V2V COMMUNICATION BASED ANTI RADIANCE HEADLIGHT USING EYE TRACKER

A PROJECT REPORT

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BONAFIDE CERTIFICATE

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"A successful man is one who can lay a firm foundation with the bricks others have thrown at him." - *David Brinkley*

Such a successful personality is our beloved founder Chairman, **Thiru. MJF. Ln. LEO MUTHU**. At first, we express our sincere gratitude to our beloved Chairman through prayers, who in the form of the Guiding Star has spread his wings of eternal support with immortal blessings.

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ABSTRACT

Accidents mainly occur due to negligence driving. This laxness costs the lives of many people. Most of the vehicular collisions happen after the sunset. In this case either the driver might have dozed off at the wheel or due to lack of concentration during driving. This dearth may occur due to vehicles coming on opposite direction with high beam lights. The high beam could affect the driver and make him lose the attention on the road. These problems can be overcome by implementing the above proposed system which is based on V2V(Vehicle to Vehicle) communication which relies upon the IEEE 1609 Family of Standards for Wireless Access in Vehicular Environments (WAVE). This standard is a upgrade of IEEE 802.11p. It combines the use of light sensors and eye tracker. This system measures the intensity of light beam and eye movement, analyses it and based on that analysis sends signals to the detection unit of the automobile approaching from the other side. The detection unit on receiving the signal dims the headlight automatically. Moreover every automobile consists of the transmitter and receiver unit.

KEYWORDS: sensors, high beam, eye movement

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LIST OF SYMBOLS, ABBREVIATIONS AND NOMENCLATURE

θ	- Visual angle
GM	- General Motors
CMOS	- Complementary Metal Oxide Semiconductor
CCD	- Charge Coupled Devices
SLM	- Spatial Light Modulator
DMD	- Digital Micro-mirror Device
RADAR	- RAdio Detection And Ranging
LIDAR	- LIght Detection And Ranging
3D	- 3 Dimension
LDR	- Light Dependent Resistor
LED	- Light Emitting Diode
MOSFET	- Metal Oxide Semiconductor Field Effect Transistor
BJT	- Bipolar Junction Transistor
V2V	- Vehicle to Vehicle
DSRC	- Dedicated Short Range Communication
ITS	- Intelligent Transportation System
WHO	- World Health Organization
ITSA	- Intelligent Transportation Society of America
WiFi	- Wireless Fidelity
VANET	- Vehicular Ad hoc Network
MANET	- Mobile Ad hoc Network
EU	- European Union
EEPROM	- Electrically Erasable Programmable Read Only Memory
USART	- Universal Synchronous Asynchronous Receiver Transmitter
RAM	- Random Access Memory
GPR	- General Purpose Register
SFR	- Special Function Register
UART	- Universal Asynchronous Receiver Transmitter
CRT	- Cathode Ray Tube
A/D	- Analog to Digital
D/A	- Digital to Analog

RF	- Radio Frequency
PCB	- Printed Circuit Board
VT	- Valid Transmission
IR	- Infra Red
ATM	- Automated Teller Machine
LCD	- Liquid Crystal Display
IVC	- Inter Vehicular Communication
RSU	- Road Side units
CAM	- Cooperative Awareness Messages
WAVE	- Wireless Access in Vehicular Environments
VNTA	- Vehicular Networks & Telematics Applications
ETSI	- European Telecommunication Standards Institute
QoS	- Quality of Service
ALS	- Ambient Light Sensor
Ω	- Resistance measure in ohm
W	- Power measured in watt
F	- Capacitance measured in faraday
V	- Voltage

CHAPTER 1

INTRODUCTION

1.1 HEADLIGHT

Night driving is a top cause for car accidents since the ability to perceive and judge distance is severely impaired at night. An estimated 90 percent of all driver decisions are made based on what they see. While the eyes are capable of seeing in limited light, the combination of headlights and road lights, with the darkness beyond them, can cause several problems for vision. Therefore, car drivers must take extra precaution to avoid an auto accident during the night.

Sunlight provides the strongest light source. When it goes down at night, there are a variety of man-made lights that help drivers safely navigate the roads. Our eyes will adjust to lower levels of light (pupils dilate in darkness and constrict in brightness), but they have difficulty functioning properly when switching from bright to dark, or vice-versa. This can happen quite a lot on the roads at night when you look directly into the headlights of oncoming traffic.

1.2 HEADLIGHT GLARE

Glare reduces seeing distance because it causes light scatter in the eyes, which in turn reduces the contrast of roadway objects. This effect is known as “disability glare.” The greater the intensity of the glare light and the closer the glare light is to where one is looking, the greater the disability glare will be. Disability glare can lead to the following effects:

- Decreasing visibility distance: The distance at which an object can be seen is known as the “visibility distance.” This distance is reduced when disability glare is present.

- Increasing reaction times: As the intensity of oncoming headlamps increases, drivers' reaction times to objects in and along the roadway become longer.
- Increasing recovery time: After drivers pass an oncoming vehicle, the glare has a lasting effect that increases the time it takes for the drivers' eyes to recover their ability to detect objects. During that time, the visibility distance is reduced and reaction times are increased.

As described above, headlamps can produce a sensation termed "discomfort glare." This is the feeling of annoyance or even pain that is possible when viewing a bright light. Experiencing discomfort can distract drivers from the driving task, cause them to slow down, and cause drift slightly in their lane.

1.2.1 NIGHT TIME GLARE ON TWO-LANE HIGHWAYS

Two-lane highways, as compared to multi-lane roadways and expressways, may present the "worst-case" scenario for night time glare. The reasons for this include:

- Lower light levels: Night time glare on unlighted roadways is more problematic because the visibility of an object is influenced by the overall light level. Since light levels tend to be lower on two-lane highways, objects along these roads are less visible in the presence of glare. In addition to the reduced visibility, the lower light levels on two lane highways increases discomfort glare because the relative brightness difference between headlamps and the roadway background is higher on these roads.
- Oncoming traffic closer to driver's line of sight: Because of the closer proximity of oncoming glare on two lane roadways, the beam pattern is directing more light at oncoming drivers, which produces more scattered light in their eyes.

- Complex roadway geometry: Two-lane highways often have complicated roadway geometries, including sharper curves and steeper grades. Thus, drivers on two lane roadways may be exposed to a higher range of oncoming headlamp glare than on multilane roadways.
- Less restricted roadway access: The greater potential for hazards to be found in any number of locations along the roadway increases the complexity of the driving task and makes glare more problematic and arguably less safe than it would be under easier driving situations.
- Fewer roadway markings: Roadway markings in and of themselves have no direct impact on the amount of light that oncoming headlamps produce toward a driver's eyes. However, they make the driving task easier by providing visual guidance about the geometry of the roadways and other roadway conditions.
- Closer proximity of pedestrians: Pedestrians are not always easily seen. While they may not be found frequently along two-lane roadways, they are in closer proximity when they are encountered on these kinds of roads. The difficulty seeing them at night can increase the difficulty of night time driving, and therefore, increase the impact of glare on both visibility and comfort.

1.2.2 FACTORS THAT CONTRIBUTE TO GLARE

The following design and operational factors are considered as they affect glare and associated risks.

- Headlamp mounting height: Higher mounting heights may produce improved visibility for drivers but could also result in higher light levels at the eyes of oncoming drivers, increasing their disability and discomfort glare.
- Lamp aim: Improperly aimed headlamps can increase glare and cause objects to remain invisible to oncoming drivers for longer durations. This effect is intensified when headlamps with higher mounting heights are improperly aimed. Improper headlamp aim can also reduce visibility for a driver.

- Headlamp beam distribution: Headlamps are optically designed to direct different intensities of light towards different directions. Federal regulations set minimum and maximum intensity levels that provide some control of the beam pattern to limit glare and provide light for seeing the roadway environment. Some locations within headlamp beams are not regulated in terms of allowable light levels. If headlamps produce high light levels in these locations, oncoming drivers might experience glare.
- Headlamp colour: Research indicates that people experience more discomfort when exposed to "bluer" high intensity discharge headlamps than when they are exposed to "yellower" halogen headlamps (halogen headlamps are found on most vehicles in the United States). Thus, colour can affect discomfort glare. No evidence exists to link the oncoming headlamp colour to visibility reductions.
- Headlamp size: While lamps of different sizes are statistically equal when seen from far away, smaller lamps might be more uncomfortable at closer distances.
- Headlamps and windshield cleanliness and condition: Headlamps that are dirty or damaged can produce higher light levels to oncoming drivers and also produce lower light levels on the roadway, reducing forward visibility for drivers who have dirty or damaged headlamps. Windshields that are soiled or damaged can scatter light and potentially increase the effects of glare

1.3 EFFECT OF GLARE

The speed, accuracy, and distance from which a person can see and recognize an object are influenced by the overall light level. Light from pole mounted roadway lighting fixtures (in addition to vehicle headlamps) often allows objects to be seen more reliably and more quickly than on unlighted roadways. Another factor contributing to visibility is the contrast of an object against its background. Glare reduces visibility by producing a brightness veil that reduces the contrast of objects. Contrast reduction can be mitigated by higher light levels on the road.

In other words, low contrast objects can be seen better if the overall light level is increased.

Traffic volume is a factor in making the decisions to install fixed lighting. Two-lane highways, especially rural two lane highways, are designed to carry less volume than expressways, so fixed lighting is often unwarranted for many two-lane highways except at complex intersections.

The sensation of glare is much larger on unlighted roads because one of the factors contributing to discomfort is the ratio in brightness between a glare light and the surrounding area – the greater the difference the greater the glare. Thus, seeing a pair of oncoming headlamps during the day or on a lighted two-lane road would likely be less disturbing than seeing the same oncoming headlamps on an unlighted two-lane road.

Many freeways and some undivided highways have more than two lanes of traffic traveling in each direction. Because the right-hand lane is usually used as the main driving lane, a significant proportion of traffic on these roads is separated from oncoming traffic by more than two lanes. This separation results in oncoming traffic being seen further off-axis than if it were on an undivided, two-lane highway; see Figure 1. This has two effects: the light at the driver's eyes from oncoming headlamps is lower in intensity because headlamps produce less light further from the forward direction, and the oncoming headlamps are further from the driver's direction of view down the roadway. Both of these factors combine to lessen the negative impacts of the glare light on visibility and comfort. On undivided, two lane roadways, both of these factors reduce drivers' visibility and increase discomfort. The visual angle (θ) toward oncoming traffic can be more than three times larger on a multiple lane roadway (lower panel) than on a two-lane roadway (upper panel).

Glare screens, mechanical barriers in the centre of the roadway, can block the view of oncoming traffic, thus reducing glare. Although these screens could perhaps be used to advantage in multi-lane highways, they are not feasible for most two lane highways.

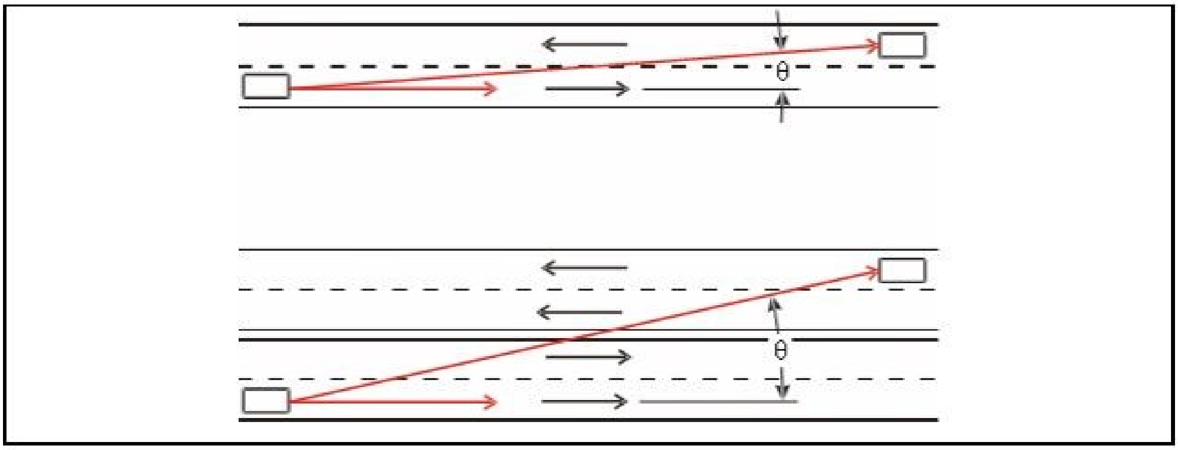


Figure 1. Effect of divided versus undivided highways on visual angle.

Freeways are designed to carry large amounts of traffic at very high speeds. They therefore tend to be built without sharp curves or steep gradients that would make high-speed travel dangerous. Two-lane highways also carry traffic at moderately high driving speeds but can have sharper curves as well as hills and changes in elevation not found on freeways. These more complicated roadway geometries expose drivers on two-lane roadways to a greater range of oncoming headlamp glare.

Consider a right-hand curve as illustrated in Figure 2. As the first driver begins to turn the vehicle into the curve, the headlamps on this vehicle must also begin to turn. Because headlamps produce higher light levels toward the passenger side of the vehicle, traffic coming from the opposite direction will be exposed to higher light levels than would normally be experienced if the same vehicles approached one another on a straight road. The impact of higher light levels from oncoming traffic can be made even worse if the driver needs to look at the centre line that is closer to the headlamps of the oncoming vehicle in order to safely navigate the curve. Higher levels will increase discomfort glare and result in increased disability glare because the contrast-reducing veil of brightness in the eyes will be even brighter.

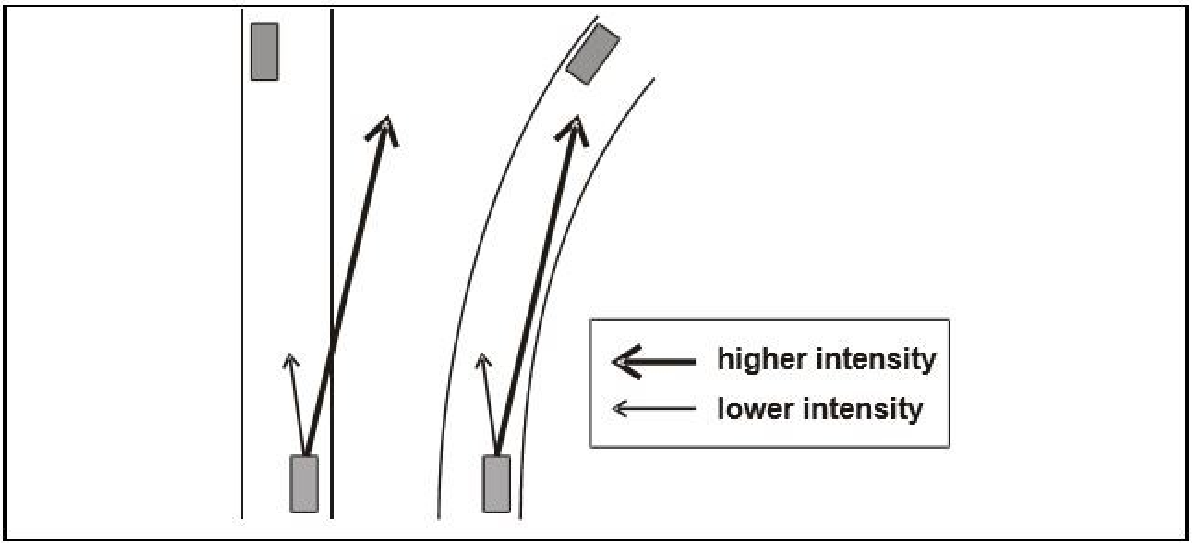


Figure 2. The effect of a curve on oncoming traffic glare exposure.

Many two-lane highways can have abutting roadways or driveways that enter traffic directly, whereas freeways with multiple lanes are more likely to have exit and entrance ramps. Previous research, has demonstrated that discomfort from headlamp glare increases when the visual task is more difficult, such as on curvy roads. The potential for hazards along a two-lane highway is greater than along a divided, multiple-lane highway because vehicles can enter a two-lane highway from a variety of locations and directions. Two-lane highways are also usually not restricted in terms of bicycle travel or pedestrian use, unlike many divided multi-lane highways. The greater hazard potential at any unknown location increases driving difficulty, making glare more uncomfortable and driving possibly less safe than on divided highways.

Multi-lane highways tend to be well marked with indications for the traffic lanes on each side of the road as well as a clearly marked median. Two lane highways, depending upon the amount of traffic they carry and their width, may not have median lines or edge lines to indicate the shoulder (if a shoulder is present); some very low volume roads and/or very narrow two lane highways have no markings at all.

The purpose of roadway markings and delineation systems is to facilitate efficient and safe traffic movement along a roadway. Perhaps no one would disagree with the observation that roadway markings make night time driving a much easier task. As with the roadway access issue, roadway markings in and of themselves have no direct impact on the amount of light that a driver is exposed to by oncoming headlamps. However, roadway markings can make the driving task easier by providing highly visible guidance to a driver about the width of the road and the probable location of oncoming vehicles, pedestrians or bicyclists. They can also alert drivers to the presence of curves or intersections before drivers might otherwise detect them on unmarked roadways.

CHAPTER 2

EARLIER WORKS

2.1 INTRODUCTION

Several developments have been made in the field of headlights ranging from General Motors headlight dimmer to the Eye tracking headlights. Automobile industry got renovated every time because of these innovations.

2.2 GENERAL MOTORS "AUTRONIC EYE"

General Motors introduced the first automatic headlight dimmer – called the Autronic Eye – in 1952, on its Cadillac and Oldsmobile models; Buick, Pontiac and Chevrolet models began offering this feature in 1953. Cars with the Autronic Eye were easily identified by a periscope-like phototube that sat on the dashboard's left side, just inside the windshield.

One criticism of early automatic headlight dimmers – GM's Autronic Eye in particular – was that the headlights tended to erratically flicker between low- and high-beams in response to minor fluctuations of light, such as street lamps.

