

EE Final Project
Smartphone Detector



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Abstract:

There is a wide variety of times when it is unacceptable to be using a smartphone, and this device could help to minimize when people are using their devices. People have become more and more reliant on their various pieces of technology such as their smartphones, and are often using them when they should be paying attention in class, attending an important meeting, watching a movie, or should just be present to their other surroundings. A device that could detect the use of smartphones at these inopportune times would be something that would benefit a wide variety of people.

The goal of this project is to build a smartphone detector that is capable of detecting nearby smartphones that are using different features. The capability of this will be to alert the user of the smartphone detector if a nearby phone is making a call or text message within a certain radius of the user. This could also be further developed to allow for the detection of different applications such as recording applications or other targeted applications. Some possible applications for this detector would include locating lost smartphones that are nearby, detecting unauthorized use of smartphones in classroom settings, or detecting unwanted recordings or videotaping. It has a wide variety of uses and could be a useful tool as the world moves more and more virtual. Some of the cool features of this device will include a dial to adjust the detection radius, a user interface that will indicate the different types of signals that are being detected by the device, and other personalized touches to ensure that the device is as user-friendly and useful as possible. This is a valuable tool that could be widely used and appreciated for all of the services that it provides.

Introduction and Background Information:

Smartphones may have been one of the best technological advancements that we have had in the last 30 years. Their convenience and ability to drastically improve the lives of everyone that uses them are part of the reason why they are so valuable. They leave the world at your fingertips: you can communicate with anyone that you have ever known, you can find the answer to any question that you have ever wondered, can play games and enjoy yourself, and watch any of your favorite TV shows. Who could deny their greatness?

As with all things, smartphones are only good in moderation. They can take away just as much as they can give to the user when they are used at the wrong times. Many teachers believe that smartphones can take away from the learning experience of their students and “were skeptical about using Smartphones for educational purposes as they considered them to be a source of distraction, wastage of time, technostress, and emotional detachment” (Iqbal). If students are too busy using their smartphones during school, then they can lose out on all of the important lessons they could be hearing from their teachers. Other times when smartphones are used when they should not be are during important meetings, when people are spending time 2 with family or friends, or when they are out in public. Similar to in-school usage of smartphones, there are many important things that are said during meetings and if the proper attention is not paid, then people will not be able to accomplish what they want at their meetings. If people are using their smartphones during social interactions then they miss out on all of the interpersonal communication skills and create real bonds with the people around them. Not only can smartphones take away a wide variety of skills and important lessons from their owners, but they can also put them in dangerous positions if they are using them in public spaces. These users become less aware of their surroundings and could accidentally put themselves in danger if they

were to walk out into a street, onto railroad tracks, or not aware of dangerous people around them. There is a time and a place when using smartphones is beneficial, people just have to know when that is.

If people knew when they were not supposed to be using their smartphones, or if they were told by someone when they were abusing this technology, then it would be greatly beneficial. That is exactly what this smartphone detector would be able to provide, that warning when someone is using their device at an inappropriate time.

Product Research:

One of the biggest current products out there that are using smartphone detection is being used for matters of protection, whether that is national security or protection of private information. “While cell phone detectors simply sense the presence of a mobile phone, a mobile phone jammer actually prevents its use – even if it is just switched on – by overpowering any network signals” (Cellbusters). They are often used in some type of manner to detect when people are using their phones in private situations where they are not supposed and can sometimes trigger a smartphone jammer, which is illegal, to prevent the user from having any access to the network signals (Cellbusters). The current products out there seem to have a slightly different role than the smartphone detector that will be developed through the course of this class.

The technology that this device will use incorporates reading RF signals from the smartphone and using some type of analog circuit to capture the signal. It uses a very sensitive capacitor that acts as an antenna to receive the signals and then uses some networks of different transistors to track the signal to a microcontroller that can then interpret the signal. Once the signal has been interpreted, then it can send whatever outputs the designer desires to have on the user interface such as flashing LEDs, alarm sounds, or other buttons.

One of the main differences between current devices that are out in the market and is designed at the current time is the market that they are being used in. They are not targeting schools as their primary customer, more of them are being used in business environments to protect sensitive information. I believe that pushing this product to the educational scene will improve “the market valued at USD 69,339.5 Million in 2019” (GlobeNewsWire). It is already a rising industry because many people see that as technology advances, there should be some type

of checks and balances to account for that. If we can get into that market before other people realize the potential goldmine that there is, then this product can be truly quite successful.

