Yellow LED Border on Pedestrian Signal

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The National Center for Sustainable Transportation Undergraduate Fellowship Report

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**Introduction**

To protect pedestrians who wish to cross, typical intersections have pedestrian signals that display three signs: the first is the Don’t Walk signal, the second is the Walk signal, and the third will be the countdown indicating the time that a pedestrian has left to cross. The controls to the pedestrian signal will be a simple Walk-button, when pressed a walk signal will be pending. The mechanism of this traditional system is very outdated and lacks the feedback that pedestrians want before crossing.

The problems in the traditional system is its inability to provide feedback to the pedestrian. Pedestrians who press the Walk-Button do not know if the walk button is functioning, they also receive no feedback if the button has actuated and a walk signal is pending. This can stir agitation among pedestrians, because pedestrians do not trust that the Walk-Button has worked, they will push the Walk-Button several times and even cross the intersection on a Don’t Walk signal, this violation to the signal will be a dangerous risk.

In addition to the lack of feedback to the pedestrians, there is no indication for turning cars. During an unprotected right or left turn, cars must yield to any incoming cars and pedestrians, it is their responsibility to spot these pedestrians who are crossing and yield. In some cases, this will not happen, cars will not yield and will cut in front of pedestrians. This is a dangerous event waiting to occur. To potentially reduce conflicts, vehicles need to be able to know in advance that pedestrians are willing to cross.

To address these problems, the proposal is to install yellow LED borders to the pedestrian signals (YPB). The YPB will appear only when the Walk-Button is pressed. The YPB will immediately highlight the Don’t Walk signal and will continue displaying throughout the Walk Signal; the period when the countdown is initiated the YPB will not be very effective and the YPB will expire. This addition will have a minimal impact on the intersection’s functions. The operation is simple and is meant to be a supplement to the existing pedestrian signal.

This will be an extension of the YPB study done by Caltrans, their tests showed that the number of Pedestrian-Vehicle conflicts decrease by 17.1%, violations decreased by 28.4%, and extra button pushes decreased by 60.2%. This project extends Caltrans study to different location to test if the YPB is effective in all cases.
Expected Outcome

Violations

Pedestrians who push the button will see the YPB and will know that the walk signal is pending. This will increase the pedestrian’s patience on the corner and will wait until the Walk signal is active before crossing.

Conflicts

Cars that will make an unprotected turn will see the YPB. They will become aware and know in advance that the pedestrian wants to cross, seeing this they will yield to the pedestrian.

Extra Button Pushes

Since there is no indication or feedback that the Walk-Button has worked, pedestrians will become uncertain if a Walk signal is truly pending and if the Walk-Button is functional. The YPB will show pedestrian if the Walk-Button has actuated.

Procedure

To understand the behavior of cars and pedestrians in California as a whole, 5 locations were chosen throughout California to become test subjects: Eureka, Fort Bragg, Napa Valley, Albany, and Irvine. This array represents Northern California, Bay Area, and Southern California. The experimental intersection was specifically chosen to be along a California State Road, this became an advantage because we were able to coordinate this project with Caltrans.

The best method to approach this project was as a before and after study. At the start of each location, cameras were installed, one focused on each crosswalk and button. Recordings began from 6AM to 10PM (16 hours) for a period of at least 7 days. To obtain the regular traffic patterns of the intersection, recordings were the first task done. Later the YPB was installed and activated, the YPB was left to function for a period of at least 30 days, the objective of this was to acclimate the YPB into the general population. Afterwards the cameras resumed recording for another period of at least 7 days. Once completed, the cameras and data were brought back and a survey for the pedestrians was conducted at the same intersection. The YPB was left untouched.