GM discarded the troublesome Autronic Eye after 1958 in favor of a revamped automatic headlight dimming system called GuideMatic. Introduced in 1959, the GuideMatic – which had a slimmer appearance than the Autronic Eye and sat at the left side of the dashboard, later moved to the center – had a switch that allowed drivers to adjust when the headlights dimmed. Though the GuideMatic system was an improvement over the Autronic Eye, many GM customers were leery through past experience and fears that the new system was still too erratic. By the mid-1960s, this feature was dropped on all GM models except Cadillac (which continued offering GuideMatic through 1988). In recent years, however, Cadillac once again began offering an automatic headlight dimming system.

2.3 AUTOMATIC HEADLIGHT DIMMER SYSTEM

This invention relates to illumination control systems, and more particularly to light sensitive control circuits for automatically controlling the dimming of vehicular headlamps, commonly referred to as automatic headlight dimmers.

For many years automobiles have been provided with dual purpose headlights, i.e., the headlights are capable of operating as bright or driving lights, or as dimmed or deflected lights. The bright condition of such lights is variously referred to as the high beam, bright or driving condition, while the other condition is variously referred to as the dimmed, low beam or deflected condition. In the modern automobile separate filaments are provided in the headlights selectively to produce the condition, and to this end manually actuable means (commonly foot actuated) are provided in such automobiles. This is to permit the driver to dim or downwardly deflect his driving lights to avoid the blinding glare otherwise imposed on the driver of the oncoming vehicle and, of course, for other purposes While still permitting him quickly to switch to his bright or high beam lights after the oncoming vehicle has passed. This manual operation becomes rather trying due to its being a highly repeated operation, particularly on heavily travelled highways. For many years attempts have been made to eliminate this highly repeated manual operation by providing arrangements for automatically operating the dimming system on an automobile. At least one such system has for some years been commercially available.

An ideally designed automatic headlight dimming system for automobile vehicles is one that automatically switches between the high and low beams of the headlights of the vehicle only at the right times to insure that the driver constantly has the best road visibility. It should provide high beam lighting for the maximum time, and at the correct time provide low beam lighting for best road visibility as the cars approach each other. Consequently, an ideal automatic headlight dimmer should operate primarily on the lights of other cars. It should dim when the approaching car with dim lights is approximately twelve hundred feet away. Moreover, for safety and courtesy, it should dim on tail lights when it approaches a car from the rear or when another car passes. But it should not be operated by other types of lights, such as street lights, caution lights flashing on and off, lighted store windows and store signs, lighted outdoor signals, reflecting route markers and the like, or when a string of cars passes across an intersection in front of the car equipped with an ideal automatic dimmer. Furthermore, such an ideal system should immediately restore the high beam lights when the oncoming vehicle has passed, and the switching operation from low to high beam or vice versa should occur only when necessary.

Unfortunately, the systems heretofore available have in no way approached the ideal. Either they fail to dim the lights when they should or they switch the lights from high to dim a number of times when this should not occur.

Most of the automatic dimming systems for Vehicular headlamps have employed means for stepping up the voltage from that normally available in such vehicles to very high voltages and have included complicated ampler arrangements and the like. The high voltages create a danger from the standpoint of the serviceman. Many of these systems involve complicated optical systems which -are expensive and generally unsatisfactory.

From the above discussion it will be appreciated that the requirements for an ideal automatic headlight dimming system are very stringent. It should have ample sensitivity to insure dimming at a desired distance; it should be provided with a delay action requiring a predetermined delay, such as three seconds before the bright lights can be restored following dimming thereof, and also it should include what might be termed a hold down feature to prevent the restoration of the lights to the bright condition immediately after the predetermined delay so that the dimmed lights of the oncoming vehicle will prevent restoration of the bright lights; it should restore the lights to the bright condition within one half second after the light source which initiated the dimming action has been removed; it should be responsive to red lights so it dims on the tail lights of the car ahead; it should be simple and have a minimum of components so its cost is comparatively low; it should have means whereby its dim condition can be overridden by manual means in case it is momentarily necessary to manually flash your own lights from low beam to high beam to signal the oncoming driver that he should dim his own lights; it should operate on battery voltage so as to eliminate any electrical hazard to service personnel as well as to the driver; it should provide a uniform response to headlights or tail lights within an established optical acceptance pattern, `and finally it should effectively screen out all objectionable for light sources outside its optical acceptance pattern to eliminate unnecessary dimming from all other light sources.

Accordingly, it is an object of this invention to provide a new and improved automatic headlight dimming system. It is another object of the present invention to provide an automatic headlight dimming system meeting all of the requirements set forth above. It is still another object of the present invention to provide an automatic headlight dimming system which is simple and compact, inexpensive to manufacture and install in a vehicle, and which is capable of operating correctly for every conceivable road and driving condition while retaining full operation at the will of the operator of the vehicle.

2.4 VEHICLE HEADLIGHT CONTROL USING IMAGING SENSOR

A headlamp control system for a vehicle includes an imaging array sensor, which has a field of view forward of the vehicle, and a control that processes images captured by the imagine array sensor. The control is operable to detect light sources in the field of view and to determine an activity level in the field of view in response to a quantity of light sources detected. The control is operable to control a headlamp of the vehicle in response to identification of at least one of a headlamp of another vehicle and a taillight of another vehicle and in response to the activity level. The control may be operable to process the captured images to detect lane markers or precipitation in the field of view and may control a steering system of the vehicle or a wiper motor of the vehicle in response to such image processing.

This invention relates generally to vehicle control systems and, in particular, to a system and method for controlling the headlights of the vehicles. The invention is particularly adapted to controlling the vehicle's headlamps in response to sensing the headlights of oncoming vehicles and taillights of leading vehicles. It has long been a goal to automatically control the state of a vehicle's headlights in order to accomplish automatically that which is manually performed by the driver. In particular, the driver of a vehicle whose headlights are in a high-beam state will dim the headlights upon conscious realization that the headlights are a distraction to the driver of an oncoming vehicle or a leading vehicle. It is desirable to relieve the driver of such duties and thereby allow the driver to concentrate on the driving task at hand. The ideal automatic control would also facilitate the use of high beams in conditions which allow their use, increasing the safety for the controlled vehicle as well as reducing the hazard caused by the occasional failure of the driver to dim the headlights when such headlights are distracting another driver. A vehicle control which is capable of identifying unique characteristics of light sources based upon a precise evaluation of light source characteristics is made in each portion of the scene forward of the vehicle, in the vicinity of each light source, by separating each light source from the remainder of the scene and analysing that source to determine its characteristics. One characteristic used in identifying a light source is the spectral characteristics of that source which is compared with spectral signatures of known light sources, such as those of headlights and taillights. Another characteristic used in identifying a light source is the spatial layout of the light source. By providing the ability to identify the headlights of oncoming vehicles and the taillights of leading vehicles, the state of the headlights of the controlled vehicle may be adjusted in response to the presence or absence of either of these light sources or the intensity of these light sources. This is accomplished according to an aspect of the invention by providing an imaging sensor which divides the scene forward of the vehicle into a plurality of spatially separated sensing regions. A control circuit is provided that is responsive to the photo sensors in order to determine if individual regions include light levels having a particular intensity. The control circuit thereby identifies particular light sources and provides a control output to the vehicle that is a function of the light source identified. The control output may control the dimmed state of the vehicle's headlamps.

In order to more robustly respond to the different characteristics of headlights and taillights, a different exposure period is provided for the array in order to detect each light source. In particular, the exposure period may be longer for detecting leading taillights and significantly shorter for detecting oncoming headlights.

According to another aspect of the invention, a solid-state light imaging array is provided that is made up of a plurality of sensors arranged in a matrix on at least one semiconductor substrate. The light-imaging array includes at least one spectral separation device, wherein each of the sensors responds to light in a particular spectral region. The control circuit responds to the plurality of sensors in order to determine if spatially adjacent regions of the field of view forward of the vehicle include light of a particular spectral signature above a particular intensity level. A solid-state light-imaging array is provided that is made up of a plurality of sensors that divide the scene forward of the vehicle into spatially separated regions, and light sources are identified, at least in part, according to their spatial distribution across the regions. This aspect of the invention is based upon a recognition that headlights of oncoming vehicles and taillights of leading vehicles are of interest to the control, irrespective of separation distance from the controlled vehicle, if the source is on the central axis of travel of the vehicle.

Oncoming headlights and leading taillights may also be of interest away from this axis, or off axis, but only if the source has a higher intensity level and is spatially larger. These characteristics of headlights and taillights of interest may be taken into consideration by increasing the resolution of the imaging array along this central axis or by increasing the detection threshold off axis, or both. Such spatial evaluation may be implemented by selecting characteristics of an optical device provided with the imaging sensor, such as providing increased magnification central of the forward scene, or providing a wide horizontal view and narrow vertical view, or the like, or by arrangement of the sensing circuitry, or a combination of these. Moreover, a sensor having the ability to preselect data from the scene forward of the vehicle is used in order to reduce the input data set to optimize subsequent data processing. The invention is especially adapted for use with, but not limited to, photo array imaging sensors, such as CMOS and CCD arrays.

2.5 PROGRAMMABLE AUTOMOTIVE HEADLIGHTS

The primary goal of an automotive headlight is to improve safety in low light and poor weather conditions. But, despite decades of innovation on light sources, more than half of accidents occur at night even with less traffic on the road. Recent developments in adaptive lighting have addressed some limitations of standard headlights, however, they have limited flexibility such as switching between high and low beams, turning o beams toward the opposing lane, or rotating the beam as the vehicle turns.

A new computational illumination design for an automotive headlight that is flexible and can be programmed to perform multiple tasks at high speeds is introduced. The key idea is the introduction of a high-resolution spatial light modulator (SLM) such as the digital micro-mirror device (DMD) present in DLP projectors. A DMD divides a light beam into approximately one million beams that can be individually controlled to shape the collective beam for any situation.

A sensor (camera) is co-located with the light source and a computer processes images to generate illumination patterns for the SLM. While the design may seem straightforward and follows many works on projector camera systems in computer vision, there are many challenges in building such a system to serve as a headlight. The accuracy requirements can be high since small errors in beam positioning and flickering are easily perceived and can be more disturbing than standard headlights. High accuracy can be achieved by minimizing the time from when a camera senses the environment to when the headlight reacts(system latency). Low latency is also required to avoid the need for complex prediction algorithms to determine where an object will move next.

Programmable headlight design consists of four main components: an image sensor, processing unit, spatial light modulator (SLM), and beam splitter.

The imaging sensor observes the road environment in front of the vehicle. Additional sensors such as RADAR or LIDAR can be incorporated into the design to complement the camera. The processor analyses image data from the sensor and controls the headlight beam via a spatial light modulator. The spatial light modulator (e.g., digital micro-mirror device, liquid crystal display, liquid crystal on silicon, etc.) modifies the beam from a light source by varying the intensity over space and time in two dimensions. We use a DMD because its high working frequency and small pixel size permit high-speed modulation and ne illumination control, which makes it possible for our headlight to quickly react to objects as small as snowflakes and objects as large as vehicles.

The camera and SLM are co-located along the same optical line of sight via a beam splitter, which virtually places the image sensor and DMD at the same location. Co-location is advantageous because it makes calculating the distance to objects unnecessary. Consequently, there is no need to perform costly computations required for depth estimation and 3D tracking. Also, a single homography will map the camera and projector image planes regardless of the scene. If the image sensor and DMD chip are placed very close to each other, the beam splitter is not required. Reactive visual systems with a similar design have been described but their systems are too slow for high-speed automotive applications. High latency in conjunction with road effects like wind turbulence and vibration will require complex prediction algorithms that will add latency to the system making it unusable. The automotive headlight should not be a passive device that can only be completely switched on or off. It should be capable of adapting to the environment to improve safety in poor visibility conditions. Moreover, the design for adaptive headlights should not be limited to a single task. It should be capable of performing many different tasks to help the driver in multiple road environments.

The headlight design provides unprecedented light beam control over space and time. We have demonstrated the exibility of the headlight for numerous tasks: allowing drivers to use high beams without glaring any other driver on the road, allowing drivers to see better in snow, and allowing better illumination of road lanes, sidewalks and dividers. The prototype can quickly react to the road environment within 1 to 2.5 milliseconds, and, thus does not create any flicker to be seen by the human eye. Further research and development is needed to make the prototype compact to within actual vehicle headlight compartments. Further engineering is required to make the system reliable in the presence of vehicular vibrations and heat. Lastly, more sophisticated algorithms and reliable software need to be developed before deploying the headlight design

2.6 EYE TRACKING HEADLIGHTS

Every year, car headlights waste an unconscionable number of photons by illuminating things that the driver of the car doesn’t care about. All those poor photons, just uselessly flying off into the darkness. GM worked on a system that made sure that car’s headlights point where eyes are looking and nowhere else. Most of the time, car’s headlights are pointed by default. But there are all kinds of situations that probably come up every single time at night that make headlights locked in the forward position less than ideal. Like when approaching crosswalks or curves in the road and even every single intersection.

Rather than just turn to follow the road like some adaptive headlights do, GM's system can move on both horizontal and vertical axes to point headlights in very specific directions, whether it's off to one side, close to the car or off in the distance, or some weird combination like the weather is bad and driving through a crowded area. In order to figure out where to point, GM relied on a relatively simple infrared camera along with infrared illuminators that can identify your pupils. The system watches eye continuously, updating the direction of gaze 50 times a second, and easily adapts to whoever is behind the wheel with no calibration.

Recognizing that drivers get easily distracted, GM's lighting system included a sort of delayed smoothing algorithm that keeps the headlights from erratically jumping up and down as eyes repeatedly glanced at the cell phone (or somewhere less dangerous), resulting in what the carmaker calls "a suitably flowing movement for the light cone." In other words, the headlights will generally keep pointing in the same direction unless the driver focus somewhere else for a little bit, which will cause them to smoothly adjust themselves to provide the best possible illumination.

CHAPTER 3

EXISTING SYSTEM

3.1 HEADLIGHT DIMMER USING BJT

The requirement of headlight is very common during night travel. The same headlight which assists the driver for better vision during night travel is also responsible for many accidents that are being caused. The driver has the control of the headlight which can be switched from high beam to low beam. The headlight has to be adjusted according to the light requirement by the driver. During pitch black conditions where there are no other sources of light, high beam is used to. On all other cases, low beam is preferred. But in a two way traffic, there are vehicles plying on both sides of the road. So when the bright light from the headlight of a vehicle coming from the opposite direction falls on a person, it glares him for a certain amount of time. This causes disorientation to that driver. This discomfort will result in involuntary closing of the driver's eyes momentarily. This fraction of distraction is the prime cause of many road accidents. The entire working of the dimmer is a simple electronic circuitry arrangement which senses and switches the headlight according to the conditions required.

The various components used in the circuit are LDR, two resistors as a potential divider, Transistor, Relay switch, LED bulbs and a Supply voltage. The LDR is used to sense the incoming light. As the name suggests, its resistance value is varied according to the intensity of light that is incident upon its sensor. Higher the light intensity, lower will be the resistance. The resistors used are a standard 0.25 watt, 1.6 kilo ohm and 30 ohm. They are used a potential divider in order to control the gate current to the transistor. The transistor can be a BJT or a MOSFET. If BJT is used, then the standard BC 547 is preferred. If a higher switching speed is required, then MOSFET-IRF 840 can be used. The relay used is a 400 ohm coil, 12 volt, 5 terminal type. The normally closed contact is connected to the high beam bulb. A supply of 12 volts is required for the circuit. It is taken form the vehicle's battery box. This is preferred for two reasons. First, it is a constant DC supply and second, there is no need for introducing a separate electrical supply source. Two 0.25 watt LED bulbs are taken for simulating the headlights of the vehicle. One represents the bright mode bulb and the other, the low beam bulb.

From the layout given in the Figure.3, the basic idea about the working of the circuit can be understood. The LDR acts a variable resistor. So the LDR and the two resistors form a potential divider network which will decide the current in the circuit. Thus, the balanced network gives a trigger to the gate/base of the transistor. The design of this particular circuit gets a trigger if there is a voltage imbalance in the circuit due to change in resistance of the LDR due to the light source.

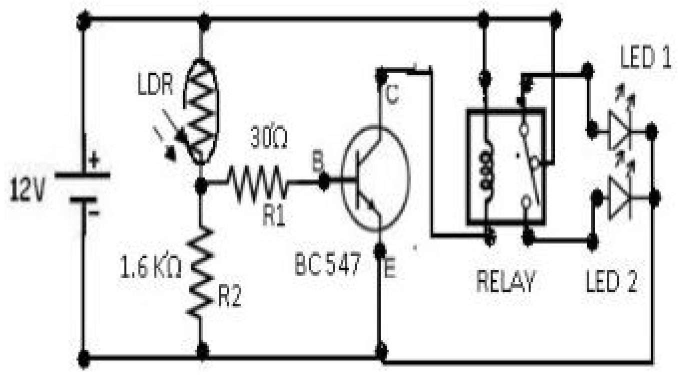


Figure 3. Schematic diagram of dimmer circuit

The basic operation is like that of a comparator. The transistor's output is connected to the relay coil. The bulbs are already connected to the relay contacts. LED 1 represents the high beam bulb which is in normally closed condition with the relay. LED 2 represents the low beam bulb of the vehicle which is at normally open terminal of the relay. Whenever a high intense light falls on the LDR, its resistance drops thus creating an unbalance in the potential divider formed between the LDR, and two resistors R1 and R2. This will create a trigger current which turns on the transistor BC 547. The transistor gets into the conduction mode and switches the relay. Hence the normally closed terminal gets disconnected and the normally open terminal will be switched. So, the vehicle headlight which is in bright mode gets turned off and the low beam mode gets turned on by the relay. This happens when the vehicle from the opposite side crosses our vehicle. Thus as the other vehicle comes nearer the intensity of that beam will increase and switch the high beam light to low beam. As it moves away, the LDR will be turned away from the moving vehicle. So, the LDR resistance increases and the bridge balances. There will hence no trigger current and the relay switches back to normal position. This will again turn on the bright beam mode bulb in the vehicle.