There are a variety of different people that would potentially buy this product for its usefulness. As the main target would be teachers that have to deal with the constant distraction of students using their phones, another main target being movie theatres wanting to get rid of the number of people that use their phones in the theatres and ruin the experiences for other people, with a smaller group of other interested parties that might have some need for this project.

Table 1: Customer Archetypes

Type of Customer	Description	Reason	Product Use
Teacher / Educator	Many teachers or educators have a difficult enough time trying to teach a large group of people the same topic, and that becomes drastically harder when these people are distracted with their smartphones	It can help them to retain a greater attention rate from their students because it can detect and alert when students are using their devices when they should not be	It can give some type of alert while the teacher is giving lessons and the teacher can take appropriate action to change up the situation whether that means just asking the student to turn off their phone or taking away privileges till the end of the day
Movie Theatres	When people are on their phones in movie theatres, it takes away from the experience of everyone around them. It would be quite beneficial if they could figure out some way to deter people from using their phones	They would benefit greatly from getting rid of smartphones during movies playing in the theatres as movies are quite expensive and people are moving away from watching in theatres all of the time. It could be helpful in making the experience better for all of the customers so they are more likely to return	This device could be installed in each of the different theatres and when it detects someone using a device, it can alert a worker to come by and handle the situation in a way that does not take away from others' movie experiences
Business / Managers	This is similar to the needs in the education field, many business meetings are conveying important and sensitive information. If people are not paying attention during these meetings, then projects can fall behind and information cannot be passed as effectively from party to party	If there was a smartphone detector present during these meetings it could work in two different ways: deter people from being distracted by technology and prevent people from recording or spreading private information to outside parties	It can be something that is installed in conference rooms as a preventative measure
Parents / Other Interested Individuals	There are other individuals out there that could have an interest in having this smartphone detection technology in their possession for whatever personal desires that they may have	Many individuals could find their own uses for this type of technology such as parents wanting to control their kids' electronics use, people using the smartphone detector as some type of locator to find misplaced devices, et cetera...	This would be up to these users' discretions of how they value the product

Setup:

The following circuit was the circuit that was built in order to detect smartphone signals. This is the simulation for the RF circuit. The voltage source acts as the RF signal that would come from a smartphone or other electronic device. It has a really high frequency in order to simulate the frequency of any RF signal that would come out of a cellphone. The two op-amps have really high gain as the signal coming from the smartphone was likely to not be very strong. It can take an input signal of 1uV and output something in the range of 8V. The LT1192 was the op amp of choice for this circuit because its properties allowed for this circuit to be functional. It runs on a voltage source that can be replaced by a 9 V battery.

Table 2: Product Specifications

Specification	Description
9 V Power Supply	Runs from +9V to Ground, can easily be powered by a battery
~1.5 mV Signal	The circuit can pick up values of ~1.5 mV
LED	The circuit contains one LED that lights up when it receives a voltage of about ~0.7 V
~1Ghz	The circuit operates on frequencies of about 1 Ghz
LT1192	LT1192 was the op-amp used for this project because it can handle high speeds and has high gain

Simulation:

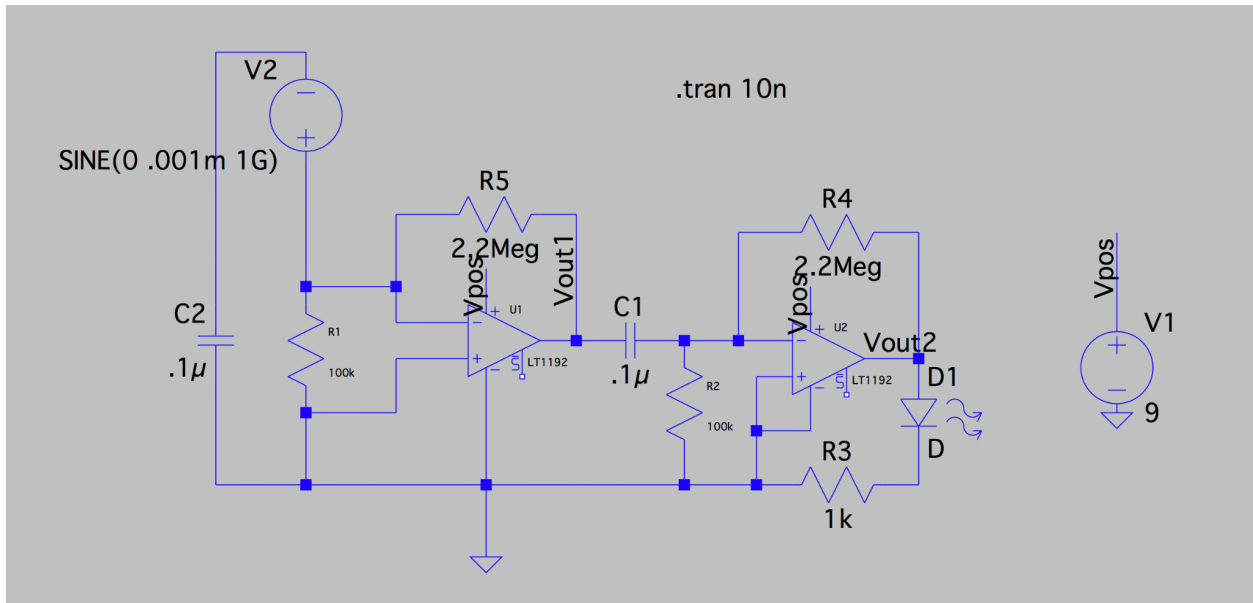


Figure 1: LTSpice Simulated Circuit

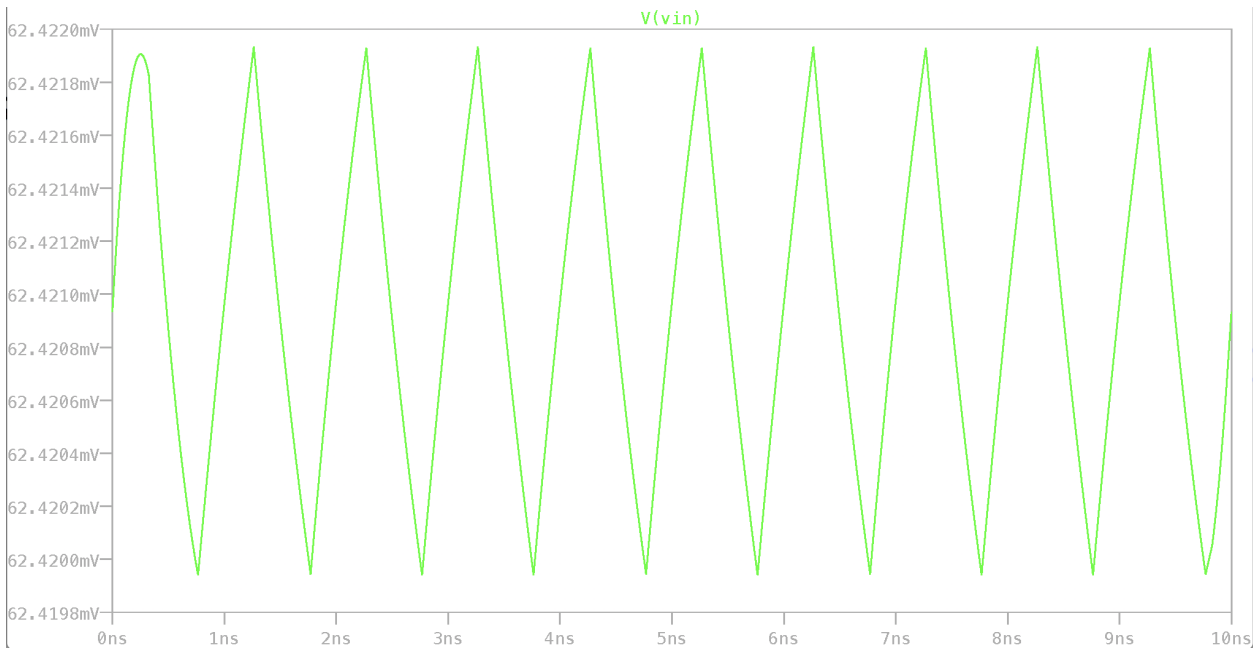


Figure 2: LTSpice Simulated input to represent Cellphone signal

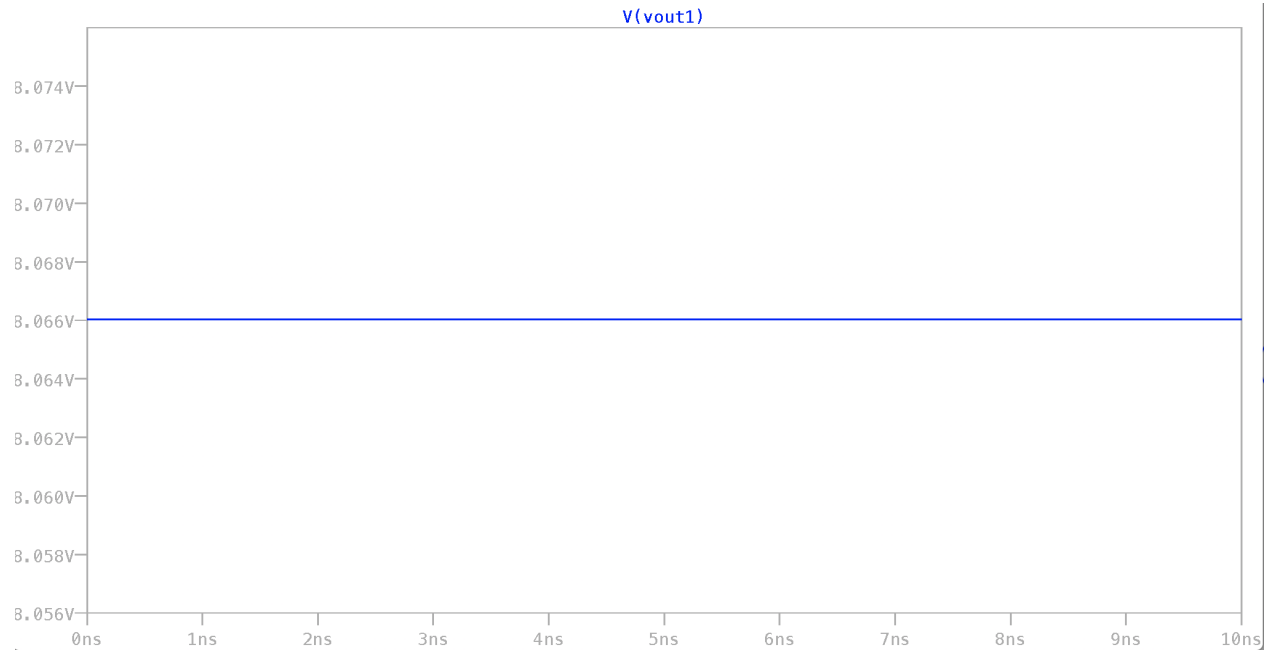


Figure 3: LTSpice Simulated Output after 1st gaining stage

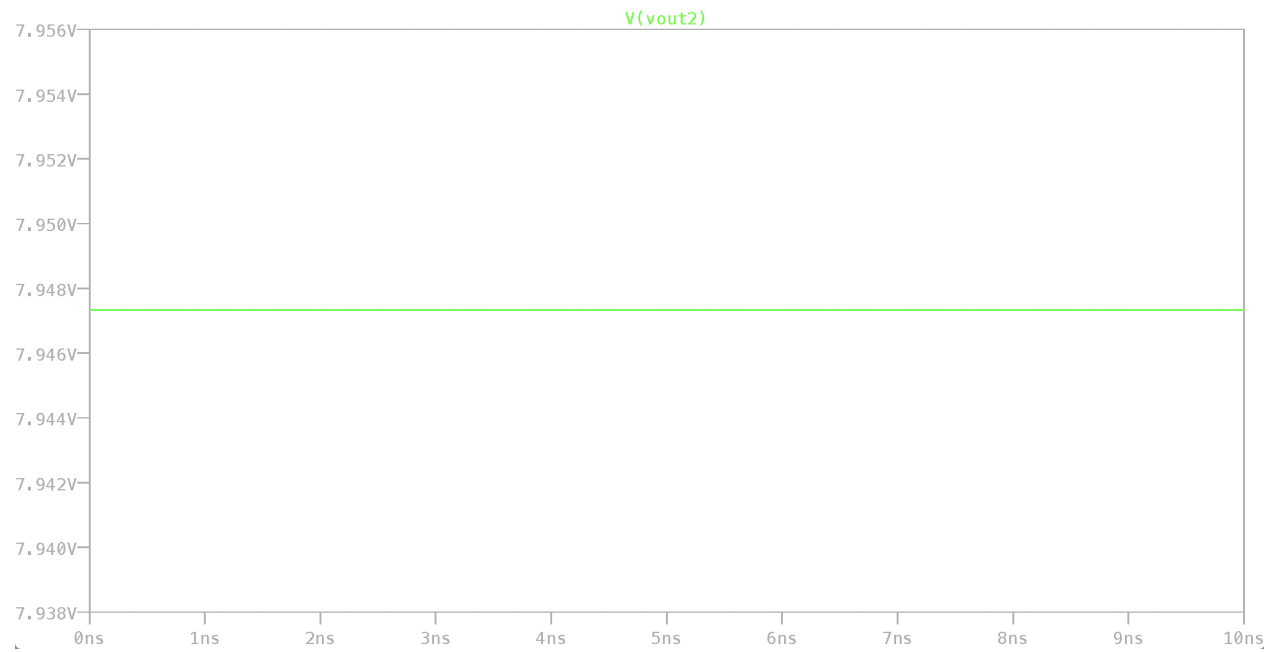


Figure 4: LTSpice Simulated Final output

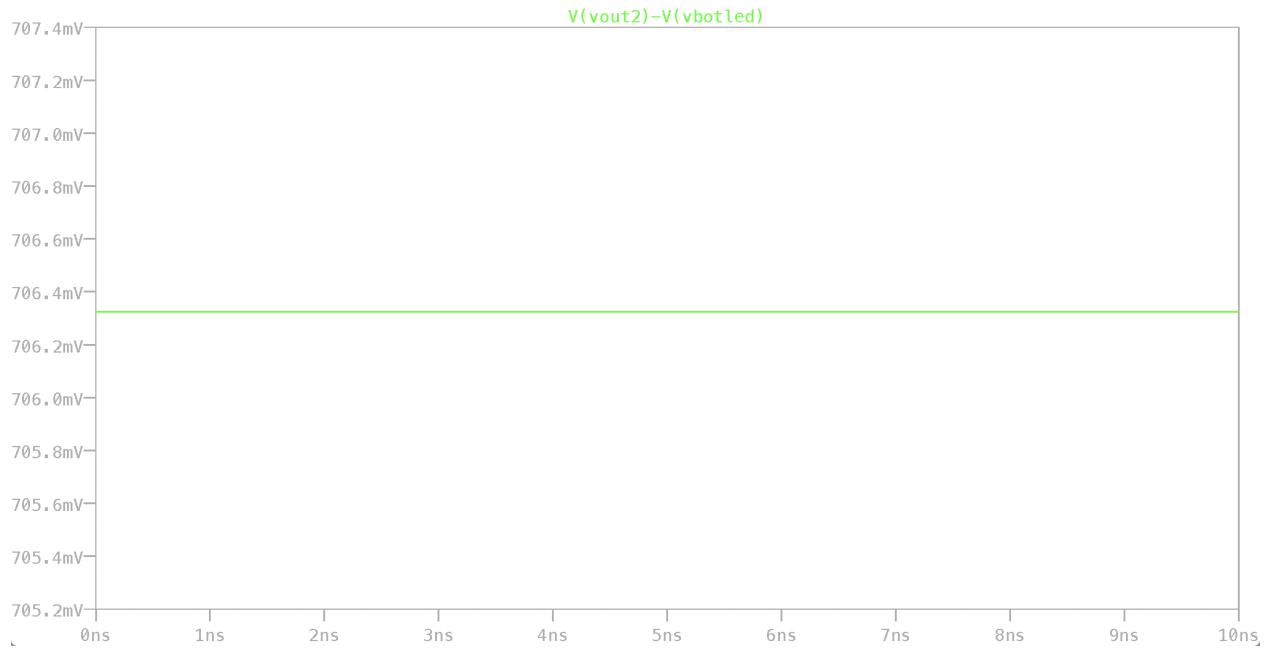


Figure 5: Voltage across LED when there is an input signal

Calculations:

$$\text{Gain} = - R_f / R_{in}$$

$$\text{Gain} = - 2.2 * 10^6 / 100k$$

$$\text{Gain} = - 22 V / V$$

-22 volts / volt is the gain for both of the non inverting amplifiers

This provides a total gain of the system of about 484 volts / volt non-inverted.

$$V_{led} = \sim .7 V$$

$$V_{input} = .7 / 484 = 1.4463 mV$$

This means that the circuit is so sensitive that it can pick up on signal with voltages as low as ~1.5 mV.

There is both an input capacitor and a capacitor connected between the two different op-amps to help filter the circuit as we are dealing with quite high frequencies.

Analysis / Conclusion:

After having built and used this circuit as a smartphone detector, the project was successful but definitely had its challenges. These challenges go all the way back to the planning stages of this project as part of the planning process was to identify who the product was for and who could get some value out of this device, to the designing section where it was hard to decide on which components would work the best and cause the least amount of issues for the circuit, to the simulation and making sure that circuit could potentially work, to finally building the circuit and troubleshooting. One hard thing about dealing with RF and looking at frequencies as high as we were, there are RF signals everywhere that love to interfere with whatever you are building. This is why the circuit had to be very sensitive and very precisely built. It was a fun project with a lot of ups and downs, but in the end, I am thankful got the experience and had the chance to build this.

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