In the meantime, video data was analyzed, recorded was violations, type of conflict and who yielded, no push scenarios, and extra push scenarios. In addition, the directions and quantities of the cars and pedestrian were recorded. We also recorded visibility and intersection type. After data entry was complete, Excel was used to sum up all the occurrences of each event.
Breaking Down the Data

Violations

Our analysis from Napa Valley in Figure 1 showed a positive response to the addition of the YPB. The Napa Valley Intersection was a small intersection meaning the appearance of the YPB was more visible to pedestrians. A factor that must be considered is the heavy pedestrian traffic consisting of mostly tourist and locals, so most of the pedestrians stayed in groups. So, if one individual decided to yield to the YPB, others would follow suit. After installing the YPB the percent of the population that has committed a violation decreased by an average of 1.7%.
Our analysis from Fort Bragg in Figure 2 also showed a positive response to the addition of the YPB. The intersections of Fort Bragg and Napa Valley have similar characteristics, they are small intersections, have surrounding local shops, and heavy amounts of tourist and local traffic. A visual inspection of the data shows that the YPB nearly eliminated pedestrian violations. The percentage of population that has committed a violation has dropped by an average of 0.42% after installing the YPB.
Unlike Napa Valley and Fort Bragg, the YPB increased the percent of pedestrian violations by an average of 8.6% shown in Figure 3. This was particularly interesting, but possible explanations why the YPB was not effective can be linked to Eureka having a much bigger intersection, as a result the narrow YPB will not be clearly visible to most pedestrians. Pedestrian foot traffic was lower compared to Fort Bragg and Napa Valley, due to this pedestrian were more likely to be solitary and considered their own benefit, as a result these Pedestrians did not take the YPB seriously. An explanation why the pedestrians have committed more violations after the installation of the YPB needs to be further explained and analyzed.
To conclude if cars were yielding more to pedestrians, we totaled the amount of times a car has yielded to a pedestrian and times that a car has not yielded to a pedestrian. Cars that saw the YPB would know, in advance, that a pedestrian is wishing to cross and therefore the car should yield. We predicted that more cars would be yielding to pedestrians.

In Figure 4 We analyzed the percentage of cars yielding to pedestrians and compared the before and after installation. Our results showed that there was no increase in cars yielding to pedestrians. Cars were yielding less, in Napa Valley there was a decrease in car yields by 6% and
in Eureka 11%. However, Fort Bragg showed a slight increase in car yields by 0.44%. This invalidates our original prediction as false.

Explanations why the YPB did not reduce pedestrian-vehicle conflicts:
1. From a driver’s perspective, the YPB was not visible because it was too small or dim.
2. Drivers do not pay attention to the pedestrian signal while waiting to turn.
3. Drivers are facing perpendicular to the YPB signal meaning zero visibility of the YPB.
4. Drivers do not understand the purpose of the YPB.
5. The YPB is not vibrant enough for drivers to comply.

Extra Pushes

![Graph showing extra pushes](image.png)

**Figure 5. Percent of Pedestrians who Push the Button More than once**

The YPB had a great effect on the number of pedestrians who pushed the button more than once. This indicates that pedestrians understood the YPB function as an indicator. The YPB gave the pedestrians confidence that the button has worked, and extra pushes are futile. In Figure 5, after the installation of the YPB extra pushes decreased 0.17% in Napa Valley and Fort Bragg. Decreasing the amount of pushes in an intersection will prolong the lifespan of the spring mechanism of the button.

Counting Extra Pushes was not an accurate task. Due to the limit video quality and resolution of the surveillance cameras, this count is not accurate. Many pedestrians who approach the Walk-Button press it several times with their thumb, this was not countable. Capturable results were only obtainable when the pedestrian showed clear limb movements. Sensors capable of recording the actuation of the button would improve this project's accuracy.
Survey

Pedestrians who have or will cross the intersection were asked to complete a survey regarding their opinion on the YPB. They were given a scale of 1 through 5. 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree.

1. The yellow border lights are noticeable. (Visibility)
2. The yellow border lights are effective in confirming the push button worked and that the walk symbol is coming soon. (Reliability)
3. The purpose of the yellow border lights is easy to understand. (Purpose)
4. Cars notice the yellow border lights and drive more cautiously when pedestrians are crossing. (Conflicting Resolution)
5. Overall, the yellow border lights are effective and a good addition to pedestrian signal heads. (Safety)

And at the end of the survey, pedestrians were free to add any sort of opinion.

Table 1. Average Survey Results from Eureka, Fort Bragg, Napa Valley, and Irvine. Of 67 Pedestrians.