3.2 TROXLER EFFECT

Troxler's fading or the Troxler effect, is an optical illusion affecting visual perception. When one fixates on a particular point for even a short period of time, an unchanging stimulus away from the fixation point will fade away and disappear. Recent research suggests that at least some portion of the perceptual phenomena associated with Troxler's fading occurs in the brain. Troxler's fading was first identified by Swiss physician Ignaz Paul Vital Troxler in 1804, who was practicing in Vienna at the time. Troxler's fading has been attributed to the adaptation of neurons vital for perceiving stimuli in the visual system. It is part of the general principle in sensory systems that unvarying stimuli soon disappear from our awareness. For example, if a small piece of paper is dropped on the inside of one's forearm, it is felt for a short period of time. Soon, however, the sensation fades away. This is because the tactile neurons have adapted and start to ignore the unimportant stimulus. But if one jiggles one's arm up and down, giving varying stimulation, one will continue to feel the paper.

A similar 'sensory fading' or filling in, can be seen of a fixated stimulus when its retinal image is made stationary on the retina (a stabilized retinal image). Stabilization can be done in at least three ways.

- First, one can mount a tiny projector on a contact lens. The projector shines an image into the eye. As the eye moves, the contact lens moves with it, so the image is always projected onto the same part of the retina;
- Second, one can monitor eye movements and move the stimulus to cancel the eye movements;
- Third, and this is the technique most people will know, one can induce an afterimage, usually by an intense, brief flash, such as when one is photographed using a photographic flash. This causes an image to be bleached onto the retina by the strong response of the rods and cones. In all these cases, the stimulus fades away after a short time and disappears.

The Troxler effect is enhanced if the stimulus is small, is of low contrast (or "equiluminant"), or is blurred. The effect is enhanced the further the stimulus is away from the fixation point. Troxler's fading can occur without any extraordinary stabilization of the retinal image in peripheral vision because the neurons in the visual system beyond the rods and cones have large receptive fields. This means that the small, involuntary eye movements made when fixating on something fail to move the stimulus onto a new cell's receptive field, in effect giving unvarying stimulation. Further experimentation this century by Hsieh and Tse showed that at least some portion of the perceptual fading occurred in the brain, not in the eyes.

3.3 DEMERITS OF EXISTING SYSTEM

- No vehicle to vehicle communication (V2V).
- Only sensors were used for automatic dimming.

- Didn’t consider about driver’s condition.
- Dependent on external factors.
- Was limited to single automobile and concepts like eye tracker was not used.

CHAPTER 4

PROPOSED SYSTEM

Driving in night causes a lot of strain in eyes because of the high beam headlight of the oncoming vehicles. The driver gets distracted due to the high beam headlight. The proposed system works based on the concept of V2V communication. Vehicular communication systems are networks in which vehicles and roadside units are the communicating nodes, providing each other with information, such as safety warnings and traffic information. They can be effective in avoiding accidents and traffic congestion. Both types of nodes are dedicated short-range communications (DSRC) devices. DSRC works in 5.9 GHz band with bandwidth of 75 MHz and approximate range of 1000 m. Vehicular communications is usually developed as a part of intelligent transportation systems (ITS). The main motivation for vehicular communication systems is safety and eliminating the excessive cost of traffic collisions. According to World Health Organizations (WHO), road accidents annually cause approximately 1.2 million deaths worldwide; one fourth of all deaths caused by injury. Also about 50 million persons are injured in traffic accidents. If preventive measures are not taken road death is likely to become the third-leading cause of death in 2020 from ninth place in 1990. However the deaths caused by car crashes are in principle avoidable. Intelligent Transportation Society of America (ITSA) aims to improve cooperation among public and private sector organizations. ITSA summarizes its mission statement as “vision zero” meaning its goal is to reduce the fatal accidents and delays as much as possible.

V2V is an automobile technology designed to allow automobiles to "talk" to each other. The systems will use a region of the 5.9 GHz band set aside by the United States Congress in 1999, the unlicensed frequency also used by WiFi. V2V is currently in active development by General Motors, which demonstrated the system in 2006. V2V is also known as VANETs (Vehicular Ad Hoc Networks). It is a variation of MANETs (Mobile Ad Hoc Networks), with the emphasis being now the node is the vehicular. In 2001, it was mentioned in a publication that ad hoc networks can be formed by cars and such networks can help overcome blind spots, avoid accidents, etc. Over the years, there have been considerable research and projects in this area, applying VANETs for a variety of applications, ranging from safety to navigation and law enforcement. Intelligent transportation systems (ITS) are advanced applications which, without embodying intelligence as such, aim to provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated, and 'smarter' use of transport networks.

Although ITS may refer to all modes of transport, EU Directive defines ITS as systems in which information and communication technologies are applied in the field of road transport, including infrastructure, vehicles and users, and in traffic management and mobility management, as well as for interfaces with other modes of transport. Thus taking the embodiment of ITS in this proposed system, a prototype has been developed which mainly depends on the components like eye tracker, light sensor, micro controller and antenna. It uses the eye tracker technology in a way such that the eye movements of the driver are studied and based on that analysis, radio waves is sent to the upcoming vehicle. The micro controller of the opposite vehicle connected with the receiver antenna analyses the data and does the appropriate action. Light sensors are used to detect the rays of the headlight and it only initiates the action. The sensors and eye tracker are interfaced with a pic microcontroller

CHAPTER 5

PROTOTYPE OF THE PROPOSED SYSTEM

5.1 PROTOTYPE CONSTRUCTION

A basic block diagram is used to explain the working of the proposed system. From the Figure 4., it is considered that Car A comes with high beam. Driver of Car B feels uneasy because of it and there will be changes in the eye movement of Driver B.

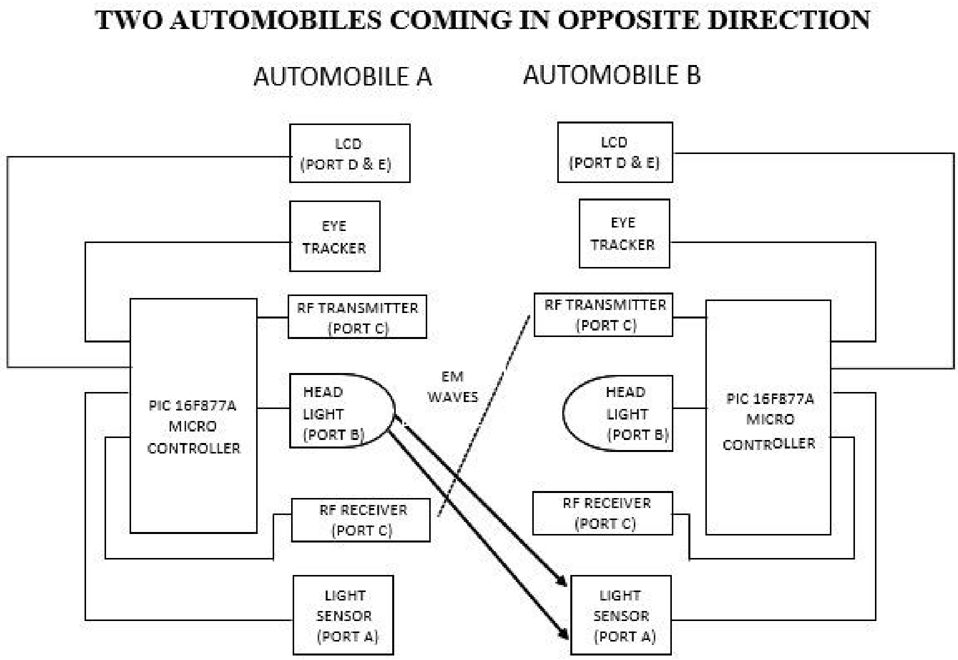


Figure 4. Basic block diagram of the proposed system

This is tracked by eye tracker fixed inside the car (near rear view mirror or behind the steering wheel) which is connected to the micro controller in Car B. Meanwhile the light sensors fixed outside the Car B will measure the intensity of the light and convey it to micro controller. Depending on the data received from eye tracker and sensors the microcontroller in Car B will communicate it to the another microcontroller in Car A. Now the high beam in Car A will be automatically changed to low beam. When Car A crosses Car B and passes on the beam will be again changed to high beam. The same is done as vice versa.

5.2 COMPONENTS USED IN PROTOTYPE

A prototype has been developed based on the above proposed system and it uses components like PIC 16F877A microcontroller, Radio Frequency transmitter and receiver, HT12E encoder, HT12D decoder, Eye tracker based on IR sensor, LCD, LDR, resistors and LED. Here LEDs are used to denote the vehicle headlight.

5.2.1 PIC16F877A

The PIC microcontroller PIC16f877a is one of the most renowned microcontrollers in the industry. This controller is very convenient to use, the coding or programming of this controller is also easier. One of the main advantages is that it can be write-erase as many times as possible because it use FLASH memory technology. It has a total number of 40 pins as shown in Figure.5 and there are 33 pins for input and output. PIC16F877A also have many application in digital electronics circuits.

Figure 5. PIC16F877A Microcontroller

PIC16f877a finds its applications in a huge number of devices. It is used in remote sensors, security and safety devices, home automation and in many industrial instruments. An EEPROM is also featured in it which makes it possible to store some of the information permanently like transmitter codes and receiver frequencies and some other related data. The cost of this controller is low and its handling is also easy.

5.2.1.1 PIN CONFIGURATION AND DESCRIPTION

As it has been mentioned before, there are 40 pins of this microcontroller IC.

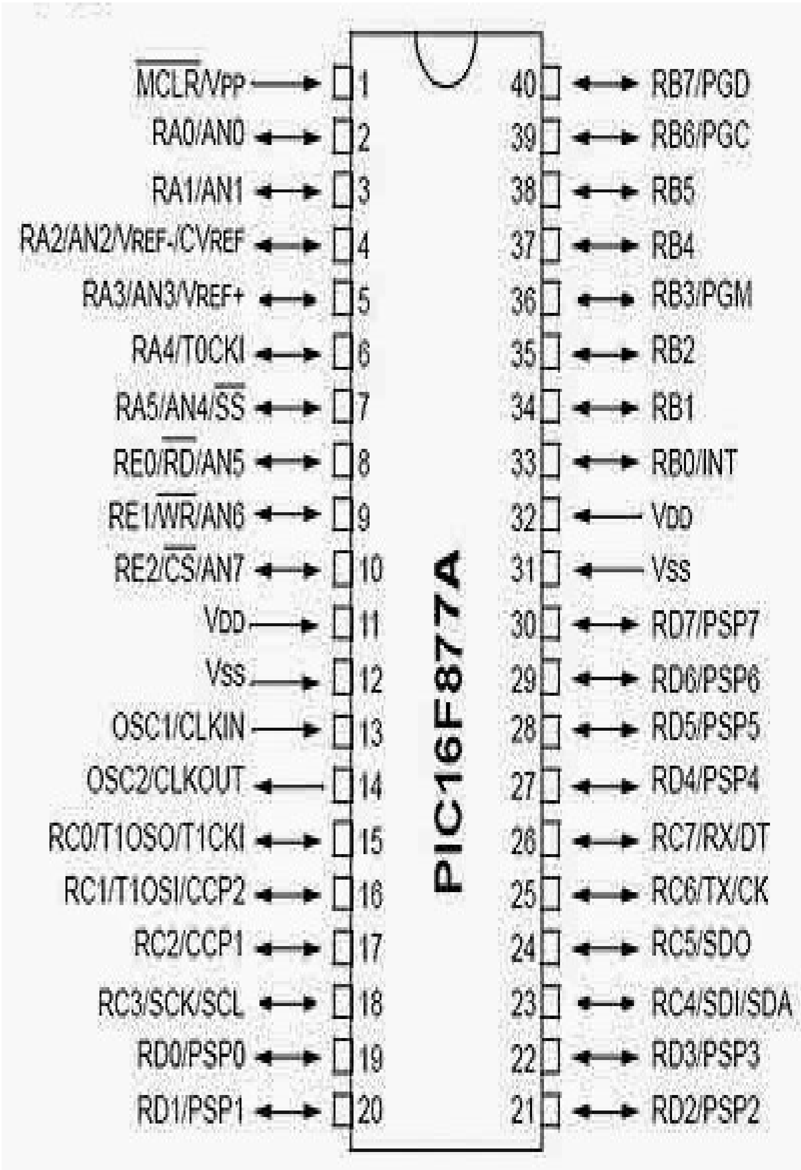


Figure 6. Pin diagram of PIC16F877A

It consists of two 8 bit and one 16 bit timer. Capture and compare modules, serial ports, parallel ports and five input/output ports are also present in the microcontroller shown in Figure 6.

- PIN 1: MCLR

  The first pin is the master clear pin of this IC. It resets the microcontroller and is active low, meaning that it should constantly be given a voltage of 5V and if 0 V are given then the controller is reset. Resetting the controller will bring it back to the first line of the program that has been burned into the IC.

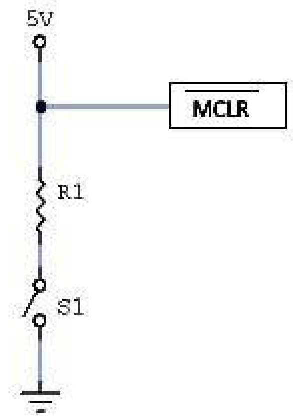


Figure 7. Microcontroller Reset

  A push button and a resistor is connected to the pin. The pin is already being supplied by constant 5V. When we want to reset the IC we just have to push the button which will bring the MCLR pin to 0 potential thereby resetting the controller.

- PIN 2: RA0/AN0

  PORTA consists of 6 pins, from pin 2 to pin 7, all of these are bidirectional input/output pins. Pin 2 is the first pin of this port. This pin can also be used as an analog pin AN0. It is built in analog to digital converter.

- PIN 3: RA1/AN1

  This can be the analog input 1.

- PIN 4: RA2/AN2/Vref-

  It can also act as the analog input2. Or negative analog reference voltage can be given to it.
- PIN 5: RA3/AN3/Vref+

  It can act as the analog input 3. Or can act as the analog positive reference voltage.
- PIN 6: RA0/T0CKI

  To timer0 this pin can act as the clock input pin, the type of output is open drain.
- PIN 7: RA5/SS/AN4

  This can be the analog input 4. There is synchronous serial port in the controller also and this pin can be used as the slave select for that port.
- PIN 8: RE0/RD/AN5

  PORTE starts from pin 8 to pin 10 and this is also a bidirectional input output port. It can be the analog input 5 or for parallel slave port it can act as a 'read control' pin which will be active low.
- PIN 9: RE1/WR/AN6

  It can be the analog input 6. And for the parallel slave port it can act as the 'write control' which will be active low.
- PIN 10: RE2/CS/A7

  It can be the analog input 7, or for the parallel slave port it can act as the 'control select' which will also be active low just like read and write control pins.
- PIN 11 and 32: VDD

  These two pins are the positive supply for the input/output and logic pins. Both of them should be connected to 5V.
- PIN 12 and 31: VSS

These pins are the ground reference for input/output and logic pins. They should be connected to 0 potential.

- PIN 13: OSC1/CLKIN

  This is the oscillator input or the external clock input pin.

- PIN 14: OSC2/CLKOUT

  This is the oscillator output pin. A crystal resonator is connected between pin 13 and 14 to provide external clock to the microcontroller. ¼ of the frequency of OSC1 is outputted by OSC2 in case of RC mode. This indicates the instruction cycle rate.

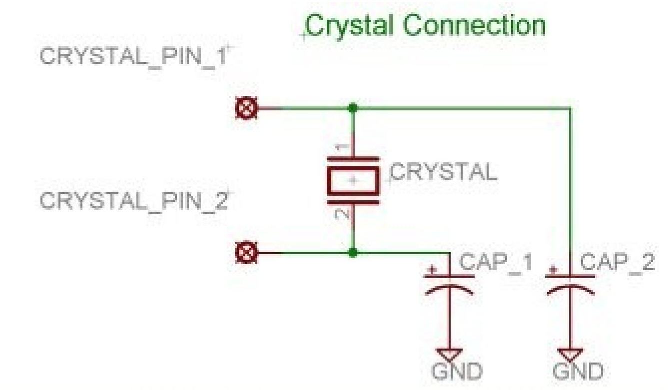


Figure 8. 13th and 14th pin of PIC16F877A

- PIN 15: RC0/T1OCO/T1CKI

  PORTC consists of 8 pins. It is also a bidirectional input output port. Of them, pin 15 is the first. It can be the clock input of timer 1 or the oscillator output of timer 2.

- PIN 16: RC1/T1OSI/CCP2

  It can be the oscillator input of timer 1 or the capture 2 input/compare 2 output/ PWM 2 output.

- PIN 17: RC2/CCP1

  It can be the capture 1 input/ compare 1 output/ PWM 1 output.

- PIN 18: RC3/SCK/SCL

  It can be the output for SPI or I2C modes and can be the input/output for synchronous serial clock.

- PIN 23: RC4/SDI/SDA

  It can be the SPI data in pin. Or in I2C mode it can be data input/output pin.
- PIN 24: RC5/SDO

  It can be the data out of SPI in the SPI mode.
- PIN 25: RC6/TX/CK

  It can be the synchronous clock or USART Asynchronous transmit pin.
- PIN 26: RC7/RX/DT

  It can be the synchronous data pin or the USART receive pin.
- PIN 19,20,21,22,27,28,29,30:

  All of these pins belong to PORTD which is again a bidirectional input and output port. When the microprocessor bus is to be interfaced, it can act as the parallel slave port.
- PIN 33-40: PORT B

  All these pins belong to PORTB. Out of which RB0 can be used as the external interrupt pin and RB6 and RB7 can be used as in-circuit debugger pins.

