[11] S. Basoor, P. Yam Ng, D. P. Chen, “Infrared proximity sensor package with reduced crosstalk,” US Patent 8,217,482 B2, Jul 10, 2012. [Online], Available: https://www.google.com/patents/US8217482. [Accessed Oct. 23, 2016].

[12] P. Jain, “Infrared Sensors or IR Sensors,” Engineers Garage, Jan 9, 2012, Available: http://www.engineersgarage.com/articles/infrared-sensors. [Accessed Oct. 23, 2016].

[13] Administrator, “IR Sensor.” Electronics Hub, Feb. 2, 2015, Available: http://www.electronicshub.org/ir-sensor/. [Accessed Oct. 23, 2016].