<table>
<thead>
<tr>
<th>Visibility</th>
<th>Reliability</th>
<th>Purpose</th>
<th>Conflict</th>
<th>Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>3.8</td>
<td>3.7</td>
<td>2.5</td>
<td>3.9</td>
</tr>
</tbody>
</table>

1. Most pedestrians claimed that the YPB was clearly visible in broad daylight, however some pedestrians did not see the YPB until I pointed the YPB out to them. A select few were visually impaired and could not see the YPB.
2. After a quick explanation of the functions of the YPB, I asked if it was a reliable feedback mechanism, I received positive responses from the pedestrians because it’s simplicity.
3. When asked if the purpose was easy to understand, I got generally neutral responses, before I explained the purpose of the YPB to the pedestrians, several pedestrians did not understand what the YPB was used for. Because of this I believe this rating should be lower.
4. Almost all pedestrians believed that cars will not drive any safer around pedestrians. Some have claimed that cars do not follow the pedestrian signal and drive at their own risk.
5. Many pedestrians generally believed this was a good addition to the intersection. They loved the idea of the YPB because they were getting feedback to wait for the Walk signal.
Final Discussion

They YPB is an excellent indicator for pedestrians that the Walk-Button has worked, and a Walk-Signal is pending. The illumination of the YPB is instant feedback for pedestrians and highlights the Don’t Walk signal, increasing the pedestrian’s patience until it is safe to cross. Although it lacks the visibility towards vehicles, vehicles may find the YPB useful in low light conditions when pedestrian visibility is much lower.

There are limits to where we can install the YPB, the different attributes of the intersection will determine the varying degrees of effectiveness the YPB has. These factors that have been identified to be varied among the intersections and may have influenced the data. We must take into consideration these factors that determine how effective is the YPB

- We should consider how large the intersection is; the YPB is more visible in smaller intersection than larger ones.
- A longer acclimation period allows more vehicles and pedestrians to get more exposure to the YPB, they will understand and comply to the traffic signs more.
- Local drivers will recognize the YPB more than non-local drivers therefore understanding and utilizing the YPB more often.
- Large groups of pedestrians are more visible to vehicles than small groups. YPB might be more effective for one or two pedestrians.
- Lighting and weather conditions should be taken into consideration, while the YPB is more visible in low light conditions, glare from the sun and raining conditions will hinder the YPB’s effectiveness.
- Car behavior differs among intersection geometry and shape.
- Consider who the pedestrians are (age, income levels, occupation, what are they doing currently). Local demographics.

Pedestrian comments are always valuable in creating a safer intersection. Many believed it was a great idea to add the YPB because it added ornamentation to the intersection. However, some believed that the YPB wasn’t vibrant enough for pedestrians and vehicles, several suggested adding a flashing crosswalk or a flashing YPB. This is more illuminating towards vehicles and pedestrians and will encourage them to behave more safely. Pedestrians were worried that the YPB cost too much. They believed if it was “cost-effective” then the YPB would certainly be necessary. An extension of the project for the future should consider the cost of installing the YPB vs. benefits of installing the YPB. More importantly there continues to be a lack of feedback for visual impaired pedestrians. Two pedestrians that I have encounter were unable to see the YPB and considering how important is it for blind pedestrians to be able to cross safely, audio feedback is important as well.
Opinion

Further along the road we can push these efforts to different types of intersections. In Downtown Sacramento, there is a unique replacement for the Walk-Button, that is to replace all of them with sensors, so crossing is hands free. As I stood on the corner I couldn’t help but wonder if the sensors have detected my presence, without an actual button to press I would have to believe in the reliability of the inanimate sensors. After my experience, I realized that this would be a perfect opportunity to apply the YPB. Crossing pedestrians will use the YPB as feedback that your presence has been detected and a Walk-Signal is pending. Such additions like the YPB will greatly improve pedestrian’s patience and safety while traveling through Sacramento. This is a great potential project for the future.

Related Images

Figure 6. YPB at Laguna Beach
Figure 7. Camera Removal at Fort Bragg
Figure 8. Location Map
References

Stinger, Robert. Yellow LED Border on Pedestrian Signal An Evaluation to Determine the Effectiveness of Adding an Actuated Yellow LED Border to Standard Pedestrian Signals in the City of Redding, CA. California Department of Transportation. 2014