5.2.1.2 MEMORY ORGANISATION

Memory of the PIC16F877 divided into 3 types of memories:

- Program Memory - A memory that contains the program(which we had written), after we've burned it. As a reminder, Program Counter executes commands stored in the program memory, one after the other.
- Data Memory – This is RAM memory type, which contains a special registers like SFR (Special Faction Register) and GPR (General Purpose Register). The variables that we store in the Data Memory during the program are deleted after we turn of the micro.

These two memories have separated data buses, which makes the access to each one of them very easy.

- Data EEPROM (Electrically Erasable Programmable Read-Only Memory) - A memory that allows storing the variables as a result of burning the written program.

Each one of them has a different role. Program Memory and Data Memory two memories that are needed to build a program, and Data EEPROM is used to save data after the microcontroller is turned off. Program Memory and Data EEPROM they are non-volatile memories, which store the information even after the power is turn off. These memories called Flash Or EEPROM. In contrast, Data Memory does not save the information because it needs power in order to maintain the information stored in the chip.

5.2.1.2.1 PROGRAM MEMORY

The PIC16F877A devices have a 13-bit program counter capable of addressing an 8K word x 14 bit program memory space. This memory is used to store the program after we burn it to the microcontroller. The PIC16F877A devices have 8K words x 14 bits of Flash program memory that can be electrically erased and reprogrammed. Each time we burn program into the micro, we erase an old program and write a new one.

Program Counter (PC) keeps track of the program execution by holding the address of the current instruction. It is automatically incremented to the next instruction during the current instruction execution.

The PIC16F877A family has an 8-level deep x 13-bit wide hardware stack. The stack space is not part of either program or data space and the stack pointer is not readable or writable. In the PIC microcontrollers, this is a special block of RAM memory used only for this purpose.

The CALL instruction is used to jump to a subroutine, which must be terminated with the RETURN instruction. CALL has the address of the first instruction in the subroutine as its operand. When the CALL instruction is executed, the destination address is copied to the PC. The PC is PUSHed onto the stack when a CALL instruction is executed, or an interrupt causes a branch. The stack is POP'ed in the event of a RETURN, RETLW or a RETFIE instruction execution.

The stack operates as a circular buffer as shown in Figure 9. This means that after the stack has been PUSHed eight times, the ninth push overwrites the value that was stored from the first push. The tenth push overwrites the second push (and so on).

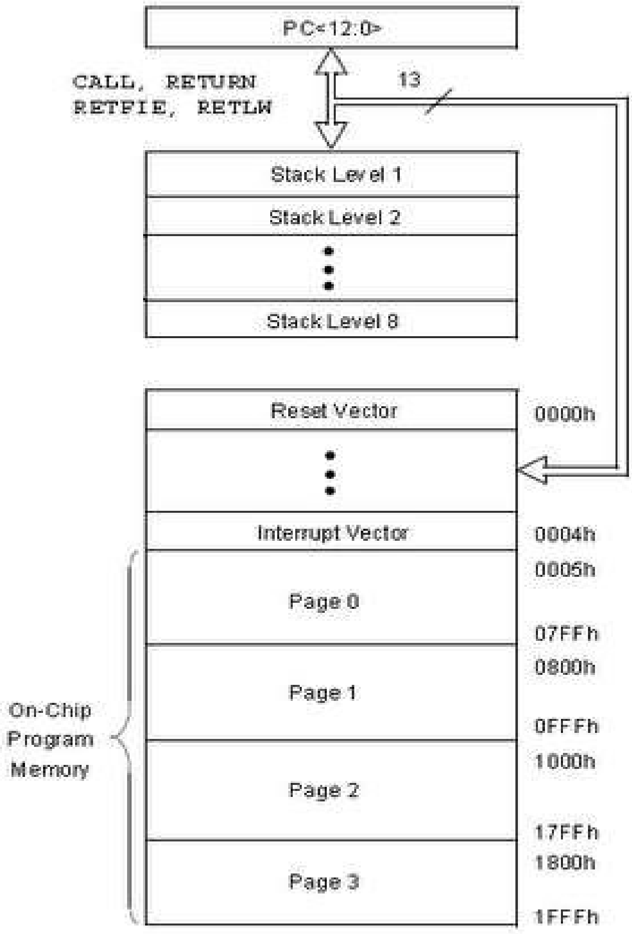


Figure 9. PIC16F877A program memory map and stack

Each time the main program execution starts at address 0000 - Reset Vector. The address 0004 is "reserved" for the "interrupt service routine" (ISR).

5.2.1.2.2 DATA MEMORY

The data memory is partitioned into multiple banks which contain the General Purpose Registers and the Special Function Registers. Number of banks may vary depending on the microcontroller; for example, micro PIC16F84 has only two banks.

Each bank extends up to 7Fh (128 bytes). The lower locations of each bank are reserved for the Special Function Registers. Above the Special Function Registers are General Purpose Registers, implemented as static RAM. While program is being executed, it is working with the particular bank. The default bank is BANK0**.** To access a register that is located in another bank, one should access it inside the program. There are special registers which can be accessed from any bank, such as STATUS register. They are

- STATUS register – changes/moves from/between the banks
- PORT registers – assigns logic values (“0”/”1”) to the ports
- TRIS registers - data direction register (input/output)

STATUS register :

In most cases, this register is used to switch between the banks (Register Bank Select), but also has other capabilities.

STATUS REGISTER (ADDRESS 03h, 83h, 103h, 183h)

R/W-0	R/W-0	R/W-0	R-1	R-1	R/W-x	R/W-x	R/W-x
IRP	RP1	RP0	$\overline{TO}$	$\overline{PD}$	Z	DC	C
bit 7							bit 0

Figure 10. PIC STATUS register

With the help of three left bits (IRP, RP1, and RP0) one can control the transition between the banks:

- IRP - Register Bank Select bit, used for indirect addressing method.

- RP1:RP0: - Register Bank Select bits, used for direct addressing method.

To distinguish between the two methods, at this point, the will use the definition of fundamental concepts. Later on, the two methods will be studied in detail. When the IRP Equal to 0, the program will work with banks 0, 1. When the IRP Equal to 1, the program will work with banks 2, 3.

The following Table 1 demonstrates, which of the Banks the program is working with, based on the selection of the RP0 and RP1 bits:

RP1:RP0	**BANK**
00	0
01	1
10	2
11	3

Table 1. Register Bank Select bits needed for program

We are setting the 5th bit, RP0, in the STATUS register to 1, and thus, based on the table we are switching/selecting Bank 1. After PortB was set as output in the second line, we switched back to Bank 0 by in changing/setting the 5th bit, RP0, in the STATUS register to 0.

PORT register:

The role of the PORT register is to receive the information from an external source (e.g. sensor) or to send information to the external elements (e.g. LCD). The 28-pin devices have 3 I/O ports, while the 40/44-pin devices, like PIC16F877, have 5 I/O ports located in the BANK 0.

- PORTA is a 6-bit wide, bidirectional port. The corresponding data direction register is TRISA. Setting a TRISA bit (= 1) will make the corresponding PORTA pin an input. Clearing a TRISA bit (= 0) will make the corresponding PORTA pin an output.
- PORTB is an 8-bit wide, bidirectional port. The corresponding data direction register is TRISB. Setting a TRISB bit (= 1) will make the corresponding PORTB pin an input. Clearing a TRISB bit (= 0) will make the corresponding PORTB pin an output.
- PORTC is an 8-bit wide, bidirectional port. The corresponding data direction register is TRISC. Setting a TRISC bit (= 1) will make the corresponding PORTC pin an input. Clearing a TRISC bit (= 0) will make the corresponding PORTC pin an output.
- PORTD is an 8-bit port with Schmitt Trigger input buffers. Each pin is individually configurable as an input or output.
- PORTE has three pins (RE0/RD/AN5, RE1/WR/AN6 and RE2/CS/AN7) which are individually configurable as inputs or outputs. These pins have Schmitt Trigger input buffers.

TRIS register:

The TRIS register is data direction register which defines if the specific bit or whole port will be an input or an output as shown in Table 2. Each PORT has its own TRIS register. The running program is working only with one bank at all time. If not set otherwise, then as stated, the default bank is BANK0. Part of the registers located inside BANK0, and some are not. When we need to access a register that is not located inside BANK0, we are required to switch between the banks.

The default mode of each TRIS is input. If you want to set a specific port as exit you must change the state of the TRIS to 0.

Here's a map of the locations:

BANK0	BANK1
PORTA	TRISA
PORTB	TRISB
PORTC	TRISC
PORTD	TRISD
PORTE	TRISE

Table 2. Ports and their Registers

5.2.1.2.3 DATA EEPROM

The data EEPROM and Flash program memory is readable and writable during normal operation (over the full VDD range). This memory is not directly mapped in the register file space. Instead, it is indirectly addressed through the Special Function Registers. There are six SFRs used to read and write to this memory.

When interfacing to the data memory block, EEDATA holds the 8-bit data for read/write and EEADR holds the address of the EEPROM location being accessed. These devices have 128 or 256 bytes of data EEPROM (depending on the device), with an address range from 00h to FFh. On devices with 128 bytes, addresses from 80h to FFh are unimplemented.

A few important points about Data EEPROM memory are

- It lets you save data DURING programming
- The data is saved during the “burning” process
- You can read the data memory during the programming and use it

5.2.1.3 USART

USART (Universal Synchronous/Asynchronous Receiver/Transmitter) facilitates communication through a computer's serial port using the RS-232C protocol. Like a UART (Universal Asynchronous Receiver/Transmitter), a USART provides the computer with the interface necessary for communication with modems and other serial devices. However, unlike a UART, a USART offers the option of synchronous mode. In program-to-program communication, the synchronous mode requires that each end of an exchange respond in turn without initiating a new communication. Asynchronous operation means that a process operates independently of other processes.

Practical differences between synchronous mode (which is possible only with a USART) and asynchronous mode (which is possible with either a UART or a USART) can be outlined as follows:

- Synchronous mode requires both data and a clock. Asynchronous mode requires only data.
- In synchronous mode, the data is transmitted at a fixed rate. In asynchronous mode, the data does not have to be transmitted at a fixed rate.
- Synchronous data is normally transmitted in the form of blocks, while asynchronous data is normally transmitted one byte at a time.
- Synchronous mode allows for a higher DTR (data transfer rate) than asynchronous mode does, if all other factors are held constant.

To communicate with external components such as computers or microcontrollers, the PIC micro uses a component called USART - Universal Synchronous Asynchronous Receiver Transmitter. This component can be configured as:

- A Full-Duplex asynchronous system that can communicate with peripheral devices, such as CRT terminals and personal computers
- A Half-Duplex synchronous system that can communicate with peripheral devices, such as A/D or D/A integrated circuits, serial EEPROMs, etc

5.2.1.4 PIC16F877A DEVELOPMENT BOARD

The prototype uses a development board of PIC16F877A to ease out the soldering hassle and resistors, capacitors are already embedded in it. The board used in this prototype is shown in Figure 10.

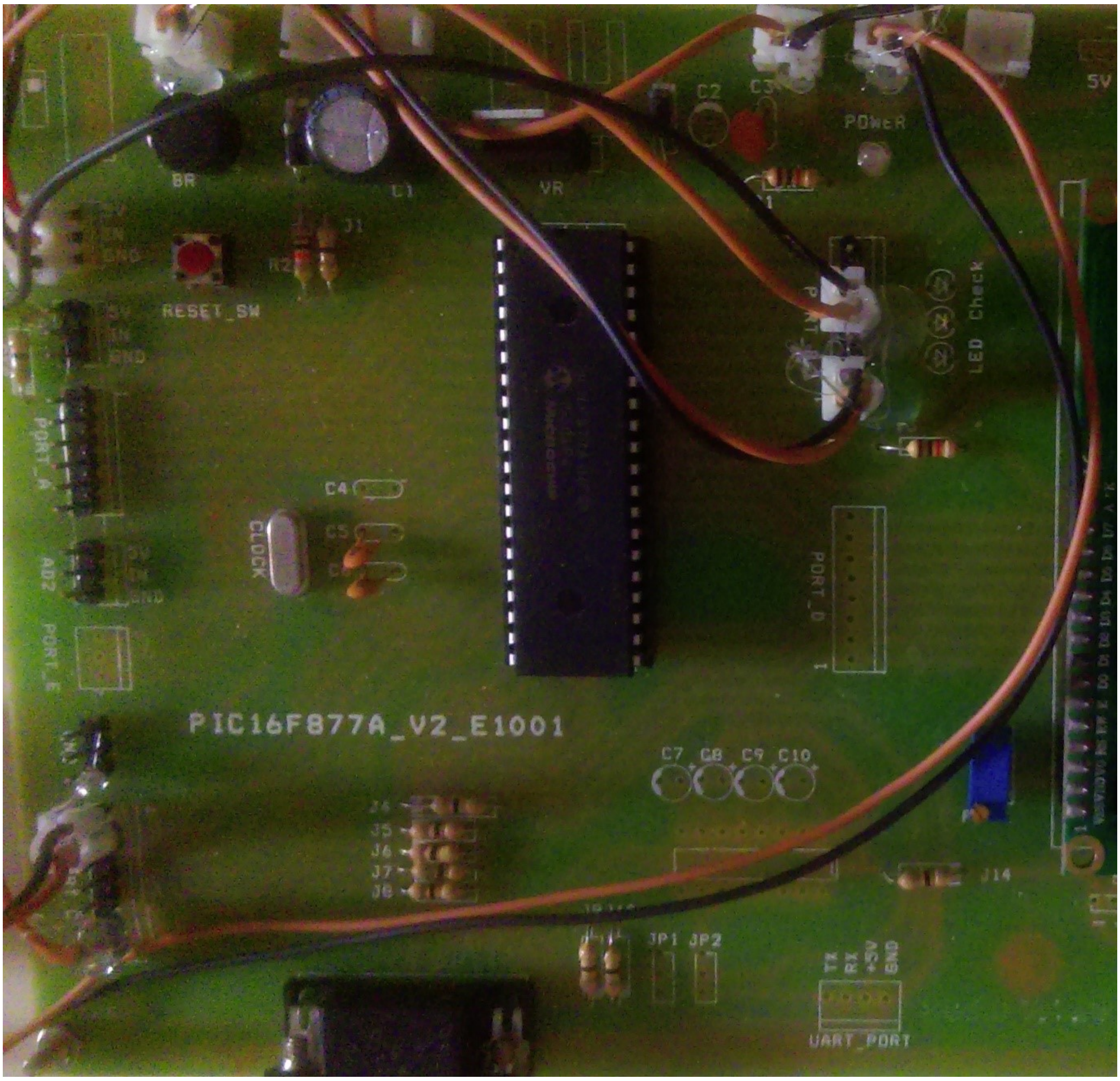


Figure 11. PIC16F877A Board

The board has two 22pf capacitors connected to a 16MHz clock oscillator. Moreover, a 5V regulator is used. 0.9 ohm resistances are used for causing the required voltage drop. 1kilo ohm resistance is used as R1 and R3 whereas 10 kilo ohm resistance is used as R2. Diodes allow current to flow in one direction only. They are used as a form of protection.

5.2.2 RF TRANSMITTER

A RF transmitter is a small electronic device used to transmit radio signals between two devices. In an embedded system it is often desirable to communicate with another device wirelessly. This wireless communication may be accomplished through optical communication or through radio frequency (RF) communication. For many applications the medium of choice is RF since it does not require line of sight. RF communications incorporate a transmitter and/or receiver.

RF modules are widely used in electronic design owing to the difficulty of designing radio circuitry. Good electronic radio design is notoriously complex because of the sensitivity of radio circuits and the accuracy of components and layouts required to achieve operation on a specific frequency. In addition, reliable RF communication circuit requires careful monitoring of the manufacturing process to ensure that the RF performance is not adversely affected. Finally, radio circuits are usually subject to limits on radiated emissions, and require Conformance testing and certification by a standardization organization.

RF modules are most often used in medium and low volume products for consumer applications such as garage door openers, wireless alarm systems, industrial remote controls, smart sensor applications, and wireless home automation systems. They are sometimes used to replace older infra-red communication designs as they have the advantage of not requiring line-of-sight operation. Several carrier frequencies are commonly used in commercially-available RF modules, including those in the industrial, scientific and medical (ISM) radio bands such as 433.92 MHz, 915 MHz, and 2400 MHz. These frequencies are used because of national and international regulations governing the use of radio for communication. Short Range Devices may also use frequencies available for unlicensed such as 315 MHz and 868 MHz.

An RF transmitter module is a small PCB sub-assembly capable of transmitting a radio wave and modulating that wave to carry data.

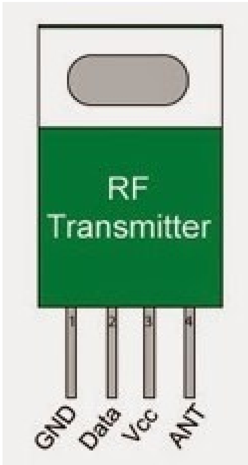


Figure 12. RF transmitter Pin diagram

Transmitter modules are usually implemented alongside a micro controller which will provide data to the module which can be transmitted. As shown in Figure 12, RF transmitters are usually subject to regulatory requirements which dictate the maximum allowable transmitter power output, harmonics, and band edge requirements. The pin description is shown in the Table 3.

Pin No	**Function**	**Name**
1	Ground (0V)	Ground
2	Serial data input pin	Data
3	Supply voltage; 5V	VCC
4	Antenna output pin	ANT

Table 3. Pin description of RF transmitter

5.2.3 HT12E ENCODER

HT12E is an encoder integrated circuit of 2^{12} series of encoders. They are paired with 2^{12} series of decoders for use in remote control system applications. It is mainly used in interfacing RF and infrared circuits. The chosen pair of encoder/decoder should have same number of addresses and data format. HT12E converts the parallel inputs into serial output. It encodes the 12 bit parallel data into serial for transmission through an RF transmitter. These 12 bits are divided into 8 address bits and 4 data bits.

HT12E has a transmission enable pin which is active low. When a trigger signal is received on TE pin, the programmed addresses/data are transmitted together with the header bits via an RF or an infrared transmission medium. HT12E begins a 4-word transmission cycle upon receipt of a transmission enable. This cycle is repeated as long as TE is kept low. As soon as TE returns to high, the encoder output completes its final cycle and then stops. The pin diagram of the encoder is shown in Figure 13.

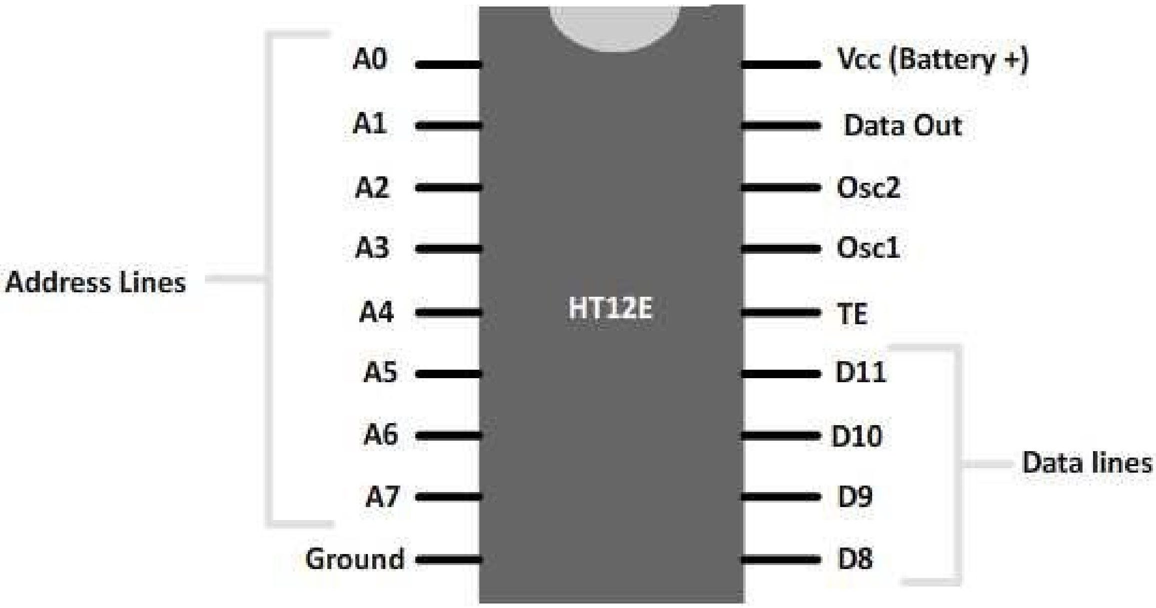


Figure 13. HT12E encoder pin diagram

HT12E is able to operate in a wide voltage range from 2.4V to 12V and has a built in oscillator which requires only a small external resistor. Its power consumption is very low, standby current is 0.1μA at 5V VDD and has high immunity against noise.

5.2.4 RF RECEIVER:

Receivers must be capable of handling a very wide range of signal powers at the input while still producing the correct output. This must be done in the presence of noise and interference which occasionally can be much stronger than the desired signal. Noise sets the threshold for minimum detectable signal power. Distortion sets the maximum signal power level. The third order input intercept is a figure of merit that is directly related to the intermodulation distortion produced. The pin diagram of RF receiver is shown in the Figure 14.

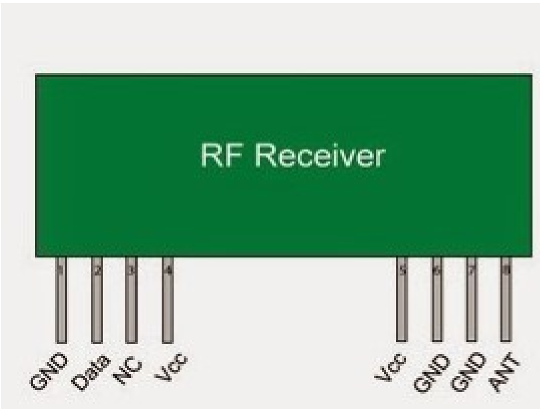


Figure 14. RF receiver Pin diagram

An RF receiver module receives the modulated RF signal, and demodulates it. There are two types of RF receiver modules: super heterodyne receivers and super-regenerative receivers. Super-regenerative modules are usually low cost and low power designs using a series of amplifiers to extract modulated data from a carrier wave. Super-regenerative modules are generally imprecise as their frequency of operation varies considerably with temperature and power supply voltage. Superheterodyne receivers have a performance advantage over super-regenerative; they offer increased accuracy and stability over a large voltage and temperature range. This stability comes from a fixed crystal design which in turn leads to a comparatively more expensive product. Moreover, the pin description of the RF receiver is given in Table 4.

Pin NO.	Function	Name
1	Ground(0V)	Ground
2	Serial data output pin	Data
3	Linear output pin; not connected	NC
4	Supply voltage; 5V	Vcc
5	Supply voltage; 5V	Vcc
6	Ground (0V)	Ground
7	Ground (0V)	Ground
8	Antenna input pin	ANT

Table 4. Pin description of RF receiver

5.2.5 HT12D DECODER

HT12D is a 2^{12} series decoder IC (Integrated Circuit) for remote control applications manufactured by Holtek. It is commonly used for radio frequency (RF) wireless applications. By using the paired HT12E encoder and HT12D decoder we can transmit 12 bits of parallel data serially. HT12D simply converts serial data to its input (may be received through RF receiver) to 12 bit parallel data. These 12 bit parallel data is divided in to 8 address bits and 4 data bits. Using 8 address bits we can provide 8 bit security code for 4 bit data and can be used to address multiple receivers by using the same transmitter.

HT12D decoder will be in standby mode initially i.e. oscillator is disabled and a HIGH on DIN pin activates the oscillator. Thus the oscillator will be active when the decoder receives data transmitted by an encoder. The device starts decoding the input address and data. The decoder matches the received address three times continuously with the local address given to pin A0 – A7. If all matches, data bits are decoded and output pins D8 – D11 are activated. This valid data is indicated by making the pin VT (Valid Transmission) HIGH. This will continue till the address code becomes incorrect or no signal is received. The pin diagram of HT12D is shown in Figure 15.

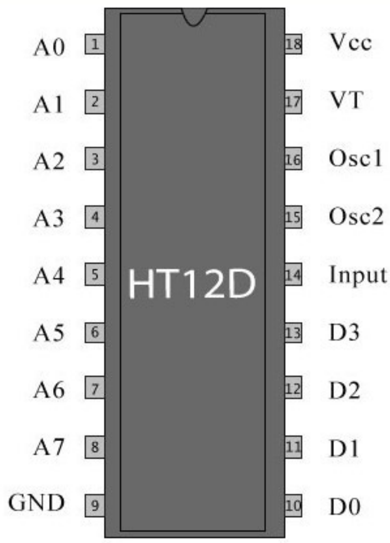


Figure 15. Pin diagram of HT12D

HT12D is a CMOS LSI IC and is capable of operating in a wide voltage range from 2.4V to 12V. Its power consumption is low and has high immunity against noise. The received data is checked 3 times for more accuracy. It has built in oscillator, we need to connect only a small external resistor

5.2.6 EYE TRACKER

Eye-tracking involves the 'tracking of eye movements'. It is a method where the scan path of a person's gaze, while looking over a picture or in a particular direction, is traced and recorded. In other words, the sequence of when and how long the test subject gazes on a particular area of the image is being measured.

Eye tracking has been perceived to be a very accurate platform for the building of rehabilitation technologies. It offers a powerful research tool for developmental scientists. Eye records precisely what people percept and what not. Eye tracking has helped provide detailed, quantitative data to the usability testing process. Most eye-trackers are designed to detect saccades and fixations. Other types of eye movements that are a frequent occurrence are the smooth-pursuit (for tracking slow-moving visual targets), the vestibulo-ocular reflex (for compensating head movements) and the vergence (for obtaining binocular vision). Not all eye tracking devices can correctly measure and identify the different types of eye movements and not all eye movements can be correctly measured. Therefore, they must be properly controlled in experiments. The use of infrared technology plays a critical role in eye tracking as it allows one to draw connections from a psychological perspective between eye-movement data and neurological processes in the brain.

In this proposed design, an eye mounted frame has been developed that is worn like spectacles shown in Fig 16.

A pairs of IR sensors has been drilled into it. IR sensor modules emit a continuous beam of IR rays. Whenever a white object (obstacle) comes in front of the receiver, these rays are reflected back and captured. When faced with a black object (no obstacle) the IR rays are absorbed by the surface and cannot be captured. The sclera is white and thus acts as an obstacle while the iris acts as the reflecting object. It has been found that the average size of the iris is 11.8 mm with the majority of population falling between 10.2 mm and 13.0 mm. The average axial length along the visual axis is 24 mm. It was found that the accurate detection of the eyeball movements can be achieved by using proximity IR sensor modules. A user has to shrink his eye lids to activate the sensor. Opening eyelids means the user doesn't suffer any disturbance due to light. The signals after being received by the IR sensors are then fed to the PIC microcontroller. PIC microcontroller is preferred because the presence of an inbuilt ADC circuit in the IC makes the circuit simpler. This device is extremely cost-effective as well as efficient.

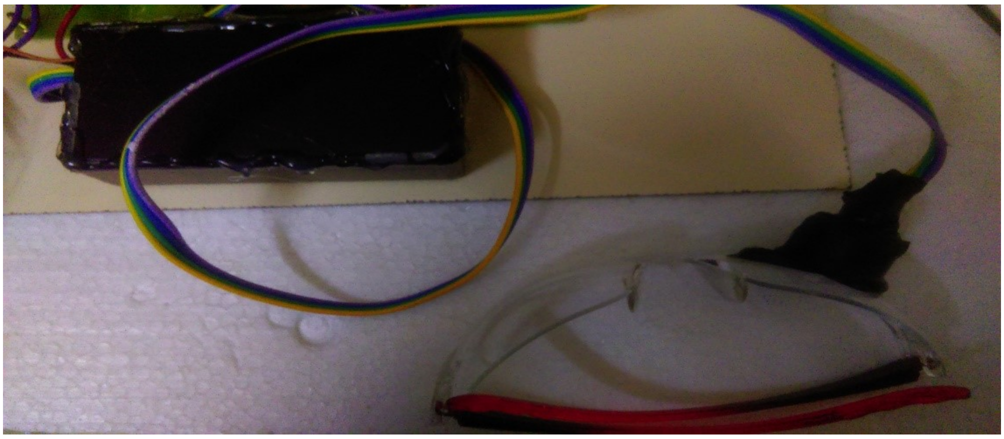


Figure 16. Eye mounted frame

The increased sophistication and accessibility of eye tracking technologies have generated a great deal of interest in the commercial sector. Applications include web usability, advertising, sponsorship, package design and automotive engineering. In general, commercial eye tracking studies function by presenting a target stimulus to a sample of consumers while an eye tracker is used to record the activity of the eye. Examples of target stimuli may include websites, television programs, sporting events, films, commercials, magazines, newspapers, packages, shelf displays, consumer systems (ATMs, checkout systems, kiosks), and software. The resulting data can be statistically analyzed and graphically rendered to provide evidence of specific visual patterns.

5.2.7 LCD

LCD stands for liquid crystal display. They come in many sizes 8x1 , 8x2 , 10x2, 16x1 , 16x2 , 16x4 , 20x2 , 20x4 ,24x2 , 30x2 , 32x2 , 40x2 etc. All the LCD's performs the same functions(display characters numbers special characters ASCII characters etc.) Their programming is also same and they all have same 14 pins (0-13) or 16 pins (0 to 15).
ALL LCDs have

- Eight Data pins
- VCC
- GND
- RS (Register select)
- RW (read - write)
- EN (Enable)
- V0 (Set Lcd contrast)

8-Data pins carries 8-bit data or command from an external unit such as microcontroller.
V0:
Set lcd contrast here. Best way is to use variable resistor such as potentiometer. Output of the potentiometer is connected to this pin. Rotate the potentiometer knob forward and backward to adjust the lcd contrast.
RS:
There are two registers in every LCD.
They are,

- Command Register

  When we send commands to lcd these commands go to Command register and are processed.

  When RS=0, Command Register is selected.
- Data Register

  When we send Data to lcd it goes to data register and is processed. When RS=1, Data Register is selected.

RW:

When RW=1, read data from LCD.

When RW=0 , write to LCD.

EN:

When the register (Command and Data) and set RW(read-write) is active, it's time to execute the instruction. By instruction it mean the 8-bit data or 8-bit command present on data lines of lcd. This requires an extra voltage push to execute the instruction and EN(enable) signal is used for this purpose. Usually we make it EN=0 and when we want to execute the instruction we make it high EN=1 for some milli seconds. After this we again make it ground EN=0.

A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD

5.2.8 LED and LDR

A light-emitting diode (LED) is a two-lead semiconductor light source. It is a p–n junction diode, which emits light when activated. When a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the colour of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor. An LED is often small in area and integrated optical components may be used to shape its radiation pattern. Appearing as practical electronic components in 1962, the earliest LEDs emitted low-intensity infrared light. Infrared LEDs are still frequently used as transmitting elements in remote-control circuits, such as those in remote controls for a wide variety of consumer electronics. The first visible-light LEDs were also of low intensity, and limited to red. Modern LEDs are available across the visible, ultraviolet, and infrared wavelengths, with very high brightness.

Early LEDs were often used as indicator lamps for electronic devices, replacing small incandescent bulbs. They were soon packaged into numeric readouts in the form of seven-segment displays, and were commonly seen in digital clocks. Recent developments in LEDs permit them to be used in environmental and task lighting. LEDs have many advantages over incandescent light sources including lower energy consumption, longer lifetime, improved physical robustness, smaller size, and faster switching. Light-emitting diodes are now used in applications as diverse as aviation lighting, automotive headlamps, advertising, general lighting, traffic signals, camera flashes and lighted wallpaper. LEDs powerful enough for room lighting remain somewhat more expensive, and require more precise current and heat management, than compact fluorescent lamp sources of comparable output. LEDs have allowed new text, video displays, and sensors to be developed, while their high switching rates are also used in advanced communications technology.

A P-N junction can convert absorbed light energy into a proportional electric current. The same process is reversed here (i.e. the P-N junction emits light when electrical energy is applied to it). This phenomenon is generally called electroluminescence, which can be defined as the emission of light from a semi-conductor under the influence of an electric field. The charge carriers recombine in a forward-biased P-N junction as the electrons cross from the N-region and recombine with the holes existing in the P-region. Free electrons are in the conduction band of energy levels, while holes are in the valence energy band. Thus the energy level of the holes will be lesser than the energy levels of the electrons. Some portion of the energy must be dissipated in order to recombine the electrons and the holes. This energy is emitted in the form of heat and light.

The attainment of high efficiency in blue LEDs was quickly followed by the development of the first white LED. In this device, phosphor coating on the emitter absorbs some of the blue emission and produces yellow light through fluorescence. The combination of that yellow with remaining blue light appears white to the eye. However using different phosphors (fluorescent materials) it also became possible to instead produce green and red light through fluorescence. The resulting mixture of red, green and blue is not only perceived by humans as white light but is superior for illumination in terms of colour rendering, whereas one cannot appreciate the colour of red or green objects illuminated only by the yellow (and remaining blue) wavelengths from the YAG phosphor. The first white LEDs were expensive and inefficient. However, the light output of LEDs has increased exponentially, with a doubling occurring approximately every 36 months since the 1960s (similar to Moore's law). This trend is generally attributed to the parallel development of other semiconductor technologies and advances in optics and materials science, and has been called Haitz's law after Dr. Roland Haitz. The light output and efficiency of blue and near-ultraviolet LEDs rose as the cost of reliable devices fell. This led to the use of (relatively) high-power white-light LEDs for the purpose of illumination which are replacing incandescent and fluorescent lighting. The data sheet of the White LED is shown in Table 5.

White LEDs can now produce over 300 lumens per watt of electricity while lasting up to 100,000 hours. Compared to incandescent bulbs, this amounts not only to a huge increase in electrical efficiency, but a similar or better prorated cost for the bulbs.

Size	5mm Straw Hat
Colour	Cool / Clear White
Luminosity/Brightness	14,000-15,000 mcd
Forward Voltage	3.2-3.4v
Current	20mA
Wavelength	N/A
Viewing Angle	120-150 degrees
Mount Style	Through Hole (DIP)
Lens Colour	Clear
LED Brightness Class	Super/Ultra/Extreme

Table 5. Datasheet of Straw hat White LED

A photoresistor (or light-dependent resistor, LDR, or photocell) is a light-controlled variable resistor. The resistance of a photoresistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. A photoresistor can be applied in light-sensitive detector circuits, and light- and dark-activated switching circuits. A photoresistor is made of a high resistance semiconductor as shown in Figure 17. In the dark, a photoresistor can have a resistance as high as several mega ohms (MΩ), while in the light, a photoresistor can have a resistance as low as a few hundred ohms. If incident light on a photoresistor exceeds a certain frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electrons (and their hole partners) conduct electricity, thereby lowering resistance. The resistance range and sensitivity of a photoresistor can substantially differ among dissimilar devices. Moreover, unique photoresistors may react substantially differently to photons within certain wavelength bands.

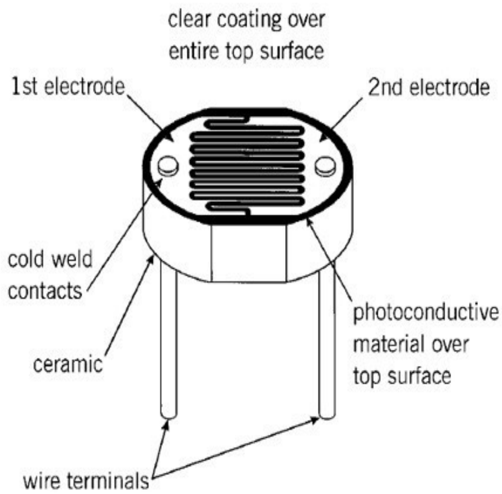


Figure 17. Light-dependent resistor

A photoelectric device can be either intrinsic or extrinsic. An intrinsic semiconductor has its own charge carriers and is not an efficient semiconductor, for example, silicon. In intrinsic devices the only available electrons are in the valence band, and hence the photon must have enough energy to excite the electron across the entire bandgap. Extrinsic devices have impurities, also called dopants, added whose ground state energy is closer to the conduction band; since the electrons do not have as far to jump, lower energy photons (that is, longer wavelengths and lower frequencies) are sufficient to trigger the device. If a sample of silicon has some of its atoms replaced by phosphorus atoms (impurities), there will be extra electrons available for conduction. This is an example of an extrinsic semiconductor.

5.2.9 POWER SUPPLY

The whole system is powered by a 12V – 0V – 12V transformer. A transformer is an electrical device that transfers electrical energy between two or more circuits through electromagnetic induction. Electromagnetic induction produces an electromotive force within a conductor which is exposed to time varying magnetic fields. Transformers are used to increase or decrease the alternating voltages in electric power applications.

A varying current in the transformer's primary winding creates a varying magnetic flux in the transformer core and a varying field impinging on the transformer's secondary winding. This varying magnetic field at the secondary winding induces a varying electromotive force (EMF) or voltage in the secondary winding due to electromagnetic induction. Making use of Faraday's Law in conjunction with high magnetic permeability core properties, transformers can be designed to change, efficiently AC voltages from one voltage level to another within power networks. Step down transformer used here lowers the voltage from 220 to 12.

CHAPTER 6

IMPLEMENTATION

6.1 INTERFACE

An interface is a shared boundary across which two separate components of a system exchange information. The exchange can be between software, computer hardware, peripheral devices, humans and combinations of these.

6.2 INTERFACING RF TRANSMITTER WITH PIC 16F877A VIA HT12E

Data is transmitted from the RF transmitter through HT12E. HT12E is a 2^{12} series encoder IC for remote control applications. It is commonly used for radio frequency applications. By using the paired HT12E encoder and HT12D decoder we can easily transmit and receive 12 bits of parallel data serially. HT12E simply converts 12 bit parallel data in to serial output which can be transmitted through a RF transmitter. These 12 bit parallel data is divided in to 8 address bits and 4 data bits. By using these address pins we can provide 8 bit security code for data transmission and multiple receivers may be addressed using the same transmitter. Since RF transmitter can transmit only serial data a encoder is used in this prototype. For simulation using software, encoder is not needed. The RC6 pin of the microcontroller can be connected directly to Data (2^{nd} pin) of the RF transmitter. But when done in hardware, it's done as shown in Figure 18. Here, pins A0,A1,A2,A3,A4,A5,A6,A7 and GND are grounded. The pins DO, D1,D2, D3, D4 of HT12E encoder are connected to pins 33,34,35,36 of the PIC 16F877A. The 1^{st} pin of RF transmitter is connected to TE of the encoder which is grounded. The OSC pins of the HT12E are connected to each other via a resistor. The DOUT pin of the encoder is connected to 2^{nd} pin of the RF transmitter. The 3^{rd} pin of the RF transmitter is connected to the 18^{th} pin of the encoder which acts as Vcc. Generally, a voltage range between 3V to 12V is preferred. Finally, the 4^{th} pin of RF transmitter acts as an antenna. The same is done in both the modules.

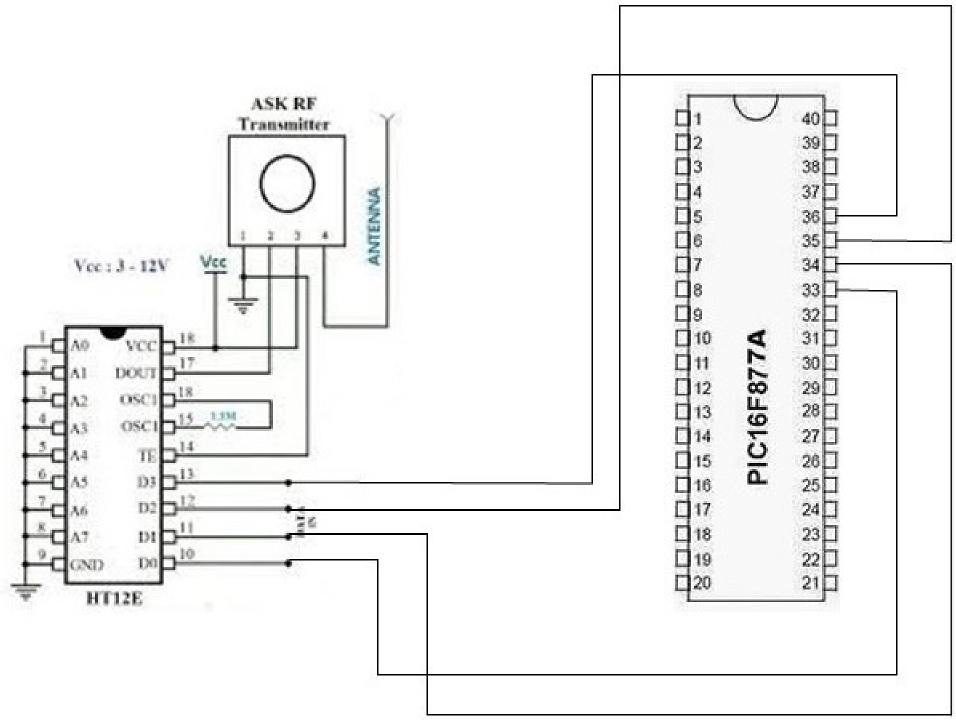


Figure 18. RF transmitter interfaced with PIC16F877A via HT12E

6.3 INTERFACING RF RECEIVER WITH PIC16F877A VIA HT12D

Transmitted data is received through HT12D to the RF receiver. HT12D is a 2^{12} series decoder IC for remote control applications. It is commonly used for radio frequency wireless applications. By using the paired HT12E encoder and HT12D decoder we can transmit 12 bits of parallel data serially. HT12D simply converts serial data to its input (received through RF receiver) to 12 bit parallel data. These 12 bit parallel data is divided in to 8 address bits and 4 data bits. Using 8 address bits we can provide 8 bit security code for 4 bit data and can be used to address multiple receivers by using the same transmitter. Since RF receiver can receive only serial data a decoder is used in this prototype. For simulation using software, decoder is not needed. The RC7 pin of the microcontroller can be connected directly to Data (2nd pin) of the RF receiver. But when done in hardware, it's done as shown in Figure 19. Here, pins A0,A1,A2,A3,A4,A5,A6,A7 and GND are grounded. The pins DO, D1,D2, D3, D4 of HT12D decoder are connected to pins 37,38,39,40 of the PIC 16F877A.

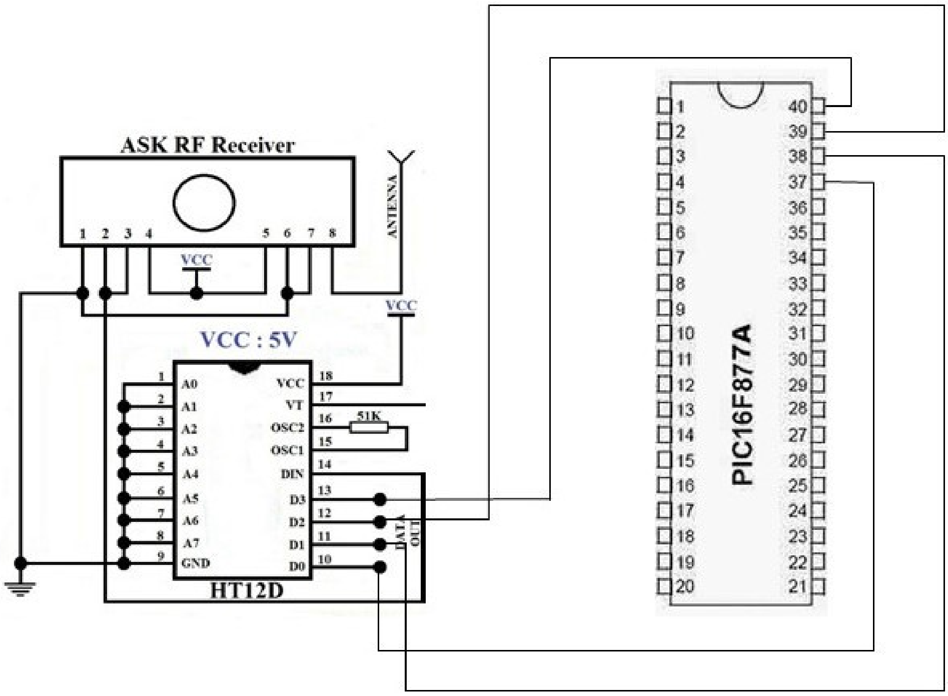


Figure 19. RF receiver interfaced with PIC16F877A via HT12D

The 1,6,7 pins of RF receiver are connected to GND of the decoder which is grounded. The OSC pins of the HT12D are connected to each other via a resistor. The DIN pin of the decoder is connected to 2^{nd} and 3^{rd} pins of the RF receiver. 4^{th} and 5^{th} pin of the RF receiver are shorted is connected to the 18^{th} pin of the decoder which acts as Vcc. Generally, a voltage range between 3V to 12V is preferred. Finally, the 8^{th} pin of RF receiver acts as an antenna. The same is done in both the modules.

6.4 INTERFACING LCD WITH PIC16F877A

16×2 Character LCD is a very basic LCD module which is commonly used in electronics projects and products. It contains 2 rows that can display 16 characters. Each character is displayed using 5×8 or 5×10 dot matrix. It can be easily interfaced with a microcontroller. Commonly used LCD Displays uses HD44780 compliant controllers. As in all devices it also has two inputs to give power Vcc and GND. Voltage at VEE determines the Contrast of the display. A microcontroller needs to send two informations to operate this LCD module, Data and Commands. Data represents the ASCII value (8 bits) of the character to be displayed and Command determines the other operations of LCD such as position to be displayed. Data and Commands are send through the same data lines, which are multiplexed using the RS (Register Select) input of LCD. When it is HIGH, LCD takes it as data to be displayed and when it is LOW, LCD takes it as a command. Data Strobe is given using E (Enable) input of the LCD.

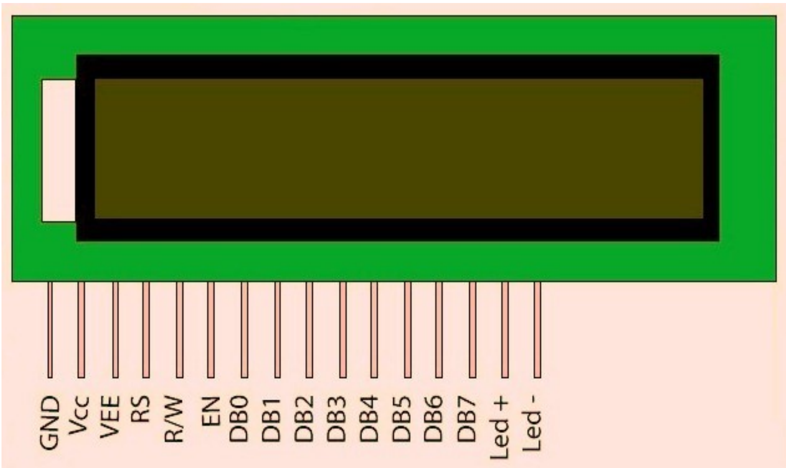


Figure 20. LCD pin diagram

When the E (Enable) is HIGH, LCD takes it as valid data or command. The input signal R/W (Read or Write) determines whether data is written to or read from the LCD. In normal cases only writing is needed hence it is tied to GROUND. The pin diagram of LCD is shown in Figure 20.

The interface between the LCD and Microcontroller as shown in Figure21., can be 8 bit or 4 bit and the difference between them is in how the data or commands are send to LCD. In the 8 bit mode, 8 bit data and commands are send through the data lines DB0 – DB7 and data strobe is given through E input of the LCD. But 4 bit mode uses only 4 data lines. In this 8 bit data and commands are splitted into 2 parts (4 bits each) and are sent sequentially through data lines DB4 – DB7 with its own data strobe through E input. The idea of 4 bit communication is introduced to save pins of a microcontroller. 4 bit mode will be slower than 8 bit.

But the speed difference is only minimal. As LCDs are slow speed devices, the tiny speed difference between these modes is not significant. Since microcontroller is operating at high speed in the range of MHz and when LCD is viewed with eyes, due to Persistence of Vision in eyes the speed difference won’t be seen.

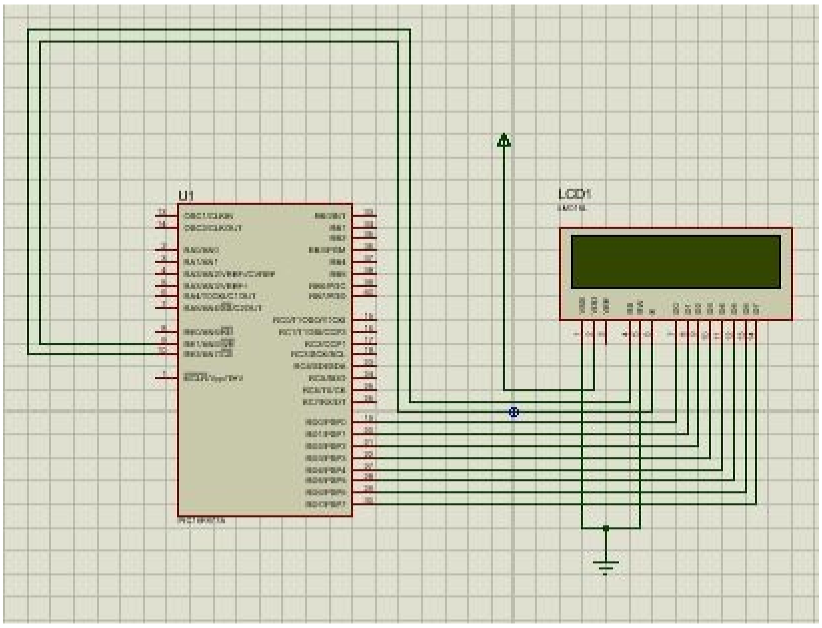


Figure 21. Interface between LCD and PIC16F877A

The pins DO,D1,D2,D3,D4,D5,D6,D7 of the LCD are connected to the microcontroller pins RDO,RD1,RD2,RD3,RD4,RD5,RD6,RD7 in PORT D . RS is connected to the RE2 in PORT E and E is connected to RE1. RW and Vss are grounded whereas V_{DD} is connected to the power supply.

6.5 INTERFACING EYE TRACKER WITH PIC16F877A

A reflective sensor that includes infrared emitter and phototransistor in a lead package which blocks visible light. It consists of Infrared transmitter which is one type of LED, which emits infrared rays generally called as IR Transmitter. Similarly, IR Receiver is used to receive the IR rays transmitted by the IR transmitter. One important point is both IR transmitter and receiver should be placed straight line to each other. The transmitted signal is given to IR transmitter whenever the signal is high, the IR transmitter LED is conducting it passes the IR rays to the receiver. The IR receiver is connected with comparator. The comparator is constructed with LM 358 operational amplifier. In the comparator circuit the reference voltage is given to inverting input terminal. The non-inverting input terminal is connected IR receiver. When interrupt the IR rays between the IR transmitter and receiver, the IR receiver is not conducting. So the comparator non inverting input terminal voltage is higher than inverting input. Now the comparator output is in the range of +5V. This voltage is given to microcontroller. The circuit is shown in Figure 22.

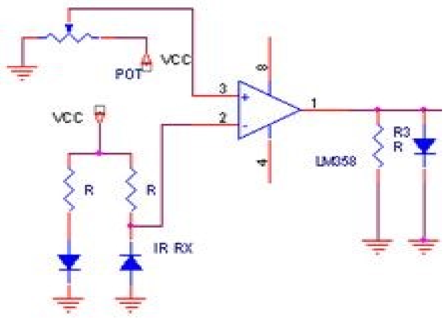


Figure 22. Eye blink sensor module

When IR transmitter passes the rays to receiver, the IR receiver is conducting due to that non inverting input voltage is lower than inverting input.

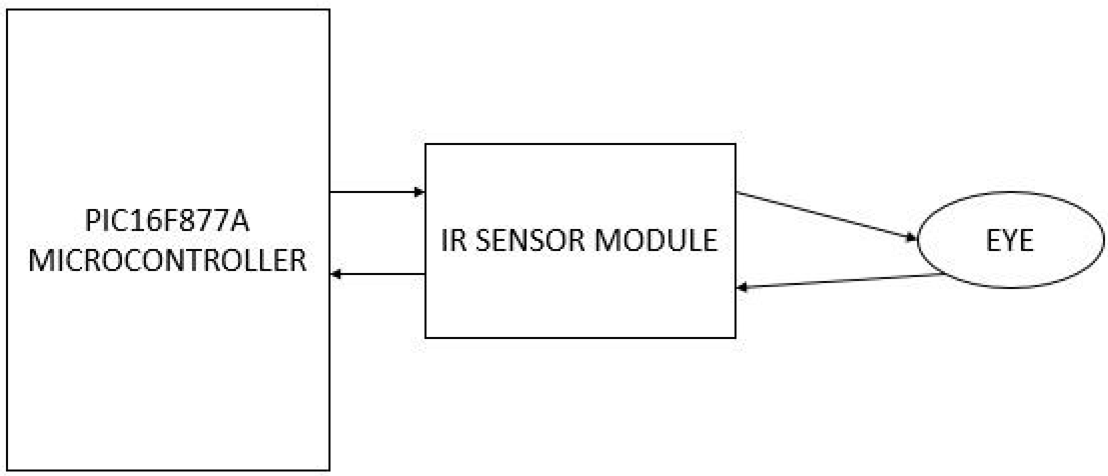


Figure 23. Block diagram of the interface

Now the comparator output is GND so the output is given to microcontroller. A block diagram depicting the interface is shown in the Figure 23.

6.6 CONNECTING LDR WITH PIC16F877A

A Light Dependent Resistor or a photo resistor is a device whose resistivity is a function of the incident electromagnetic radiation. Hence, they are light sensitive devices. They are also called as photo conductors, photo conductive cells or simply photocells. They are made up of semiconductor materials having high resistance. There are many different symbols used to indicate a LDR. LDR's are light dependent devices whose resistance is decreased when light falls on them and that is increased in the dark. When a light dependent resistor is kept in dark, its resistance is very high. This resistance is called as dark resistance. It can be as high as 10^{12} ohm and if the device is allowed to absorb light its resistance will be decreased drastically. If a constant voltage is applied to it and intensity of light is increased the current starts increasing. The LDR is connected to the analog pin of the PIC16F877A microcontroller as shown in Figure 24.

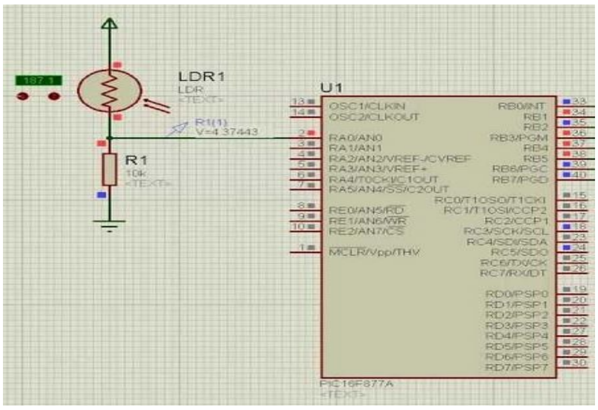


Figure 24. LDR connected to PIC16F877A

One end of the LDR is connected to the power supply and another end is connected to the RA0 pin of PORTA. A resistor of 10kilo ohm is grounded and it is also connected to LDR.

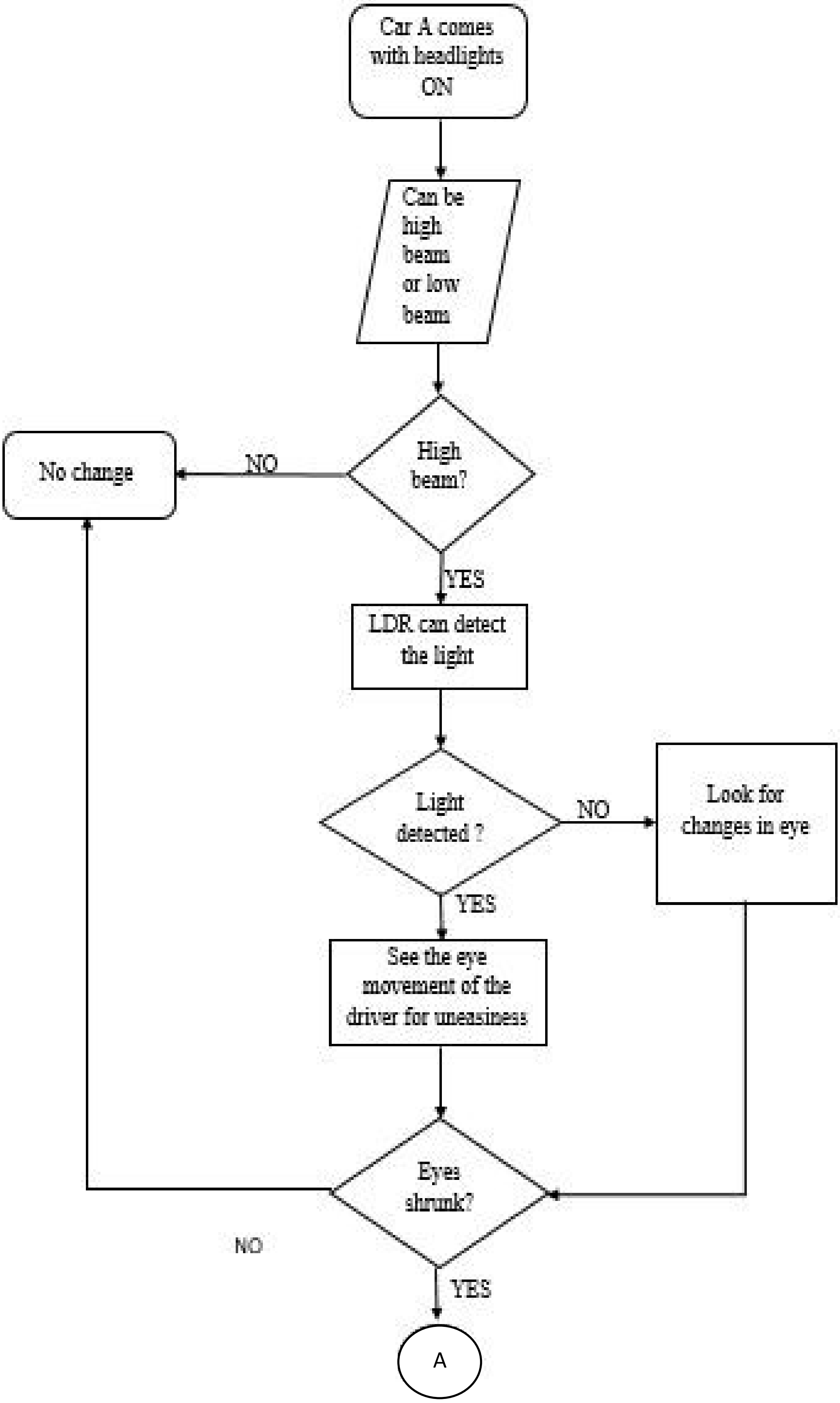
CHAPTER 7

OPERATION

The interaction between automobiles is the important aspect of this application. V2V communication based Anti Radiance headlight using Eye tracker is based on the interfacing of eye tracker and sensor with the microcontroller. This high intensity light is detected by the light sensor in the automobile B. Simultaneously it also observes the position and movement of the driver's eye. When it detects that some strain is caused by the light, it sends radio waves to the opposite approaching automobile A through a RF transmitter interfaced to the microcontroller. The receiver interfaced with microcontroller in the opposite automobile A receives these radio waves and does the necessary action. The microcontroller works at a maximum frequency of 16MHz. Because of this, the passage of information to the components interfaced with the micro controller will happen at high speeds. No latency is seen. Eye blink sensor is used as eye tracker in this prototype. It is used because of easy implementation and economic cost. The electromagnetic waves travel at the speeds of light and hence the communication between these two vehicles won't be disturbed. A flow chart which describes the operation of the system is shown in Figure 25

Four actions are considered as shown in Table 6. They are,

- When the headlight beam from the upcoming vehicle is high, and the driver of this vehicle can sustain it, no radio waves are sent and the beam is allowed to be in high itself. This sustainability is based on the driver's eye lid movement which is observed by the eye tracker. On the failure of this condition of sustainability, the approaching vehicle's headlight are dimmed


Car A comes with headlights ON
Can be high beam or low beam
High beam?
NO
No change
YES
LDR can detect the light
Light detected ?
NO
Look for changes in eye
YES
See the eye movement of the driver for uneasiness
Eyes shrunk?
NO
YES
A

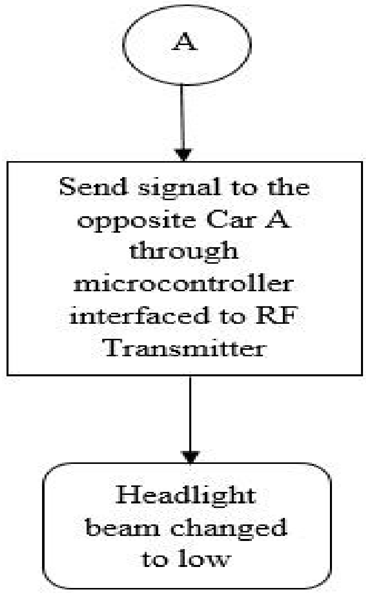


Figure 25. Flow chart depicting the proposed system working

- When the LDR fails to detect the light intensity, still the effect of high beam on the driver can be found. This is possible because of the presence of eye tracker which constantly keeps a track on driver's eye.
- When both LDR and eye tracker is in OFF state, no radio waves are sent to the approaching vehicle
- When Eye tracker and LDR are ON, the information is conveyed to the microcontroller of the approaching vehicle and the headlight is made to go to low beam.

Cases	LDR status	Eye tracker status	Action initiated
1	OFF	OFF	No change
2	ON	OFF	No change
3	OFF	ON	Headlight becomes dim
4	ON	ON	Headlight becomes dim

Table 6. Conditions for dimming the headlight

CHAPTER 8

SOFTWARE

8.1 MPLAB

MPLAB is a free integrated development environment for the development of embedded applications on PIC and dsPIC microcontrollers, and is developed by Microchip Technology. MPLAB X is the latest edition of MPLAB, and is developed on the NetBeans platform. MPLAB and MPLAB X support project management, code editing, debugging and programming of Microchip 8-bit, 16-bit and 32-bit PIC microcontrollers. MPLAB is designed to work with MPLAB-certified devices such as the MPLAB ICD 3 and MPLAB REAL ICE, for programming and debugging PIC microcontrollers using a personal computer. PICKit programmers are also supported by MPLAB. Here, the program is compiled by HITECH ANSI C Compiler.

8.2 MPLAB X IDE

MPLAB X IDE is a software program that is used to develop applications for Microchip micro controllers and digital signal controllers. This development tool is called an Integrated Development Environment or IDE, because it provides a single integrated ‘environment’ to develop code for embedded micro controllers.

8.3 IMPLEMENTING AN EMBEDDED SYSTEM DESIGN WITH MPLAB X IDE

A develop system for embedded controllers is a system of programs running on a computer that help to write, edit, debug and program code which is the intelligence of embedded system applications into a micro controller. MPLAB X IDE is such a system, it contains all the components needed to design and deploy embedded system applications.

The typical tasks for developing an embedded controller application are

- Create the high level design. From the features and performance desired, decide the PIC MCU, then design the associated hardware circuitry. After determining which peripherals and pins control the hardware, write the firmware – the software that will control the hardware aspects of the embedded application. A language tool such as an assembler, which is directly translatable into machine code, or a complier that allows a more natural language for creating programs, should be used to write and edit code. Assemblers and compliers help make the code understandable, allowing function which labels to identify code routines with variables that have names associated with their use
- Compile, assemble and link the software using the assembler and complier and linker to convert the code into "ones and zeroes", the machine code for PIC MCUs. This machine code will eventually become the firmware.
- Test the code. Usually a complex program does not work exactly the way imagined and 'bugs' needed to be removed from the design to get proper results. The debugger allows "ones and zeroes" execute, related to the source code written. Debugging allows to experiment with code to see the value of variables at various points in the program and to do 'what if' checks, changing variable values and stepping through routines.
- "Burn" the code into a microcontroller and verify that it executes correctly in the finished application.

Of course, each of these steps can be quite complex. The important thing is to concentrate on the details of the design.

CHAPTER 9

RESULTS

9.1 PROTOTYPE OUTPUT

The prototype is designed based on the components described in the previous chapters and the output is shown in the figure 26 and figure 27 as two separate modules. Two automobiles are defined as those two individual modules i.e. Module A and Module B.

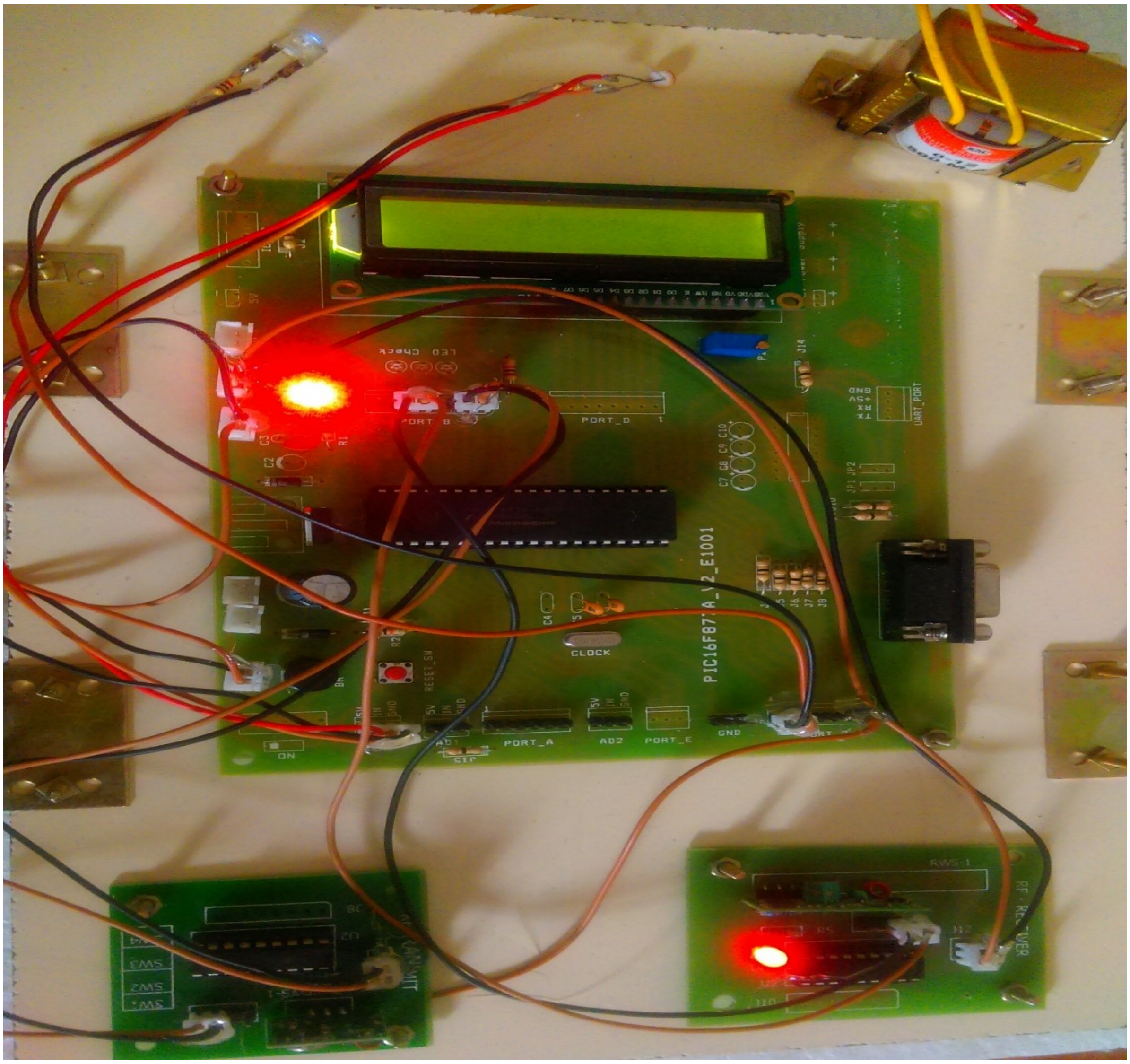


Figure 26. Module A

One module has an eye blink sensor which works as eye tracker in this case. Another module is made with RF transmitter, RF receiver and LCD.

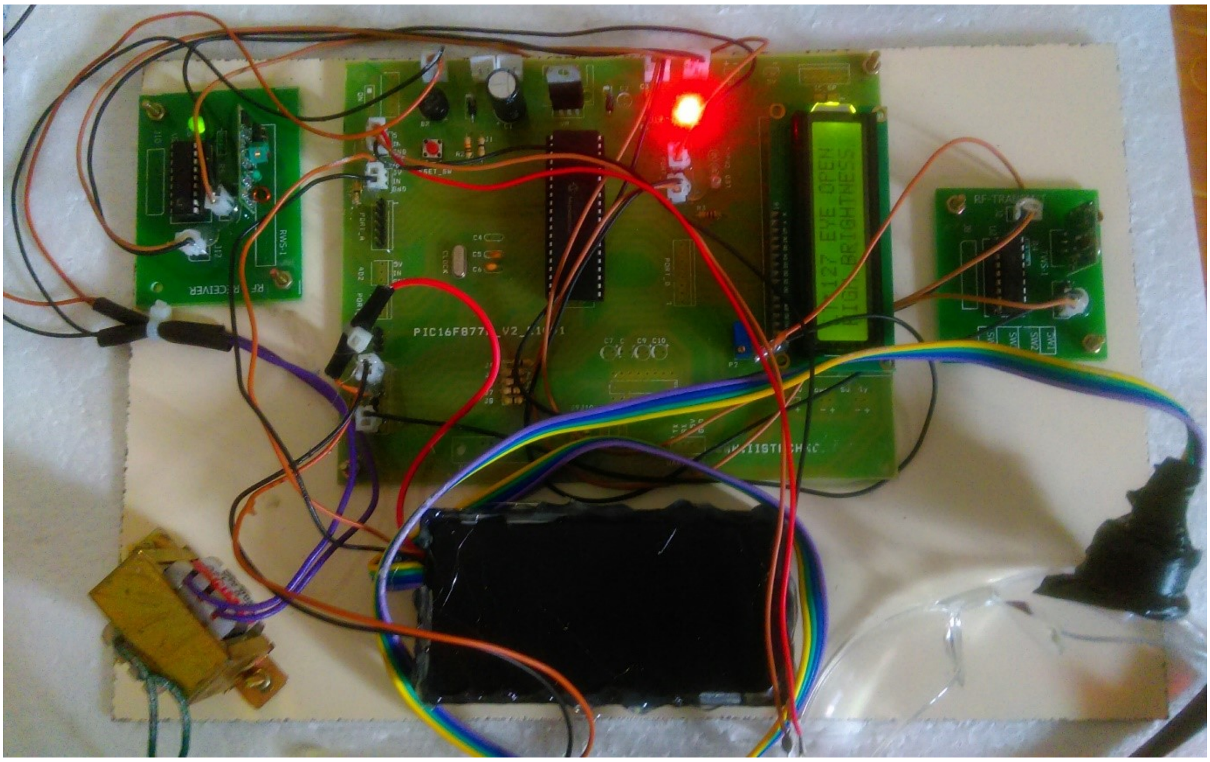


Figure 27. Module B

9.2 FUTURE ADVANCEMENTS

The prototype used Eye blink sensor as eye tracker. Latest technologies such as Pupillary Light Reflex sensor can be used to track the eye ball movements. Moreover, Ambient light sensors are better efficient than LDR. Further, the reaction time can be improved by using reflex sensors. In practical situation, eye tracker is not mounted on the eye frame. It is placed at a calculated distance from the eye mostly in the rear view mirror or in the dashboard of the vehicle.

9.3 CONCLUSION

Glare during driving is a serious problem for drivers. This is caused due to sudden exposure of our eyes to a very bright light; the bright headlights of vehicles in this case. This causes a temporary blindness called the Troxler effect. Eventually this becomes the major reason for night accidents. In most cases, the driver of approaching vehicles neglects it and continues to drive with the high beam. Thus the proposed system solves it by taking the condition of driver into account. A prototype has been developed on the proposed system using simple and economical components. Hence, installing this system in every vehicle in future will reduce accidents caused by headlight radiance to a greater extent.

APPENDIX 1

PROGRAM CODE

```
/* ---------------------------------------------------------------------------

* File:   andiradiance_headlight_main.c

---------------------------------------------------------------------------- */

#include <stdio.h>

#include <stdlib.h>

#include <xc.h>

#include <stdint.h>

#include "adc.h"

#include "config.h"

#include "delay_ver2.h"

#include "lcd_20x4_v2.h"

 /*-----------------------------Macro function--------------------------*/

/*-----macro for RF Transceiver----*/

#define RF_MEDIUM PORTB

#define SEND_HIGH_BRIGHT1 0x01

#define SEND_HIGH_BRIGHT2 0x02

#define NONE 0x00

/*--------macro for LCD-----*/

#define LDR_INDEX 1

#define LDR_ADDR 4

#define IR_PAIR RC3
```

```
#define ENABLE_RF RC6
#define ENABLE_RF1 RB7
#define HIGH 1
#define LOW 0
#define EYE_CLOSED ( IR_PAIR == LOW )
#define LIGHT_THRESHOLD 60
 #define HIGH_LIGHT (ldr_val > LIGHT_THRESHOLD)
/*---conditional directive-----*/
#define NODE1_ENABLE 1
#define NODE2_ENABLE 0
/*--------------------prototype function declaration-----------------------------*/
void  timer0_init(void);
void soft_pwm_dutycycle(uint8_t dutycycle);
/*-------------------Global variable declaration---------------------------------*/
static volatile unsigned char pwm_dutycycle = 0;
static volatile unsigned long count;
/*-----------------------------------------------------------------------------*/
int main() {
/*-----Port and local variable declaration----*/
uint8_t ldr_val=0;
uint8_t light_dim_flag1 =0,light_dim_flag2 =0;
/*------ iniitializing RF pair--- */
TRISB = 0x30; ////LSB bit set as output for txmiting signal
```

```
// RB4 -> MSB bits set as input for receiving rf signal
PORTB = 0x00;
/*------pwm_init-------*/
TRISC1 = 0;//LED array//head light
TRISC0 = 0;
RC0=0;
timer0_init();
TRISC3 =1; // ir pair
TRISC6= 0;
ENABLE_RF =HIGH;
/*-------initializing lcd ----------*/
lcd_init();
lcd_fix_num(LDR_INDEX,LDR_ADDR);
lcd_print(1,(uint8_t*) "ANDIRADIANCE");
#if NODE1_ENABLE
   lcd_print(17,(uint8_t*)"HEADLIGHT  N:1");
#elif NODE2_ENABLE
   lcd_print(17,(uint8_t*)"HEADLIGHT  N:2");
#endif
delayMs(2000);
lcd_clrscr();
/*----initializing adc---*/
adc_init();
```

```
soft_pwm_dutycycle(100); //turn on led with full brightness
/*------------------continues processing--------------------------*/
for(;;){
   lcd_print(1,(uint8_t*)"LT:");
   ldr_val = adc_read(0);
   ldr_val / =2;
   lcd_print_num(LDR_INDEX,ldr_val);
#if NODE1_ENABLE
if(EYE_CLOSED){
   lcd_print(8,(uint8_t*)"EYE CLOSED");
   }
else
   {
   lcd_print(8,(uint8_t*)"EYE OPEN  ");
   }
// #elif NODE2_ENABLE
//// if(EYE_CLOSED){
////
//// lcd_print(8,(uint8_t*)"EYE CLOSED");
//// }
//// else {
//// lcd_print(8,(uint8_t*)"EYE OPEN  ");
////       }
```

```
#endif
delayMs(1500);
/*-----------------transmtting data----------------*/
#if NODE1_ENABLE
if(EYE_CLOSED || HIGH_LIGHT)
#elif NODE2_ENABLE
if(HIGH_LIGHT)
#endif
   {
   // soft_pwm_dutycycle(50); //reduceing brightness
#if NODE1_ENABLE
   ENABLE_RF = LOW;
   RF_MEDIUM = SEND_HIGH_BRIGHT1;
   lcd_print(17,(uint8_t* )"HIGH BRIGHTNESS");
   light_dim_flag1 = 1;
#elif NODE2_ENABLE
   ENABLE_RF = LOW;
   RF_MEDIUM = SEND_HIGH_BRIGHT2;
   lcd_print(17,(uint8_t* )"HIGH BRIGHTNESS");
   light_dim_flag2 = 1;
#endif
   }
else
```

```
    {
#if NODE1_ENABLE
if(light_dim_flag1 == 1)
    {
    ENABLE_RF = LOW;
    RF_MEDIUM = NONE;
    light_dim_flag1 = 0;
    delayMs(500);
    }
ENABLE_RF = HIGH;
// RF_MEDIUM = SEND_NONE_NODE1; //none
// lcd_print(17,(uint8_t* )"high brightness");
#elif NODE2_ENABLE
if(light_dim_flag2 == 1)
    {
    ENABLE_RF = LOW;
    RF_MEDIUM = NONE;
    light_dim_flag2 = 0;
    delayMs(500);
    }
ENABLE_RF = HIGH;
// RF_MEDIUM = ; //none
// lcd_print(17,(uint8_t* )"high brightness");
```

```
#endif
lcd_print(17,(uint8_t* )"                ");
    }
/*-------------------receiveing data---------------------*/
#if NODE1_ENABLE
if(RB4 == 0 && RB5 == 1 )
    {
    soft_pwm_dutycycle(5); //reduceing brightness
    lcd_print(17,(uint8_t* )"REDUCE BRIGHT1");
    }
#elif NODE2_ENABLE
if(RB4 == 1 && RB5 == 0  )
   {
    soft_pwm_dutycycle(5); //reduceing brightness
    lcd_print(17,(uint8_t* )"REDUCE BRIGHT2");
    }
#endif
else
    {
     soft_pwm_dutycycle(100);
     }     }
return (EXIT_SUCCESS);
     }
```

APPENDIX 2

VEHICULAR ADHOC NETWORK

Vehicular Ad Hoc Networks (VANETs) are created by applying the principles of mobile ad hoc networks (MANETs) - the spontaneous creation of a wireless network for data exchange - to the domain of vehicles. They are a key component of intelligent transportation systems (ITS). While, in the early 2000s, VANETs were seen as a mere one-to-one application of MANET principles, they have since then developed into a field of research in their own right. By 2015, the term VANET became mostly synonymous with the more generic term inter-vehicle communication (IVC), although the focus remains on the aspect of spontaneous networking, much less on the use of infrastructure like Road Side Units (RSUs) or cellular networks.

VANETs support a wide range of applications - from simple one hop information dissemination of, e.g., cooperative awareness messages (CAMs) to multi-hop dissemination of messages over vast distances. Most of the concerns of interest to mobile ad hoc networks (MANETs) are of interest in VANETs, but the details differ. Rather than moving at random, vehicles tend to move in an organized fashion. The interactions with roadside equipment can likewise be characterized fairly accurately. And finally, most vehicles are restricted in their range of motion, for example by being constrained to follow a paved highway. Major standardization of VANET protocol stacks is taking place in the U.S., in Europe, and in Japan, corresponding to their dominance in the automotive industry.

In the U.S., the IEEE 1609 WAVE (Wireless Access in Vehicular Environments) protocol stack builds on IEEE 802.11p WLAN operating on seven reserved channels in the 5.9 GHz frequency band. The WAVE protocol stack is designed to provide multi-channel operation (even for vehicles equipped with only a single radio), security, and lightweight application layer protocols. Within the IEEE

Communications Society, there is a Technical Subcommittee on Vehicular Networks & Telematics Applications (VNTA). The charter of this committee is to actively promote technical activities in the field of vehicular networks, V2V, V2R and V2I communications, standards, communications-enabled road and vehicle safety, real-time traffic monitoring, intersection management technologies, future telematics applications, and ITS-based services.

In Europe, ETSI ITS G5 builds on a variant of the same radio technology with some adaptations operating on up to five reserved channels in the 5.9 GHz frequency band. The ETSI ITS G5 protocol stack is designed to provide multi-radio multi-channel operation, security, and a complex hierarchy of higher layer protocols integrating a broad range of basic services.

In Japan, ARIB STD-T109 builds on a variant of the same radio technology operating on a single frequency in the 700 MHz band. The protocol stack provides TDMA operation to split use between road side services and pure vehicle to vehicle communication.

VANET is a type of networks that is created from the concept of establishing a network of cars for a specific need or situation. VANETs have now been established as reliable networks that vehicles use for communication purpose on highways or urban environments. Along with the benefits, there arise a large number of challenges in VANET such as provisioning of QoS, high connectivity and bandwidth and security to vehicle and individual privacy.

APPENDIX 3

AMBIENT LIGHT SENSOR

In portable electronic products, reducing the power consumption to provide the user with increased battery life is one of today's critical design considerations. The liquid crystal display (LCD) and its associated back lighting are among the more (and frequently the most) power hungry loads in portable products. As a result, the use of an ambient light sensor (ALS) to optimize the operation of the backlight LEDs under a variety of environmental lighting situations is increasing while, at the same time, the preferred technology choices available to designers for sensing have shifted towards more integrated solutions.

Ambient light sensors are also called illuminance or illumination sensors, optical sensors, brightness sensors or simply light sensors. One very important application for ALS technology is cell phones. In a cell phone, the ALS enables automatic control of display backlight brightness over a wide range of illumination conditions from a dark environment to direct sunlight. With the ALS input, a microcontroller (MCU) or baseband processor increases or decreases the display brightness depending on the environment. This control dramatically improves visibility and reduces power consumption since LCD backlighting can draw as much as 51% of the power in the input standby mode. In addition, the ALS signal can be used to instruct the keypad LED driver to minimize keypad backlighting reducing up to 30% of the power in the input standby power mode. In a bright environment, the LED keypad brightness is reduced for minimal power consumption.

Designers have more technology choices for ambient light sensors including photoelectric cells, photodiodes, phototransistors, and photo ICs. Each technology has advantages and disadvantages. One of the key criteria for selecting an ALS is its ability to detect wavelengths visible to the human eye in the 380 to 780 nm range.

Both analog and digital ALS devices are silicon monolithic circuits with an integrated light-sensitive semiconductor photodiode—a PN junction which converts light into an electrical signal. Both technologies are available in small surface mount technology packages. Understanding the difference between analog and digital photo ICs is essential to selecting the proper ALS solution.

The analog ambient light sensor IC has an analog current output proportional to the incident light level. The IC combines the photodiode, signal amplification and control logic. The current source output is typically converted to a voltage by means of a simple load resistor. This voltage output is typically applied to either the input of an analog-to-digital converter interface or directly as an input to an LED driver IC equipped with auto-luminous control. Fundamental design advantages for the analog ALS include an output current that is proportional to the brightness of the environment and spectrum sensitivity similar to the human eye.

The typical digital output ambient light sensor has a 16-bit digital I2C output. In addition to amplification for the photodiode, the IC's integrated ADC converts the photo sensor's output to an I2C signal for direct connection to the I2C communication bus or base band processor. The I2C interface simplifies the circuitry in an application by removing the need for an external ADC. The digital ALS includes more integration than an analog ALS and can result in an overall cost savings as well as space savings on the printed circuit board.

APPENDIX 4

PUPILLARY LIGHT REFLEX

The pupillary light reflex or photopupillary reflex is a reflex that controls the diameter of the pupil, in response to the intensity (luminance) of light that falls on the retinal ganglion cells of the eye, thereby assisting in adaptation to various levels of lightness/darkness. A greater intensity of light causes the pupil to constrict (miosis/myosis) (allowing less light in), whereas a lower intensity of light causes the pupil to dilate (mydriasis, expansion). Thus, the pupillary light reflex regulates the intensity of light entering the eye.

The pupillary light reflex pathway has an afferent limb and efferent limb. The ganglion cells of the retina project bilaterally to the pretectal nuclei. The pretectal nuclei projects crossed and uncrossed fibers to the Edinger-Westphal nucleus, which gives rise to the preganglionic parasympathetic fibers. These fibers exit the midbrain and synapse with postganglionic parasympathetic neurons of the ciliary ganglion, which innervates the sphincter muscle of the iris.

In addition to controlling the amount of light that enters the eye, the pupillary light reflex provides a useful diagnostic tool. It allows for testing the integrity of the sensory and motor functions of the eye. Under normal conditions, the pupils of both eyes respond identically to a light stimulus, regardless of which eye is being stimulated. Light entering one eye produces a constriction of the pupil of that eye, the direct response, as well as a constriction of the pupil of the unstimulated eye, the consensual response. Comparing these two responses in both eyes is helpful in locating a lesion. For example, a direct response in the right pupil without a consensual response in the left pupil suggests a problem with the motor connection to the left pupil (perhaps as a result of damage to the oculomotor nerve or Edinger-Westphal nucleus of the brainstem). Lack of response to light stimulation of the right eye if both eyes respond normally to stimulation of the left eye indicates damage to the sensory input from the right eye (perhaps to the right retina or optic nerve). Emergency room physicians routinely assess the pupillary reflex because it is useful for gauging brain stem function. Normally, pupils react (i.e. constrict) equally. Lack of the pupillary reflex or an abnormal pupillary reflex can be caused by optic nerve damage, oculomotor nerve damage, brain stem death and depressant drugs, such as barbiturates. Normally, both pupils should constrict with light shone into either eye alone. On testing each reflex for each eye, several patterns are possible.

The pupillary response to light is not purely reflexive, but is modulated by cognitive factors, such as attention, awareness, and the way visual input is interpreted. For example, if a bright stimulus is presented to one eye, and a dark stimulus to the other eye, perception alternates between the two eyes (i.e. binocular rivalry). Sometimes the dark stimulus is perceived, sometimes the bright stimulus, but never both at the same time. Using this technique, it has been shown the pupil is smaller when a bright stimulus dominates awareness, relative to when a dark stimulus dominates awareness. This shows that the pupillary light reflex is modulated by visual awareness. Similarly, it has been shown that the pupil constricts when you covertly (i.e. without looking at) pay attention to a bright stimulus, compared to a dark stimulus, even when visual input is identical. Moreover, the magnitude of the pupil light reflex following a distracting probe is strongly correlated with the extent to which the probe captures visual attention and interferes with task performance. This shows that the pupillary light reflex is modulated by visual attention and trial-by-trial variation in visual attention. Finally, a picture that is subjectively perceived as bright (e.g. a picture of the sun), elicits a stronger pupillary constriction than an image that is perceived as less bright (e.g. a picture of an indoor scene), even when the objective brightness of both images is equal. This shows that the pupillary light reflex is modulated by subjective (as opposed to objective) brightness.

APPENDIX 5

WIRELESS ACCESS FOR VEHICULAR ENVIRONMENTS

Wireless Access for Vehicular Environments (WAVE) is an approved amendment to the IEEE 802.11 standard. WAVE is also known as IEEE 802.11p. WAVE is required to support the Intelligent Transportation Systems (ITS) applications in the short-range communications. The communication between vehicles (V2V) or between the vehicles and the roadside infrastructure (V2I) is relied on the band of 5.9 GHz (5.85-5.925 GHz). With the equipment installed in the car and on the road, WAVE supplies the real time traffic information, improves the safety of the transportation and reduces the traffic congestion. It also benefits for the transport sustainability. In 1992, Unite States started to research the Dedicated Short Range Communication (DSRC). It is the wireless communication protocol for the vehicles. United States, Europe and Japan are the main countries of research and application for DSRC. From 2004, the concentration of DSRC has been migrating to the IEEE 802.11 standard group. At first DSRC is based on the IEEE 802.11a, which focus on the low overhead operations. DSRC standard is based on the Wireless Fidelity (Wi-Fi) architecture. However, in order to support high speed moving vehicle and simplify the mechanisms for communication group, IEEE working group dedicate more efforts on the WAVE, which is the core of the DSRC. WAVE ensures the traffic information collection and transmission immediate and stable, and keeps the information security. Besides the IEEE 802.11p, WAVE also contains the standard of IEEE 1609, which is the upper layer standard. IEEE 1609 completes the WAVE by its sub detail standards, for instance, IEEE 1609.2 standard is responsible for the communication security; IEEE 1609.3 standard covers the WAVE connection setup and management. IEEE 1609.4 standard that is based on the IEEE 802.11p. Physical layer and Medium Access Control layer supplies operation of high level layers across multiple channels.

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